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Why Did Japan's TFP Growth Slow Down in the Lost Decade?

An Empirical Analysis Based on Firm-Level Data of Manufacturing Firms

FUKAO Kyoji
RIETI

KWON Hyeog Ug
Hitotsubashi University

RIETI
Research Institute of Economy, Trade & Industry, IAA
The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

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Why Did Japan's TFP Growth Slow Down in the Lost Decade? An Empirical Analysis Based on Firm-Level Data of Manufacturing Firms*

Kyoji Fukao**
Hitotsubashi University[a] and RIETI[b]

Hyeog Ug Kwon
Hitotsubashi University[c]

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**Correspondence: Kyoji 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

[a] Professor.

[b] Faculty fellow.

[c] Research Fellow.

1. Introduction

For more than a decade Japan has experienced a phase of unprecedentedly slow growth. The causes of this stagnation are the subject of considerable controversy. One group of scholars attributes the disappointing performance to a lack of effective demand and a liquidity trap caused by deflation.[1] The other group points out that there are several important supply-side factors, which reduced Japan's economic growth. For example, Japan's aging population and a gradual reduction in the statutory work-week have contributed to a slowdown in the growth of labor input.[2] Japan also experienced a decline in total factor productivity (TFP), which has important effects on economic growth not only because it reduces output growth by itself but also because it diminishes the rate of return to capital and discourages private investment.

Although there are as many different estimates for Japan's recent TFP growth as there are studies on this issue, most economists seem to agree that Japan's TFP growth substantially declined in the 1990s. Probably the most popular explanation of Japan's TFP growth slowdown is the "zombie" hypothesis. This states that in order to conceal their bad loans, Japanese banks have been keeping alive money-losing large borrowers by "evergreening" loans and discounting lending rates, although the chance that these borrowers will recover is slim (Caballero, Hoshi and Kashyap 2004). Because of the existence of zombie firms, the entry and growth of more productive firms are impeded and TFP growth slows down in industries infested by zombies (Ahearne and Shinada 2004). Japanese banks' bad loans are concentrated in non-manufacturing sectors, such as real estate, construction, commerce, and services, since a major cause of the bad loans is the burst of the land price bubble in the early 1990s. For example, according to Caballero, Hoshi, and Kashyap (2004) the share of total assets held by zombie firms in the total assets held by publicly traded firms was around 10 percent in the

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1 For example, see Yoshikawa (2003) and M. Fukao (2003).

2 On these supply side factors, see Hayashi and Prescott (2002).

manufacturing sector in the 1998-2002 period whereas it was around 30 percent in real estate and services, and 20 percent in construction and retail and wholesale (excluding the nine largest general trading companies).[3] Therefore, according to the zombie hypothesis, we would expect that the slowdown of Japan's TFP has been concentrated mainly in the non-manufacturing sector.

Contrary to this conjecture, the majority of recent studies on sectoral TFP growth have found that the slowdown in TFP growth was more serious in the manufacturing than in the non-manufacturing sector (Yoshikawa and Matsumoto 2001, Nishimura and Minetaki 2003, Miyagawa 2003, and Fukao et al. 2004). Given that the slowdown in TFP growth has been more severe in the manufacturing sector, there is a need for more detailed analysis of this trend and its causes. The present paper aims to examine the issue using firm-level data of the Ministry of Economy, International Trade and Industry's *Kigyo Katsudo Kihon Chosa* (Basic Survey on Business Activities by Enterprises), which cover most of Japan's manufacturing activities for the period of 1994-2001.

In our analysis, we concentrate on two issues in particular. First, we decompose TFP growth in the manufacturing sector into a within-firm effect, a reallocation effect, and an entry-exit effect. If firms compete with each other and entry barriers are low, high-productivity firms will enter the market and expand their production. This "metabolism" will enhance the TFP growth of the industry. Using the same micro-data of the *Kigyo Katsudo Kihon Chosa*, for the 1994-1998 period, Nishimura, et al. (2003) and Fukao and Kwon (2003) studied the productivity of firms and conducted productivity decompositions. In spite of the difference of the methodology adopted,[4] both studies found that the

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[3] We should note that their dataset, which is taken from the Development Bank of Japan Database covers a very limited percentage of economic activity in Japan. In the case of the non-manufacturing sectors, the coverage measured by the percentage of workers is less than 10%. We will discuss this issue in more detail in section 4.

[4] Nishihmura et al. adopted the methodology used by Griliches and Regev (1995) and Aw, Chen, and Roberts (2001). However, this methodology makes it difficult to separate the entry and exit effects and to identify the covariance effect (the definition of these effects is presented in section 3).

average TFP level of exiting firms was higher than that of staying firms in some industries. This "negative metabolism" may have slowed down TFP growth in the manufacturing sector. In this paper, using the updated data, we decompose TFP growth for the longer period of 1994-2001. By adopting the methodology used by Baily et al. (1992) and Forster et al. (1998), which has been commonly used in recent studies, we can compare our results with preceding studies on the US, a number of European countries, and Korea.

Second, we measure the gap in the TFP level between a group of high–TFP firms and a group of low–TFP firms and compare the characteristics of these two groups. We show that the TFP gap between the two groups is widening in many industries, including drugs and medicine, electronic data processing machines and electronic equipment, and motor vehicles, where R&D intensity is high and the internationalization of firms is more advanced (we measure internationalization by outward direct investment, the introduction of foreign capital, and procurements from abroad). We found that the high–TFP firms tend to have a higher R&D intensity, a higher degree of internationalization, larger scale, and a lower liability-asset ratio.

We also found that greater R&D intensity and internationalization have positive effects on firms' TFP growth. Similar to the "IT (information technology) divide" among workers, a new divide caused by R&D and internationalization seems to be emerging and growing in Japan's manufacturing industry.[5] We also show that the reduction of the number of workers by the low–TFP firms is not much

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Fukao and Kwon adopted the methodology used by Baily, Hulten and Campbell (1992) and Forster, Haltiwanger and Krizan (1998), which allows us to separate the entry and exit effects and identify the covariance effect. Another difference is that Nishimura et al. used value added as a measure of output whereas Fukao and Kwon used gross output as a measure of output.

[5] In several years, the METI Survey included questions on firms' introduction of information technology, such as the introduction of CAD (computer-aided design) and CAM (computer-aided manufacturing) systems and the use of LANs (local area networks) within a firm group. But the questions changed over time and the response ratio was not high. If we used these data in our

larger than the reduction by the high–TFP firms. The sales growth of the high–TFP firms is smaller than that of the low-TFP firms. Most high-TFP firms are also reducing their employment, probably because of organizational restructuring and the relocation of production abroad. This finding suggests that the "metabolism" is not working well in Japan's manufacturing sector.

The paper is organized as follows: in the next section, we present an overview of studies on Japan's TFP growth in the 1990s at the macro- and the industry-level. In section 3 we conduct a decomposition of TFP growth in the manufacturing sector and compare our results with preceding studies on other developed economies. In section 4, we examine the movement in the TFP level gap between the 75 percentile firm and the 25 percentile firm by industry and by year and show that the gap has widened in major industries. We also compare the characteristics, TFP growth, and growth rate of employment of the top firm-group and the bottom firm-group. In section 5, we summarize our results and discuss the policy implications of our findings.

2. Did TFP Growth Really Slow Down in the 1990s?

In this section we present a brief overview of the empirical research on Japan's TFP growth rate at the macro- and sectoral-levels in the 1990s. Table 2.1 summarizes the major results of preceding studies and compares the methodologies adopted. We placed studies with more pessimistic results (a large decline in TFP growth during the 1990s when compared with the 1980s) at the top of the table and placed those with more optimistic results at the bottom of the table.

Insert Table 2.1

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regression analysis, our sample size would be drastically reduced. For this reason, we do not analyze the effect of information technology on TFP growth in this paper.

The table shows that there are substantial differences among the studies in the estimated decline in TFP growth from the 1980s to the 1990s. Hayashi and Prescott (2002) and Yoshikawa and Matsumoto (2001) obtained the most pessimistic results, suggesting that the TFP growth rate at the macro-level declined by more than 2 percentage points from the 1980s to 1990s. 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 2 percentage-point decline in TFP growth will cause a 3 percentage-point (=2+2/3) decline in the balanced growth rate. In contrast with these pessimistic results, several studies, such as Jorgenson and Motohashi (2003) and Kawamoto (2004), found that the TFP growth in the 1990s was not substantially smaller than in the 1980s.

If we carefully compare the methodologies adopted and the datasets used, we can see what causes the great variation in results and try to obtain a more accurate measure of TFP trends.[6] For example, Hayashi and Prescott (2002) do not take account of changes in the quality of labor. As the improvement in the quality of labor in Japan has slowed in recent years, their study overestimates the decline in TFP growth by neglecting such changes. Moreover, they do not take account of changes in capacity utilization. This factor also contributed to their overestimation of the decline in TFP growth.[7]

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[6] Such a comparison is provided by Inui and Kwon (2004), who used the original datasets for factor inputs, gross outputs, and income and cost shares used in the studies by Hayashi and Prescott (2002), Jorgenson and Motohashi (2003), Cabinet Office (2002), and Fukao et al. (2003) and examined what differences in the datasets and methodologies were responsible for the large discrepancies among the results for TFP growth.

[7] When the capital stock is not fully utilized, the marginal productivity of capital might be different from the cost of capital. As Morrison (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 (2004) estimated variable cost functions and made adjustments for 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 from 1994 to 2001 in many manufacturing sectors.

Finally, in their growth accounting they use real GNP instead of GDP as an output measure and include Japan's net external assets in the capital stock. In GNP statistics, the rate of return to domestic capital is in gross terms and includes capital depreciation. On the other hand, the rate of return to Japan's external assets is recorded in net terms. 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 accumulated a huge amount of net external assets in the 1990s,[8] Hayashi and Prescott seem 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.

A more optimistic result was obtained by Jorgenson and Motohashi (2003). They found that Japan's TFP growth rate declined from 0.96% in 1975-90 to 0.61% in 1990-95 but then accelerated again to 1.04% in 1995-2000. This optimistic result is partly based on their assumption on the deflator for information technology (IT) products. They assumed that the relative price of IT products compared with non-IT products in Japan has declined in a similar fashion as in the US. They used their own IT product deflator, 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 estimate of the GDP growth rate and the TFP growth rate.[9]

Jorgenson and Motohashi adopt this procedure because they believe that quality improvements

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[8] From the end of 1991 to the end of 2001, Japan accumulated net external assets of 117.7 trillion yen (*Annual Report of National Accounts* (various years), Economic and Social Research Institute, Cabinet Office, Government of Japan.)

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

in IT products are not sufficiently taken into account in Japan's price statistics.[10] Although the authors raised an important question, it seems 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 actual quality improvements in IT products.

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

Another important study with optimistic results is that of Kawamoto (2004). He found that the TFP growth rate for Japan's private sector in 1990-1998 was 1.9%, which is identical with the TFP growth rate he obtained for 1980-1990. This optimistic result is mainly based on the following two factors. First, following Basu and Kimball (1997), Kawamoto assumed that the sole cost of changing the workweek of capital is a "shift premium" — firms need to pay higher wages to compensate employees for working overtime — and used changes in hours per worker as a proxy for unobserved changes in both labor effort and capital utilization. Second, he found that there are large diseconomies of scale in the non-manufacturing sector. The estimated returns-to-scale coefficient in the non-manufacturing sector was 0.65. Since the production share of the non-manufacturing sector expanded rapidly in the 1990s, he attributed a substantial part of the productivity growth slowdown to the diseconomies of scale instead of to the slowdown in technological progress.[11]

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

[11] It is interesting to note that even Kawamoto (2004) finds that there was a considerable slowdown in TFP growth in the durable manufacturing sector in the 1990s (see Table 2.1).

Despite the boldness of his assumption on the "shift premium" he does not validate its applicability to the Japanese economy. Although his findings on the large diseconomies of scale in the non-manufacturing sector seem to be inconsistent with the actual existence of large firms, he does not confirm this finding using firm-level data. Kawamoto raised very interesting issues; but it seems that we need more empirical research to verify his surprising results.

Table 2.1 also shows another important point, which we would like to stress. Many studies, such as Yoshikawa and Matsumoto (2001), Nishimura and Minetaki (2003), Miyagawa (2003), Fukao et al. (2004), and Kawamoto (2004) found that the slowdown in TFP growth in the manufacturing sector was more severe than that in the non-manufacturing sector, even if we take account of changes in capacity utilization.[12] While recent studies on Japan's economic stagnation, such as those on zombie firms (Caballero, Hoshi, and Kashyap 2004, and Ahearne and Shinada 2004), have tended to focus on the non-manufacturing sector, we need more research on why TFP growth slowed in the manufacturing sector.

To sum up the above brief survey, the decline in TFP growth in Japan during the 1990s seems to be more modest than suggested by Hayashi and Prescott. And although the majority of studies show

[12] Cabinet Office (2002) and Hattori and Miyazaki (2000) obtain opposite results in their studies. Based on growth accounting at the 2-digit industry level, these studies 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 two factors are responsible for the different results. Firstly, the Cabinet Office and Hattori and Miyazaki take account neither of changes in capacity utilization in non-manufacturing sectors nor of changes in the quality of labor. Secondly, in order to evaluate each factor's contribution to output growth, the Cabinet Office study and the Hattori and Miyazaki study use that factor's distribution share, whereas Nishimura and Minetaki (2003) and Fukao et al. (2004) use 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 and the Hattori and Miyazaki study arrive at a higher TFP growth in the manufacturing sector.

that there was some decline in TFP growth in Japan, we need more empirical research to purify the Solow residuals and investigate the extent and nature of the slowdown in TFP growth. Another important point is that many studies found that the slowdown in TFP growth in the manufacturing sector was more severe than that in the non-manufacturing sector.

3. Decomposition Analysis of TFP Growth in the Manufacturing Sector

As Baily, Hulten and Campbell (1992) and Foster, Haltiwanger and Krizan (1998) have shown in their productivity decomposition analyses, the start-up of productive establishments and the closure of unproductive establishments substantially contributed to US TFP growth. As Figure 3.1 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 widened in the 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. We examine these issues in this section.

We use the firm-level panel data underlying the *Kigyo Katsudo Kihon Chosa* (Basic Survey of Japanese Business Structure and Activities) conducted annually by the Ministry of Economy, Trade and Industry (METI).[13] The survey covers all firms with at least 50 employees and 30 million yen of paid-in capital in the Japanese manufacturing, mining and commerce sectors. We use the data for manufacturing firms. Our data cover the period 1994–2001. After some screening of the data our unbalanced panel data consists of 110,856 observations.[14]

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[13] The compilation of the micro-data of the METI survey was conducted as part of the project "Foreign Direct Investment in Japan" at the Cabinet Office, Government of Japan.

[14] We exclude all observations with zero values for material costs, compensation of employees, and tangible fixed assets from our data set. We also exclude observations with an extremely high or low capital-labor ratio. Through this screening process, the number of observations declined by about

Insert Figure 3.1

Following Good, Nadiri, and Sickles (1997) and Aw, Chen, and Roberts (1997), we define the TFP level of firm *f* in year *t* in a certain industry in comparison with the TFP level of a hypothetical representative firm in year 0 in that industry by[15]

$$\begin{aligned} \ln TFP_{f,t} &= (\ln Y_{f,t} - \overline{\ln Y_t}) - \sum_{i=1}^{n} \frac{1}{2}(S_{i,f,t} + \overline{S_{i,t}})(\ln X_{i,f,t} - \overline{\ln X_{i,t}}) \\ &+ \sum_{s=1}^{t} (\overline{\ln Y_s} - \overline{\ln Y_{s-1}}) - \sum_{s=1}^{t}\sum_{i=1}^{n} \frac{1}{2}(\overline{S_{i,s}} + \overline{S_{i,s-1}})(\overline{\ln X_{i,s}} - \overline{\ln X_{i,s-1}})] \end{aligned} \qquad (2.1)$$

where $Y_{f,t}$, $S_{i,f,t}$, and $X_{i,f,t}$ denote the gross output of firm *f* in year *t*, the cost share of factor *i* for firm *f* in year *t*, and firm *f*'s input of factor *i* in year *t*, respectively. The variables with an upper bar denote the industry average of that variable. We assume constant returns to scale. As factor inputs, we take account of capital, labor and real intermediate inputs. For details on the definition and source of each variable, please see Appendix A.[16] Because of the limitation of the data we cannot take account of the change in labor quality in our TFP analysis. It is probably because of this difference that we arrive at a higher TFP growth estimate than the industry-level result in Fukao et al. (2004). We also

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0.8% in comparison with our original set of observations.

[15] We divide the manufacturing firm data into 30 sets of different industries and evaluated each firm's relative TFP level in relation to the industry average.

[16] The approach used here also tries to deal with the following shortcomings of Nishimura et al. (2003). First, Nishimura et al. used value-added instead of gross output as their output measure. As Domar (1961) has shown, value-added-based TFP may differ from gross-output-based TFP, which is commonly used in theoretical and empirical studies. Second, Nishimura et al. derived real value-added using the value-added deflator of the SNA statistics. However, this deflator is based on a relatively aggregated industry classification, so that their approach risks underestimating the TFP growth of firms in high-tech industries, where output prices decline more rapidly. Compared with their approach, we use the more disaggregated deflator of *the Wholesale Price Statistics* and *Corporate Goods Price Statistics*.

assume that working hours and the capacity utilization rate at each firm are identical with those of the industry average.

We define the representative firm for each industry as a hypothetical firm whose gross output as well as input and cost share of all production factors are identical with the industry average. The first two terms on the right hand side of equation (2.1) denote the gap between firm *f*'s TFP level in year *t* and the representative firm's TFP level in that year. The third and the fourth term denote the gap between the representative firm's TFP level in year *t* and the representative firm's TFP level in year 0. Therefore, $lnTFP_{f,t}$ in equation (2.1) denotes the gap between firm *f*'s TFP level in year *t* and the representative firm's TFP level in year 0.

Adopting the methodology used by Baily, Hulten and Campbell (1992) and Forster, Haltiwanger and Krizan (1998), we define the industry-level TPF of a certain industry in year *t* by

$$\ln TFP_t = \sum_{f}^{n} \theta_{f,t} \ln TFP_{f,t} \qquad (2.2)$$

where $\theta_{f,t}$ denotes firm *f*'s sales share in year *t* in that industry. Then, as Forster, Haltiwanger and Krizan (1998) showed, we can approximate the manufacturing sector's TFP growth from year τ to year *t*, $lnTFP_t - lnTFP_\tau$, by the sum of the following five factors.

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

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

Covariance effect: $\sum_{f \in s} \Delta\theta_{f,t} \Delta \ln TFP_{f,t}$,

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

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

where *S* is the set of firms that stayed in that industry from year *τ* to year *t*, *N* is the set of newly entered firms and *X* is the set of exited firms.[17] *TFP* with an upper bar denotes the industry-average TFP level.

Our decomposition result for the period from 1994 to 2001 is reported in Table 3.1. It has been pointed out in preceding studies that decomposition results are affected by business cycles.[18] In order to take this into account, we also conducted our decomposition on an annual basis. The results are reported in Table 3.2. The switch-in and switch-out effects in Tables 3.1 and 3.2 denote the contribution of those firms that moved from one industry to another to the industry average of the TFP level. Table 3.3 compares our results with those of preceding studies for the US, South Korea, and a number of European countries. We should note that our decomposition and the decomposition for the European countries are based on firm-level data whereas the studies on the US and South Korea are based on establishment-level data.

Insert Tables 3.1, 3.2, and 3.3

Our major findings are as follows.

1. Both the exit effect (excluding the switch-out effect) and the switch-out effect for the manufacturing sector as a whole from 1996 to 2001 were negative and substantially contributed to the decline in TFP growth in the manufacturing sector (Table 3.1). The negative exit effect

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[17] As already mentioned, the METI survey covers only those firms in the manufacturing and the commerce sectors that are of a size that is greater than the cut-off level. Thus, our data on firms that "exited" includes firms which shrunk or changed their main business from the manufacturing sector to other sectors. We should also note that firms, which were merged and became part of another firm, are treated as "exited."

[18] In 1990-2002, there were three official business cycle peaks, February 1991, May 1997, and November 2000, and three troughs, October 1993, January 1999, and January 2002. Official peak and trough dates are available in *Business Cycle Reference Dates*, Economic and Social Research Institute, Cabinet Office, Government of Japan (<http://www.esri.cao.go.jp/>).

means that the average TFP level of exiting firms was higher than that of staying firms. Even when we decompose TFP growth on an annual basis, we find that the exit effect (including the switch-out effect) was negative for all seven years (Table 3.2). It is interesting to note that this negative exit effect is not special to Japan. Italy and the Netherlands also experienced a negative exit-effect (including the switch-out effect) in 1987-1992.

2. Both the entry effect (excluding the switch-in effect) and the switch-in effect were positive in almost all the industries (Table 3.1). Moreover, the entry effect (including the switch-in effect) was positive in both the upturn and the downturn periods (Table 3.2). But probably as a result of the low entry rate, the size of the entry effect was not large. The entry effect (including the switch-in effect) increased the TFP level of the manufacturing sector by 1.13% in 1994-2001, which is much smaller than Korea's entry effect in 1990-98 (15.60%) and Italy's entry effect in 1987-1992 (5.12%) (Table 3.3).
3. The redistribution effect – that is, the between effect plus the covariance effect – was positive (0.33%) but relatively small in comparison with that for the other countries (with the exception of the Netherlands) (Table 3.3).
4. The within effect, i.e. the effect of TFP growth within staying firms, was the largest factor among all the effects (Table 3.1). Moreover, this effect changed pro-cyclically (Table 3.2).

The above result suggests that in order to accelerate TFP growth in Japan's manufacturing sector it is important to promote new entries and to make both the exit process and the process of resource allocation more efficient. 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 resolution forms an integral part of any attempt to raise the TFP growth rate.

Unfortunately, the METI survey does not include detailed information on firms' financial affairs, such as each firm's main bank or its interest payments for borrowing from banks. The only available information is firms' total liability. Using regression analysis based on pooled 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.[19] That is, in industries where the liability-asset ratio is high, the exit effect tends to be negative. There is a possibility that the malfunction of Japan's financial system contributes to the negative exit effect by allowing zombie firms to survive while high-productive small firms fail as a result of a credit crunch.

4. Inter-firm Differences in TFP

Following Japan's recent economic recovery from the trough of January 2002, it has been argued in newspapers and business journals that differences between firms in terms of their business performances are increasing. In the case of the manufacturing sector, while large and internationalized firms considerably managed to improve their performance, the performance of small and less internationalized firms continued to stagnate.

Figure 4.1 compares the diffusion index (D.I.) of business conditions ("favorable" minus "unfavorable") for large and small manufacturing firms. The figure shows that the gap of the D.I. between large and small firms has increased in recent years. While it is not unusual for this gap to widen during a recovery, the recent extent is the largest in the past thirty years. Figure 4.2 compares the labor productivity (in natural logarithm) of large and medium-sized firms on the one hand and small firms on the other. Again, the gap has widened to an unprecedented level.

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[19] For this cross-industry regression, Fukao and Kwon (2003) divide the manufacturing firm data into 58 sets of different industries and estimated the "exit effect" in each industry. Their result is also reported in Fukao et al. (2004).

These trends suggest that there is a group of firms that has been excluded from recent innovations and their stagnation hinders TFP growth in the manufacturing sector. In this section, we examine this issue. Using the micro-data of the METI survey we measure the gap in the TFP level between a group of high–TFP firms and a group of low–TFP firms and compare the characteristics of these two groups.

Insert Figures 4.1 and 4.2

To date, the number of studies on the dispersion of productivity among Japanese firms is very limited. Using the same firm-level data of the METI survey, Morikawa (2004) found that there is no rising trend in the standard deviation of the current-profit/sales ratio or of the current-profit/total-asset ratio of manufacturing firms in the period of 1991-2001. But he also found that the standard deviation of sales growth substantially increased in 1991-2001.

Using firm-level data of publicly traded firms in the Development Bank of Japan (DBJ) database, Shinada (2003) studied the technology gap between a group of firms at the technology frontier and other firms in the manufacturing and the non-manufacturing sector for the period 1982-2000. He found that the technology gap widened in the 1990s when compared with the 1980s, especially in the electrical machinery and equipment industry and in the automobile and auto-parts industry. From the viewpoint of the TFP growth slowdown in the 1990s, Shinada's finding is very interesting.

A major shortcoming of Shinada's analysis is that his dataset covers only a limited range of activities in the Japanese economy. Compared with the number of all workers in each industry in 2001, which we obtain from the *Establishment and Enterprise Census for 2001* conducted by the Japanese Ministry of Public Management, Home Affairs, Posts and Telecommunications, the total of the number of workers employed by the firms covered by the DBJ Database in 2001 is very small. In the case of the manufacturing sector, the DBJ Database covers 1,716 firms, accounting only for 24.7% (=2,461,384/9,960,231) of the workforce overall. The coverage in the construction sector, in terms of workers employed, is only 9.6%, while in the retail and wholesale sector (including eating and drinking places) it is 5.9%, in the real estate sector it is 8.1%, and in the service sector it is 5.5%. The METI survey covers a much larger number of firms: in the case of the manufacturing sector, the survey covers 13,470 firms and 51.4% of the entire workforce. The coverage is still not complete, but much better than in the case of the DBJ Database.

Table 4.1 shows how the TFP level gap (in natural logarithm) between the 75 percentile firm and the 25 percentile firm changed over time in each industry in the period 1994-2001. We used the same TFP data as in section 3. In the table, we placed industries in which the gap grew by a large margin at the top of the table and those in which it declined by a large margin at the bottom. The widening of the gap was particularly pronounced in drugs and medicine, petroleum and coal products, and electronic data processing machines and electronic equipment. Since the gap widened in large-sized industries, such as electronic data processing machines and automobiles, the average gap of all the manufacturing industries, which is shown at the bottom of Table 4.1 also increased.[20] In the case of the average gap for the whole manufacturing sector, the widening occurred after 1997, the year of Japan's financial crisis.

According to preceding studies on other countries, the TFP gap moves counter-cyclically over time (Bartelsman and Doms 2000). In 2001, the D.I. of business conditions for the whole manufacturing sector was -41.8%, which is worse than the D.I. in 1994, -26.3. Therefore, there is some risk that the TFP gap in 2001 is partly exaggerated by the recession. But even when we compare the TFP gap in 2000, when the D.I. was as high as -11, with the TFP gap in 1994, we can observe an

[20] To calculate the average value, we used each industry's total sales as the weight.

increase in the TFP gap in many industries.[21]

Insert Table 4.1

Are there any common characteristics among the industries where the TFP gap widened? We compared several industry characteristics which we expect to have a close relationship with the productivity of firms. Figure 4.3 shows that the TFP gap widened mainly in industries with a high R&D intensity and where the internationalization of firms is more advanced (we measure internationalization by outward direct investment, the introduction of foreign capital, and procurements from abroad).[22, 23] There are statistically significant positive correlations between the change of the TFP gap and three of the four characteristics, the R&D/sales ratio, the amount of materials purchased from abroad/total amount of materials purchased, and the percentage of firms owned by foreign firms. The correlation between the change in the TFP gap and the stock of direct investment abroad/total assets was positive but statistically insignificant.

Insert Figure 4.3

[21] In order to check the robustness of these results, we also calculated the change of the TFP gap for the period 1995-2001. The results are displayed in Table 4.1 and are not qualitatively different.

[22] As measures of industry characteristics, we used average values of pooled firm-data for each industry.

[23] The petroleum and coal products industry seems to have different characteristics from the other industries where the TFP gap widened. In this industry, the R&D ratio and the stock of direct investment abroad/total assets are very low. Probably we can explain the widening of the TFP gap in this industry by the deregulation of 1997. Until 1997, imports of specific kinds of petroleum refined products were regulated through a system of registration of importers, the Provisional Measures Law on the Importation of Specific Kinds of Petroleum Refined Products. The gap between winners and losers may have widened as a result of fierce competition after deregulation.

Next, we compare the characteristics, TFP growth, and the growth rate of sales and employment of the top quartile firm-group and the bottom quartile firm-group. For each year and for each industry, we select firms, whose TFP level is higher than the 75 percentile TFP level, as the top-quartile firms. Panel A of Table 4.2 compares the pooled data of all the top-quartile firms with the pooled data of all the bottom-quartile firms. The comparison between the top and the bottom firm-group shows that the top firm-group is more internationalized than the bottom firm-group. The top-quartile firms show a higher R&D intensity and the ratio of their number of non-production workers/number of all workers is 11 percentage points higher than for the bottom-quartile firms. The top-quartile firms are also on average 78% (= (exp (5.484-4.906)-1)*100) bigger (measured by the number of workers) and have a liability/total asset ratio that is 16 percentage points lower. All these differences are statistically significant.

Insert Table 4.2

It is also important to note that a large percentage of top-quartile firms is owned by other domestic firms, and this percentage considerably increased after the currency crisis of 1997. In the case of the pooled data of 1998-2001, 41 percent of top-quartile firms were majority-owned either by a domestic or a foreign firm.

Table 4.2 also compares the performance of the top–quartile firm-group with the bottom–quartile firm-group. The bottom firm-group exhibits a higher growth rate of both TFP and sales. This phenomenon can probably be explained either by a convergence mechanism or by temporary shocks. Table 4.2 also shows that the bottom-quartile firms reduce their employment more rapidly and have a lower return-on-asset ratio.

Panel B of Table 4.2 compares the top-quartile firms with the bottom-quartile firms at the industry level for six relatively large industries, where the TFP gap substantially widened. We can confirm that almost all the above differences between the top and the bottom firm group hold in each industry. Panel B also provides a number of further insights. The gaps in R&D intensity, the percentage of foreign-owned firms, and in firm size between the top firms and the bottom firms are largest in the drugs and medicine industry. The gap in the ratio of the stock of direct investment abroad to total assets is largest in the automobile industry, while the gap in the percentage of domestically-owned firms is largest in the electronic data processing machines and electronic equipment industry. Finally, the gap in the number of non-production workers/number of all workers is largest in the communication equipment and related products industry. These diverse patterns of gaps among industries suggest that the main factor determining the advantage of the top firms is different for different industries.

Our findings, so far, suggest the following tentative explanation for the recent widening of the TFP gap among manufacturing firms. In the 1990s, many Japanese firms, especially large firms in high-tech and globalized industries, further pressed ahead with internationalization and intensified R&D efforts in order to improve their productivity. In such industries, the reorganization of relationships among firms also proceeded through M&As. On the other hand, some firms, mainly relatively small and borrowed-up firms, could not follow this innovation process and were left behind in their productivity.

It is important to note that the causality behind these relationships could be the reverse. In other words, the relationship may result not from the fact that characteristics such as a high R&D intensity and a high degree of internationalization enhance firms' productivity, but rather that only high-productivity firms are able to conduct intensive R&D and internationalize and are targeted in mergers and acquisitions. In order to examine this issue, we investigated the determinants of TFP growth using our firm-level data. Table 4.3 shows descriptive statistics of the variables used for the regression analysis. The regression results are reported in Table 4.4.[24]

Insert Tables 4.3 and 4.4

We found that greater R&D intensity and internationalization have a positive effect on firms' TFP growth. We also found that larger firms, firms owned by another domestic firm, firms with a higher percentage of non-production workers in total workers and a lower liability-asset ratio have higher TFP growth. These findings seem to support our hypothesis that a new divide caused by R&D, internationalization, and reorganizations of relationships among firms through M&As is emerging and growing in Japan's manufacturing industry.

Our result also shows that firms with a lower TFP level tend to have higher TFP growth. As we have already argued, we can explain this phenomenon either by a convergence mechanism or by temporary shocks or noise. Some firms have lower TFP because of a temporary negative shock or observation noise but the effect of the shock or the noise disappears in the next period.

In order to examine whether the determinants of TFP growth have changed in the estimation period, we divided the period of 1995-2001 into two sub-periods, 1995-1997 and 1998-2001, and estimated specification (4) of Table 4.4 for each sub-period. We did not find considerable changes in the estimated coefficients except for a decline of the absolute value of the coefficient on the TFP level (the beta-convergence coefficient). Running a regression for 1995-2001 with an additional cross term of a dummy variable for 1998-2001 period and the TFP level in year *t*-1, we tested whether the there

[24] Column 5 of Table 4.4 reports the results for the "long difference" estimator. In order to check the robustness of our regression results based on annual TFP growth, we regressed the TFP growth from 1994 to 2001 on the variables for 1994. The results we obtained were qualitatively similar to those based on annual TFP growth.

was a decline in the absolute value of the beta-convergence coefficient. The result is reported in Table 4.5. We found that the absolute value of the negative beta-convergence coefficient declined significantly in the later sub-period. In the case of specifications (A) and (B) in Table 4.5, the coefficient on beta-convergence declined from -0.386 to -0.235. These values mean that the half-life of the GDP gap increased from 1.42 years (=ln(0.5)/ln(1-0.386)) in 1995-1997 to 2.59 years (=ln(0.5)/ln(1-0.235)) in 1998-2001. We also ran this regression for each industry and found that in many industries, the absolute value of the beta-coefficient declined.

Insert Table 4.5

The slowdown of the beta-convergence mechanism seems to have contributed to the widening of the TFP dispersion among firms. Until the middle of the 1990s, large firms and many small firms were closely tied by sub-contracting and *keiretsu* relationships and it seems that through this network advanced technologies of assemblers and key-component producers were transferred to lower-tier small suppliers.[25] But as large firms relocated their production abroad and rationalized their procurement processes, this technology-transfer mechanism probably slowed down.

According to our interview, Toshiba now makes almost all decisions on procurements of parts and components for all of its three notebook PC factories at its headquarters in Tokyo taking a global viewpoint. Toshiba's PC factories are located in Hangzhou, China, the Laguna Technopark in the Philippines and in Ome, near Tokyo. In the case of Toshiba Hangzhou, the major suppliers are Japanese, Taiwanese, and Korean affiliates in China and firms located in East Asia. Another good

[25] Using plant-level data for Japan's automobile industry for 1981-1996, Ito (2002) found that parts producers, which were located close to assembler's plant, tended to achieve higher TFP growth than other parts producers.

example is Nissan Motors. Based on its "Revival Plan" Nissan Motors drastically reduced the number of its suppliers and introduced more competition into its procurement process.

So far, we found that compared with firms with low TFP, firms with high TFP tend to be more R&D intensive and more internationalized. High-TFP firms also typically are larger and have a lower liability/total asset ratio. These differences further raise the TFP growth rate of the firms with a high TFP level. On the other hand, we also found a mechanism of convergence, which is probably caused by technology spillovers and catching up. From a quantitative viewpoint, how much do these two factors contribute to the dispersion of TFP among firms? In order to answer this question we need a model.[26] Let us assume that specification (4) of Table 4.4 is the correct model and the dynamics of firms' TFP level are determined by this equation.[27] Then, the larger the dispersion of firms'

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[26] On theories on the dispersion of firms' TFP level, see Baily et al. (1992) and Bartelsman and Doms (2000).

[27] If we assume that all firm characteristics except the TFP level are exogenously determined and constant, then the unconditional standard deviation of the TFP level among firms depends on three factors. Suppose that firm i's TFP level (in natural logarithm), $y_{i,t}$ is determined by the following dynamics.

$$y_{i,t+1} - y_{i,t} = -\beta y_{i,t} + \sum_{i=1}^{n} \gamma_i x_i + u_{i,t}$$

where $x_{j,i}$ denotes firm i's j'th characteristic. $u_{i,t}$ denotes a random shock. We assume that β satisfies $0<\beta<1$. Then we have

$$y_{i,t+1} = \sum_{\tau=0}^{\infty}\left[(1-\beta)^{\tau}\sum_{i=1}^{n}\gamma_i x_i\right] + \sum_{\tau=0}^{\infty}(1-\beta)^{\tau} u_{i,t-\tau} \ .$$

The unconditional standard deviation of the TFP level among firms is given by

$$\sigma(y) = \frac{1}{\beta}\left(\sigma(\sum_{i=1}^{n}\gamma_i x_i) + \sigma(u)\right)$$

where σ denotes the standard deviation of each variable.

Unfortunately, it seems unrealistic to assume that firms' characteristics except the TFP level are exogenously determined and constant. For this reason, we did not calculate the unconditional standard deviation of the TFP level.

characteristics, the larger will be the dispersion of the TFP level. Similarly the larger the standard deviation of the random shock or the smaller the absolute value of the beta-convergence coefficient, the larger will be the unconditional standard deviation of the TFP level.

In Table 4.6 we compared the size of the random shock, the effect of the beta convergence and the divergence effect caused by firms' characteristics. Table 4.6 shows that the disparity of firms' characteristics between the top quartile firm-group and the bottom quartile firm-group continuously worked to widen the TFP gap between the two groups by about 1% a year. On the other hand, the beta-convergence mechanism became weak in the period 1998-2001. There was no considerable change in the size of random shocks.

Insert Table 4.6

Next we show the degree of persistence of firms' relative productivity level among continuing firms. Table 4.7 shows the transition matrix. According to this table, the degree of persistence is very high. More than one-half of firms which originally ranked in the bottom three deciles in 1994 remained in the same three deciles in 2001. Similarly more than one-half of firms which originally ranked in the top three deciles in 1994 remained in the same three deciles in 2001.[28]

Insert Table 4.7

If the bottom firms reduce employment or exit and the top firms stay and expand employment, the macro-level TFP will increase. To conclude this section, we analyze this "metabolism" issue.

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[28] In the case of plant-level TFP in the US manufacturing sector, several studies have shown that the degree of persistence is very high (Baily et. al 1992, Bartelsman and Doms 2000).

Table 4.8 compares firms' employment growth and firm "exits" between the top firm-group and the bottom firm-group. The table shows that the reduction of the number of workers by the low–TFP firms is not much larger than the reduction by the high–TFP firms. Thus, while we might expect that high-TFP firms would be expanding employment and output, this is not the case. The likely reasons are that high-TFP firms are in the process of restructuring their activities and many of them are relocating production abroad. This finding suggests that the "metabolism" – the expansion of employment and output by high-TFP firms and the contraction or exit of low-TFP firms – is not working well in Japan's manufacturing sector.

Insert Table 4.8

5. Conclusion

Our results can be summarized as follows. Using firm-level data of the METI survey, we examined why Japan's TFP growth slowed down in the manufacturing sector. Our decomposition analysis showed that the exit effect 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 was higher than that of staying firms. We also found that although both the entry effect and the redistribution effect were positive, they were very small when compared with those in other countries. This "low metabolism" seems to have slowed down the TFP growth of the manufacturing sector.

In section 4 we measured the gap of the TFP level between a group of high–TFP firms and a group of low–TFP firms and compared the characteristics of these two groups. We found that the TFP gap between the 75 percentile firm and the 25 percentile firm is widening in many industries where R&D intensity is high and the internationalization of firms is more advanced. The TFP gap seems to be widening because high–TFP firms tend to have a higher R&D intensity, a higher degree of internationalization, are larger, and have a lower liability-asset ratio, and these characteristics enhance their productivity further. It is also important to note that a large percentage of top–quartile firms are owned by other domestic firms. In the case of the pooled data for 1998-2001, 41 percent of top quartile firms were majority owned either by a domestic a foreign firm. We also found that the catching-up mechanism of low-productive firms slowed down after 1997.

Appendix A: Definition of Variables Used in the Econometric Analysis and Data Sources

We used each firm's total sales and cost of intermediate inputs as nominal gross output and nominal intermediate input data. We derived the deflator for each industry's gross output and intermediate input from the Bank of Japan's *Wholesale Price Statistics* and *Corporate Goods Price Statistics*.

For capital stock, the only data available are the nominal book values of tangible fixed assets in the *Basic Survey of Japanese Business Structure and Activities*. Using these data, we calculated the net capital stock of firm *f* in industry *j* in constant 1995 prices as follows:

$$K_{ft} = BV_{ft} * (INK_{jt} / IBV_{jt})$$

where BV_{ft} represents the book value of firm *f*'s tangible fixed capital in year *t*, INK_{jt} stands for the net capital stock of industry *j* in constant 1995 prices, and IBV_{jt} denotes the book value of industry *j*'s capital. INK_{jt} is calculated as follows. First, as a benchmark, we took the data on the book value of tangible fixed assets of year 1976 from the *Census of Manufactures 1976* published by METI. We then converted the book value of year 1976 into the real value in constant 1995 prices using the net fixed assets deflator provided in the *Annual Report on National Accounts* published by the Cabinet Office, Government of Japan. Second, the net capital stock of industry *j*, INK_{jt}, for succeeding years was calculated using the perpetual inventory method. We used the capital formation deflator in the *Annual Report on National Accounts* and Masuda's (2000) estimate of the depreciation rate of 0.0792 for the calculation.

In order to obtain capital input, we multiplied the net capital stock by the capital utilization ratio of each industry provided in the JIP database.[29]

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[29] The JIP Database was compiled as part of an ESRI (Economic and Social Research Institute, Cabinet Office, Government of Japan) research project. The detailed result of this project is reported in Fukao, Miyagawa, Kawai, Inui (2004). The database contains annual information on 84 sectors, including 49 non-manufacturing sectors, from 1970 to 1998. These sectors cover the whole Japanese

As labor input, we used each firm's total number of workers multiplied by the sectoral working-hours from the Ministry of Health, Labour and Welfare's *Monthly Labor Survey*. We were not able to take account of differences in labor quality among firms, though it seems fair to assume that a group of high-TFP firms probably tend to employ more educated workers. Our estimates of TFP level might be biased upwards for high-TFP firms as a result of this neglect of the labor quality.

Finally, we derived the cost shares of the factors of production. For labor cost, we used the wage data provided in the *Basic Survey of Japanese Business Structure and Activities*. Intermediate input cost is defined as total production cost plus cost of sales and general management minus wages minus depreciation. Capital cost was calculated by multiplying the real net capital stock with the user cost of capital. The latter was estimated as follows:

$$P_k = q * (\frac{1-\tau z}{1-\tau})[r + \delta_k - \frac{dq}{q}]$$

where q, r, δ, τ and z are the prices of investment goods, interest rates, depreciation rates, corporate tax rates, and the present values of depreciation deduction on a unit of nominal investment, respectively. Data on investment goods prices, interest rates, and corporate tax rates were taken from the *Annual Report on National Accounts*, the *Ministry of Finance Statistics Monthly*. The depreciation rate for each industry is estimated using the book value of tangible fixed assets at the beginning of year *t* and the depreciation expense during year *t* in the *Census of Manufactures* published by METI.

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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 on ESRI's web site.

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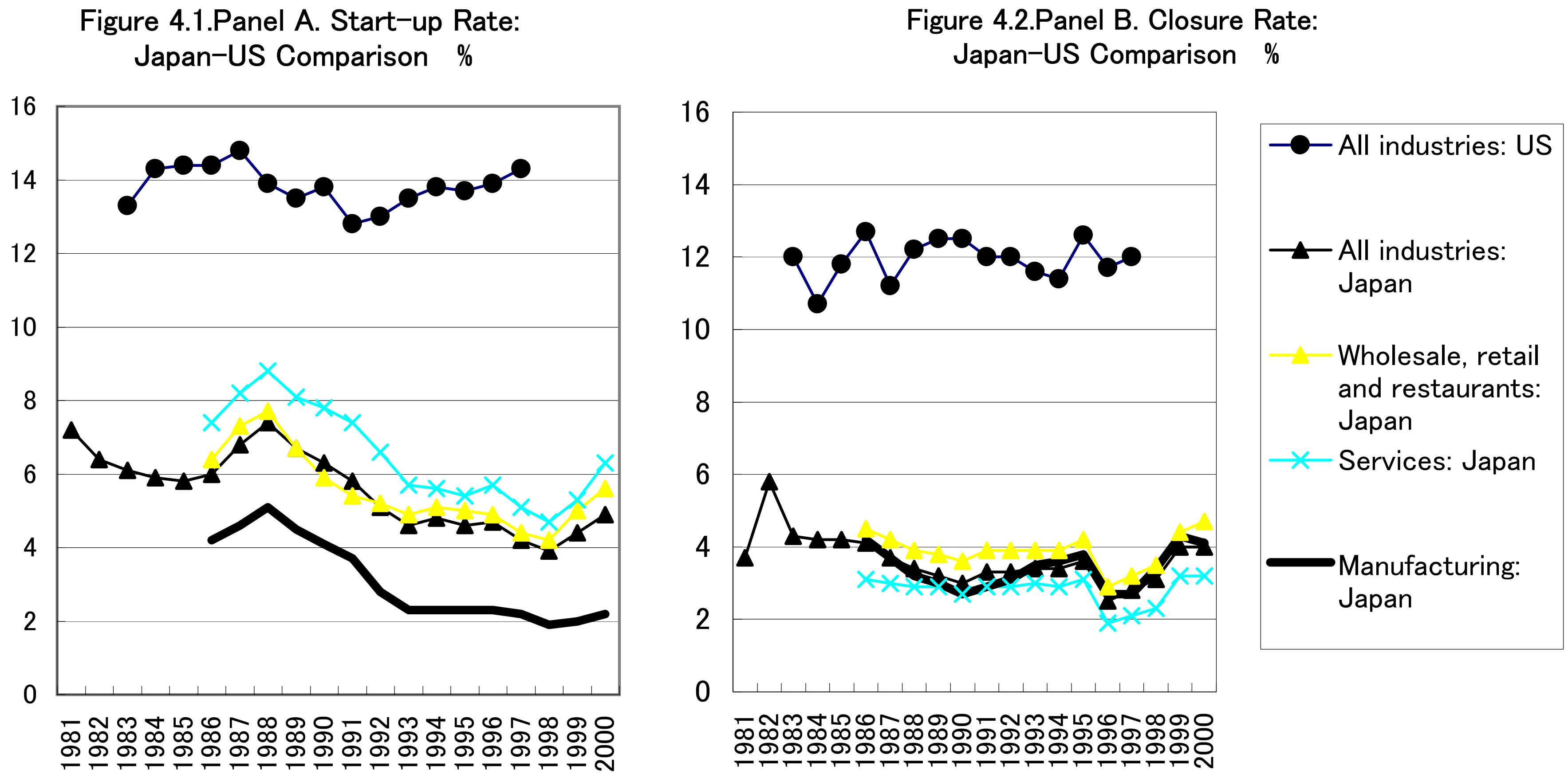
Table 2.1 Comparison of Empirical Studies on Japan's TFP growth in 1990s

Study	Period	Outputs	Capital services		Labor Services		Share	Adjustment of deflator for IT products	Assumptions on market structure	Production technology	Estimated annual TFP growth rate		
			Capital stock and capital service prices	Capital utilization	Labor quality	Hours worked					Macro level	Manufacturing sector	Non-manufacturing sector
Hayashi and Prescott (2002)	1960-2000	GNP (based on 1968 SNA)	Net capital stock estimated by the perpetual inventory method. Net foreign assets and inventories are included in the capital stock.	Unadjusted	Unadjusted	Adjusted by total hours worked	Income share within value added (fixed)	Unadjusted	Perfect competition in both output and input markets	Constant returns to scale (CRS)	**1983-91: 2.36%** **1991-00: 0.19%**		
Yoshikawa and Matsumoto (2001)	1980-1999	GDP (based on 1968 SNA), sectoral value added	Gross capital stock of private enterprises (statistics published by the Cabinet Office)	Unadjusted	Unadjusted	Not reported	Income share within value added (fixed)	Unadjusted	Perfect competition in both output and input markets	CRS	**1980-90: 1.20%** **1990-98: -0.90%**	**1980-90: 2.5%** **1990-98: 0.3%**	**1980-90: 0.5%** **1990-98: -1.3%**
Hattori and Miyazaki (2000)	1978-1997	GDP (based on 1968 SNA), sectoral value added	Gross capital stock of private enterprises (statistics published by the Cabinet Office)	Adjusted by capacity-utilization rate only in the case of manufacturing sectors	Unadjusted	Adjusted by total hours worked	Income share within value added (fixed)	Unadjusted	Perfect competition in both output and input markets	CRS	**1987-93: 1.20%** **1994-97: -0.60%**	**1987-93: 1.61%** **1994-97: 1.54%**	**1987-93: 1.61%** **1994-97: -1.43%**
Cabinet Office, Government of Japan (2002)	1981-2000	GDP (based on 1993 SNA), sectoral value added	Gross capital stock of private enterprises (statistics published by the Cabinet Office)	Adjusted by capacity-utilization rate both in the manufacturing sectors and in the non-manufacturing sectors	Unadjusted	Adjusted by hours worked in each sector	Income share within value added (fixed)	Unadjusted	Perfect competition in both output and input markets	CRS	**1981-90: 1.60%** **1991-00: 0.20%**	**1981-90: 2.1%** **1991-00: 1.8%**	**1981-90: 1.3%** **1991-00: -0.3%**
Nishimura and Minetaki (2003)	1975-1998	Sectoral value added (based on 1968 SNA)	Net capital stock and service prices of five capital goods (JCER database)	Adjusted by assuming that the capital is a quasi-fixed factor	Adjusted by age, education attainment, and type of occupation	Adjusted by hours worked in each sector	Cost share	Adjusted by IT deflator of the US ("harmonized approach")	Perfect competition in input markets	CRS		**1981-89: 2.67%** **1990-98: 0.30%**	**1981-89: 1.21%** **1990-98: -0.26%**
Miyagawa (2003)	1981-1999	GDP (based on 1993 SNA), sectoral value added	Net capital stock and service prices of five capital goods (JCER database)	Adjusted by capacity-utilization rate in the case of manufacturing sectors and adjusted by information on electricity input in the case of non-manufacturing sectors	Unadjusted	Adjusted by hours worked in each sector	Income share within value added (fixed)	Unadjusted	Perfect competition in both output and input markets	CRS	**1981-90: 1.63%** **1991-99: 0.84%**	**1981-90: 2.81%** **1991-99: 1.37%**	**1981-90: 1.18%** **1991-99: 0.64%**
Fukao, Inui, Kawai, and Miyagawa (2003)	1970-1998	GDP (based on 1968 SNA), sectoral gross output	Net capital stock and service prices of 37 capital goods (JIP database)	Adjusted by capacity-utilization rate in the case of manufacturing sectors and adjusted by diffusion indices on excess capacity (BOJ) in the case of non-manufacturing sectors (JIP Database)	Adjusted by gender, age and education attainment (JIP database)	Adjusted by hours worked in each sector	Cost share	Unadjusted	Perfect competition in input markets	CRS	**1983-91: 0.40%** **1991-98: 0.03%**	**1983-91: 0.78%** **1991-98: -0.16%**	**1983-91: -0.15%** **1991-98: 0.27%**
Jorgenson and Motohashi (2003)	1975-1998	Based on their own definition of GDP	Net capital stock and service prices of 62 capital goods plus input of land, inventory stock, software, and durable consumption goods	Not explicitly adjusted	Adjusted by gender, age, education attainment, and type of occupation (KEO database)	Adjusted (KEO database)	Cost share	Adjusted by IT deflator of the US ("harmonized approach")	Perfect competition in input markets	CRS	**1975-90: 1.01%** **1990-98: 0.89%**		
Kawamoto (2004)	1973-1998	GDP (based on 1968 SNA), sectoral gross output	Net capital stock and service prices of 37 capital goods (JIP database)	Changes in hours per worker is used as a proxy for unobserved changes in both labor effort and capital utilization	Adjusted by gender, age and education attainment (JIP database)	Adjusted by hours worked in each sector (statistics published by the Ministry of Welfare and Labor)	Cost share	Unadjusted	Perfect competition in input markets	CRS is not assumed.	**Private sector 1980-90: 1.9** **Private sector 1990-98: 1.9**	**Durable manufacturing 1980-90: 2.8% 1990-98: 1.4%** **Non-durable manufacturing 1980-90: 1.7% 1990-98: 1.9%**	**1980-90: 1.6%** **1990-98: 2.1%**

Source: Inui and Kwon (2004) and the papers listed.

Figure 3.1 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 3.1 Decomposition of Sectoral TFP Growth: 1994-2001 (Growth over the Seven Year Period)

	Industry	**Within effect**	Between effect	Covariance effect	**Total effect among stayers**	Entry effect (excluding switch-in effect)	Exit effect (excluding switch-out 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**
1	Food	0.003	-0.001	0.001	0.003	0.006	-0.005	0.001	0.000	0.002	0.005
2	Textiles	-0.008	-0.002	0.007	-0.002	0.007	-0.027	0.001	0.000	-0.019	-0.020
3	Wood and furniture	0.000	-0.002	0.001	0.000	0.004	-0.017	0.001	-0.015	-0.027	-0.028
4	Pulp and paper	0.007	0.000	0.001	0.008	0.000	-0.002	0.000	0.000	-0.001	0.007
5	Printing and publishing	0.008	-0.001	0.003	0.011	0.010	0.000	0.000	0.000	0.010	0.020
6	Industrial chemicals and chemical fibers	0.007	0.001	0.002	0.010	0.001	-0.001	0.002	0.000	0.000	0.011
7	Oils and paints	0.004	-0.001	0.001	0.004	0.003	-0.004	0.001	0.000	0.000	0.005
8	Drugs and medicine	0.073	0.005	0.022	0.100	0.010	0.000	0.001	0.000	0.010	0.110
9	Other chemical products	0.016	0.001	0.000	0.017	0.007	0.001	0.002	0.001	0.012	0.028
10	Petroleum and coal products	0.027	0.015	0.014	0.056	0.000	-0.010	0.000	0.000	-0.010	0.046
11	Plastic products	-0.003	-0.002	0.003	-0.001	0.004	-0.002	0.005	-0.001	0.006	0.005
12	Rubber products	-0.024	0.002	0.000	-0.022	0.000	0.000	0.001	-0.001	0.000	-0.022
13	Ceramics	0.013	-0.003	0.003	0.013	0.002	-0.004	0.003	0.008	0.009	0.022
14	Iron and steel	0.003	-0.005	0.000	-0.002	0.000	0.001	0.001	-0.001	0.000	-0.002
15	Non-ferrous metals and products	0.008	-0.001	0.002	0.009	-0.006	-0.005	0.001	-0.001	-0.011	-0.002
16	Fabricated metal products	-0.009	-0.006	0.006	-0.009	0.003	-0.003	0.003	-0.003	0.000	-0.009
17	Metal working machinery	0.037	-0.002	0.015	0.050	0.009	0.000	0.012	-0.007	0.015	0.065
18	Special industrial machinery	0.022	-0.003	-0.002	0.017	0.003	-0.004	0.003	-0.001	0.000	0.018
19	Office, service industry and household machines	0.040	-0.001	0.009	0.048	0.013	0.000	0.045	-0.002	0.055	0.103
20	Miscellaneous machinery and machine parts	-0.005	-0.002	0.002	-0.005	0.003	-0.003	0.002	-0.002	-0.001	-0.006
21	Industrial electric apparatus	-0.015	-0.005	0.002	-0.018	0.005	-0.003	0.001	-0.003	0.000	-0.018
22	Household electric appliances	0.015	-0.002	-0.002	0.010	0.007	0.001	0.005	-0.002	0.010	0.020
23	Communication equipment and related products	0.071	-0.001	0.010	0.081	0.008	0.003	0.108	0.002	0.120	0.201
24	Electronic data processing machines and electronic equipment	0.026	0.003	0.005	0.033	0.008	-0.002	0.004	-0.012	-0.002	0.031
25	Electronic parts and devices	0.044	-0.001	0.010	0.053	0.017	-0.008	0.007	-0.002	0.014	0.067
26	Miscellaneous electrical machinery and supplies	0.014	0.000	0.004	0.017	0.033	-0.012	0.011	-0.007	0.025	0.042
27	Motor vehicles	0.018	0.000	0.005	0.023	0.001	-0.001	0.000	0.000	0.000	0.022
28	Miscellaneous transportation equipment	0.040	0.000	0.002	0.041	0.005	0.002	0.003	0.000	0.011	0.052
29	Precision instruments	0.017	-0.002	0.011	0.026	0.011	0.003	0.003	-0.001	0.016	0.041
30	Other manufacturing	-0.005	0.004	-0.001	-0.002	0.046	-0.005	0.009	-0.004	0.046	0.045
	Weighted average of all the industries	0.012	-0.001	0.004	0.015	0.006	-0.004	0.005	-0.001	0.006	0.021
	Share of each effect in industry's TFP growth	0.56	-0.04	0.20	0.71	0.28	-0.17	0.25	-0.07	0.29	1.00

Table 3.2 Decomposition of Annual TFP Growth in the Manufacturing Sector

Period	TFP growth total	Contribution of each effect								
		Within effect	**Redistribution effect subtotal**	Between effect	Covariance effect	**Net entry effect subtotal**	Entry effect (excluding switch-in	Exit effect (excluding switch-out effect)	Switch-in effect	Switch-out effect
	a=b+c+f	**b**	**c=d+e**	d	e	**f=g+h**	g	h	i	j
1994-1995	**0.029**	**0.024**	**0.000**	-0.002	0.002	**0.005**	0.006	-0.003	0.006	-0.003
1995-1996	**0.011**	**0.008**	**0.001**	0.000	0.002	**0.002**	0.004	-0.002	0.005	-0.005
1996-1997	**-0.002**	**-0.002**	**0.003**	0.001	0.002	**-0.003**	0.001	-0.004	0.004	-0.004
1997-1998	**-0.007**	**-0.008**	**0.001**	0.000	0.002	**0.000**	0.003	-0.003	0.002	-0.001
1998-1999	**0.011**	**0.010**	**0.000**	-0.002	0.002	**0.001**	0.003	-0.003	0.002	-0.002
1999-2000	**0.017**	**0.013**	**0.003**	0.001	0.002	**0.001**	0.004	-0.004	0.002	-0.001
2000-2001	**-0.005**	**-0.008**	**0.003**	-0.001	0.004	**-0.001**	0.003	-0.004	0.003	-0.003

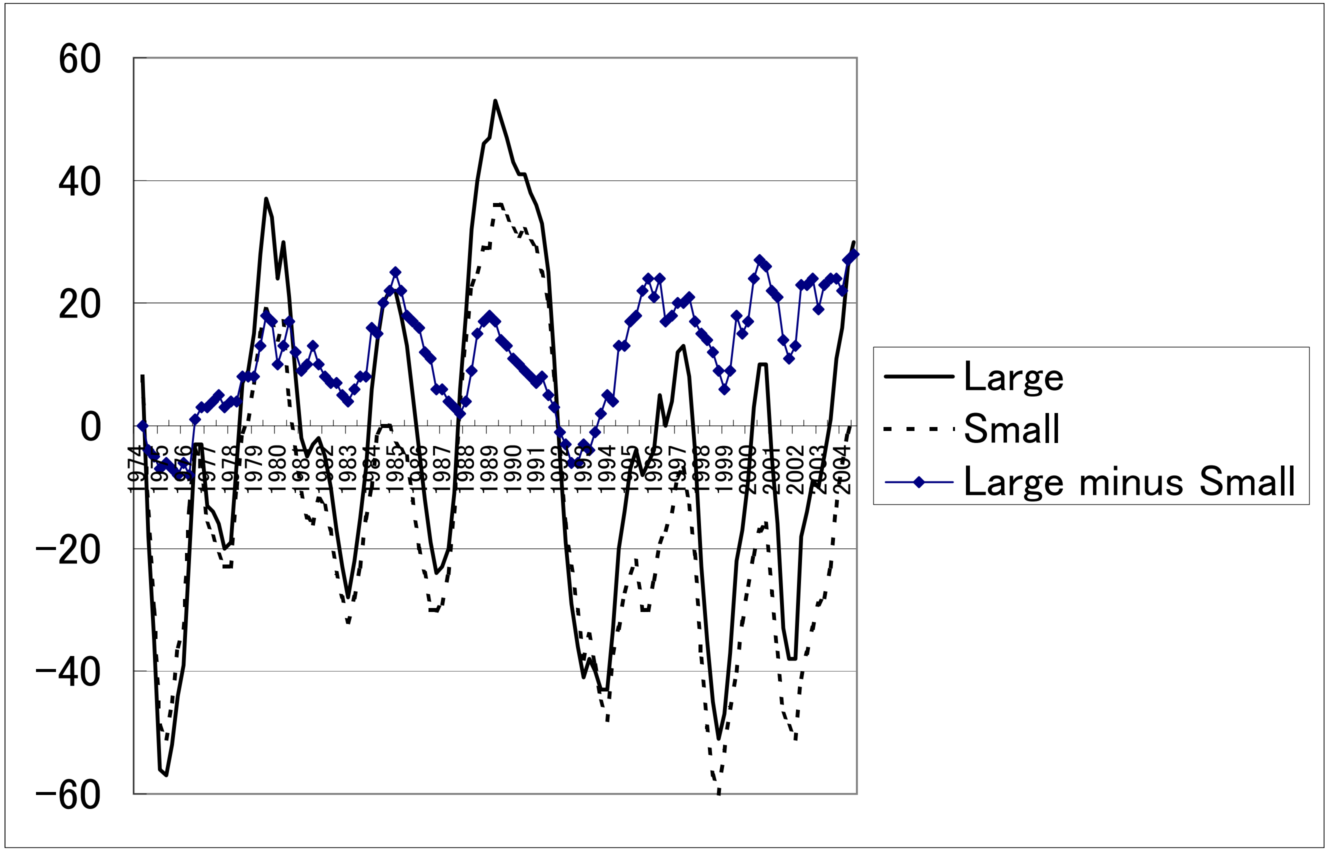
Note: The entry and exit effect in this paper include the switch-in and switch-out effect, respectively.

Table 3.3 Comparison of Total Factor Productivity Decompositions of Each Country's Manufacturing Sector Based on Foster, Haltiwanger, and Krizan Method

Source	Country	Unit of analysis	Period	TFP growth total (%)	Contribution of each effect						
					Within effect	Redistribution effect subtotal	Between effect	Covariance effect	Net entry effect subtotal	Entry effect (including switch-in effect)	Exit effect (including switch-out effect)
				a=b+c+f	b	c=d+e	d	e	f=g+h	g	h
Ahn, Kwon, Fukao (2004)	Korea	Establishment	1990-98	28.1	11.35 (0.40)	0.63 (0.02)	-2.28 (-0.08)	2.90 (0.10)	16.11 (0.57)	15.60 (0.56)	0.50 (0.02)
Foster, Haltiwanger, and Krizan (1998)	USA	Establishment	1977-87	10.2	4.92 (0.48)	2.66 (0.26)	-0.82 (-0.08)	3.48 (0.34)	2.66 (0.26)		
This paper	Japan	Firm	1994-2001	2.1	1.20 (0.56)	0.33 (0.15)	-0.09 (-0.04)	0.42 (0.20)	0.61 (0.29)	1.13 (0.53)	-0.52 (-0.24)
Barnes, Haskell, and Maliranta (2001)	Finland	Firm	1987-92	5.4	-5.08 (-0.94)	6.37 (1.18)	2.86 (0.53)	3.51 (0.65)	4.10 (0.76)	2.92 (0.54)	1.19 (0.22)
	France	Firm	1987-92	-7.7	-10.16 (1.32)	1.46 (-0.19)	1.62 (-0.21)	-0.15 (0.02)	1.00 (-0.13)	0.92 (-0.12)	0.08 (-0.01)
	Italy	Firm	1987-92	15.5	8.22 (0.53)	2.17 (0.14)	3.57 (0.23)	-1.40 (-0.09)	5.12 (0.33)	5.43 (0.35)	-0.31 (-0.02)
	Netherlands	Firm	1987-92	2.7	4.16 (1.54)	-0.16 (-0.06)	2.46 (0.91)	-2.62 (-0.97)	-1.30 (-0.48)	0.16 (0.06)	-1.46 (-0.54)
	UK	Firm	1987-92	-4.5	-6.93 (1.54)	1.40 (-0.31)	-1.04 (0.23)	2.43 (-0.54)	1.04 (-0.23)	0.23 (-0.05)	0.77 (-0.17)

Notes: The entry and exit effects in this paper and in Ahn, Kwon, and Fukao (2004) include the switch-in and switch-out effects, respectively. Values in parentheses denote the share of each effect in total TFP growth.

Figure 4.1 Diffusion Index of Business Conditions ("Favorable" minus "Unfavorable") in the Manufacturing Sector: by Firm Size

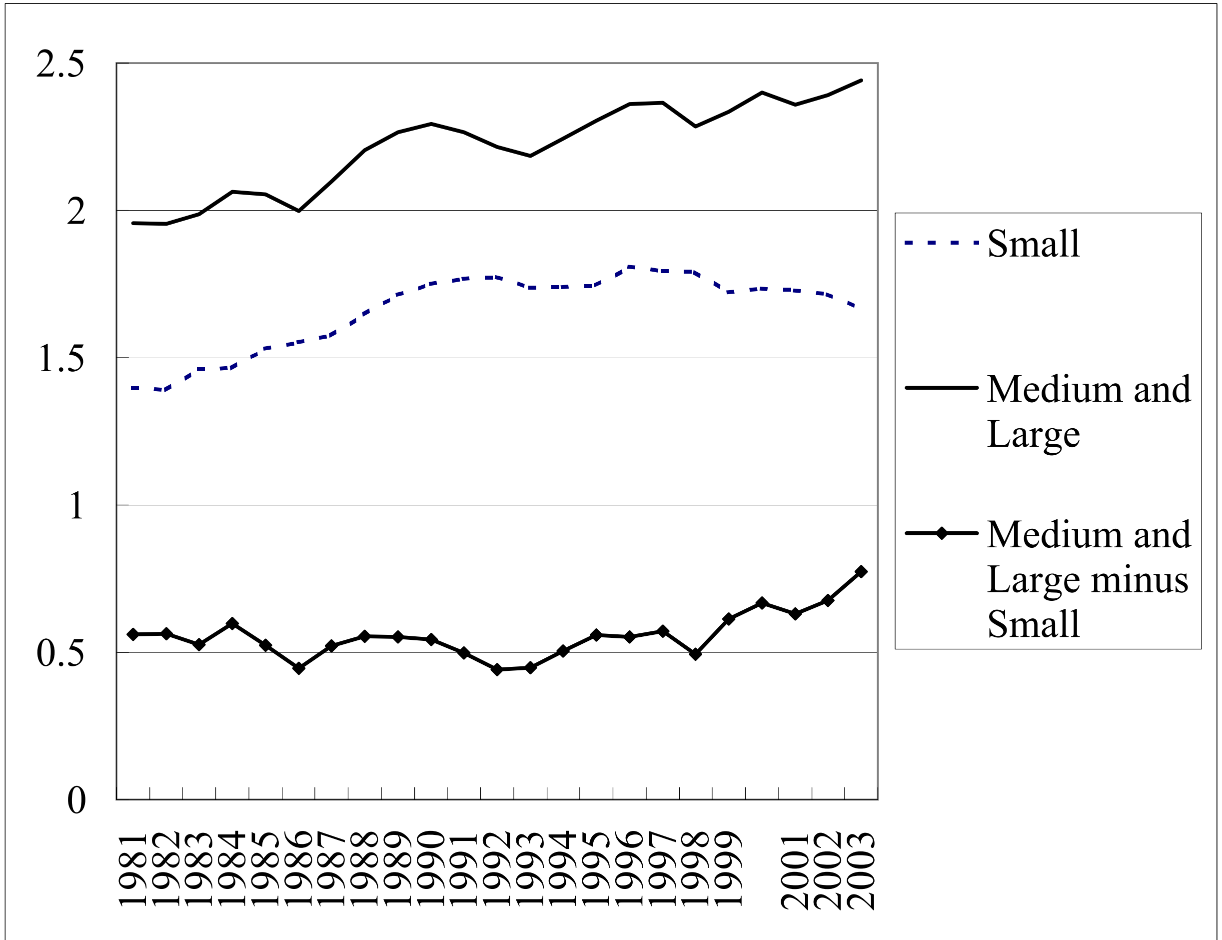


Source: Bank of Japan 'Tankan (Short-term Economic Survey of Enterprises in Japan)'

Notes: The BOJ revised the Tankan from the March 2003 survey onwards. In the case of the December 2003 survey, both the data based on the old format and the data based on the new format are available. Using these data we linked the statistics before and after the revision.

Before March 2004, small firms are defined as firms with 50-299 employees and large firms are defined as firms with 1000 employees or more. After March 2004, small firms are defined as firms capitalized at 20 million yen or more to less than 100 million yen and large firms are defined as firms capitalized at 1 billion yen or more.

Figure 4.2 Labor Productivity in the Manufacturing Sector: by Firm Size, Logarithm of Value Added (in Million Yen) per Worker



Source: ***Ministry of Finance Statistics Monthly: Annual Financial Statements Statistics of Corporations*** **,**

Notes: Small firms are defined as firms capitalized at 10 million yen or more to less than 100 million yen. Medium and large firms are defined as firms capitalized at 100 million yen and more.

Table 4.1 TFP Level Gap between the 75 Percentile Firm and the 25 Percentile Firm; by Industry and by Year

Industry	1994	1995	1996	1997	1998	1999	2000	2001	Change of dispersion: 1994-2001	Average market share of each industry: 1994-2001
Drugs and medicine	0.158	0.165	0.180	0.201	0.197	0.207	0.227	0.216	0.058	0.021
Petroleum and coal products	0.123	0.121	0.142	0.197	0.164	0.155	0.193	0.176	0.053	0.030
Electronic data processing machines and electronic equipment	0.164	0.182	0.180	0.178	0.181	0.189	0.193	0.208	0.044	0.060
Electronic parts and devices	0.149	0.150	0.150	0.153	0.151	0.168	0.167	0.190	0.042	0.055
Miscellaneous transportation equipment	0.104	0.103	0.107	0.117	0.193	0.151	0.108	0.142	0.038	0.014
Other manufacturing	0.119	0.127	0.128	0.128	0.131	0.139	0.153	0.155	0.036	0.018
Oils and paints	0.094	0.088	0.098	0.092	0.101	0.101	0.145	0.129	0.035	0.010
Non-ferrous metals and products	0.100	0.085	0.096	0.093	0.097	0.104	0.117	0.122	0.022	0.024
Miscellaneous electrical machinery and supplies	0.132	0.120	0.115	0.127	0.117	0.141	0.138	0.154	0.022	0.013
Motor vehicles	0.100	0.099	0.101	0.103	0.106	0.114	0.114	0.120	0.020	0.135
Communication equipment and related products	0.167	0.183	0.156	0.154	0.181	0.156	0.166	0.186	0.019	0.037
Household electric appliances	0.124	0.116	0.114	0.110	0.128	0.142	0.153	0.136	0.012	0.008
Rubber products	0.122	0.121	0.124	0.122	0.115	0.128	0.138	0.131	0.009	0.010
Plastic products	0.106	0.096	0.109	0.100	0.105	0.111	0.115	0.115	0.009	0.027
Office, service industry and household machines	0.130	0.147	0.135	0.119	0.125	0.133	0.131	0.137	0.007	0.018
Fabricated metal products	0.123	0.119	0.112	0.107	0.116	0.129	0.129	0.129	0.006	0.053
Textiles	0.186	0.189	0.201	0.196	0.199	0.199	0.193	0.188	0.002	0.024
Industrial chemicals and chemical fibers	0.115	0.100	0.106	0.108	0.111	0.109	0.104	0.114	-0.001	0.042
Wood and furniture	0.112	0.099	0.099	0.097	0.095	0.094	0.110	0.109	-0.003	0.014
Special industrial machinery	0.120	0.124	0.112	0.111	0.106	0.117	0.135	0.117	-0.003	0.024
Pulp and paper	0.102	0.090	0.089	0.087	0.097	0.097	0.105	0.098	-0.004	0.025
Food	0.132	0.122	0.118	0.111	0.116	0.113	0.117	0.128	-0.004	0.119
Printing and publishing	0.157	0.141	0.145	0.137	0.136	0.141	0.153	0.151	-0.005	0.039
Miscellaneous machinery and machine parts	0.127	0.113	0.111	0.119	0.119	0.138	0.125	0.119	-0.008	0.043
Industrial electric apparatus	0.139	0.136	0.140	0.124	0.139	0.146	0.155	0.130	-0.009	0.030
Other chemical products	0.126	0.123	0.124	0.138	0.132	0.138	0.129	0.117	-0.009	0.017
Precision instruments	0.160	0.137	0.152	0.133	0.149	0.148	0.143	0.149	-0.011	0.016
Iron and steel	0.118	0.089	0.088	0.083	0.117	0.112	0.097	0.106	-0.011	0.038
Ceramics	0.140	0.123	0.132	0.123	0.123	0.114	0.124	0.126	-0.014	0.026
Metal working machinery	0.185	0.130	0.112	0.101	0.139	0.139	0.149	0.128	-0.057	0.009
Weighted average of all the industries	0.130	0.125	0.125	0.125	0.130	0.134	0.137	0.141	0.011	1.000

Figure 4.3 Change in TFP Gap by Industry and Industry Characteristics: 1994-200

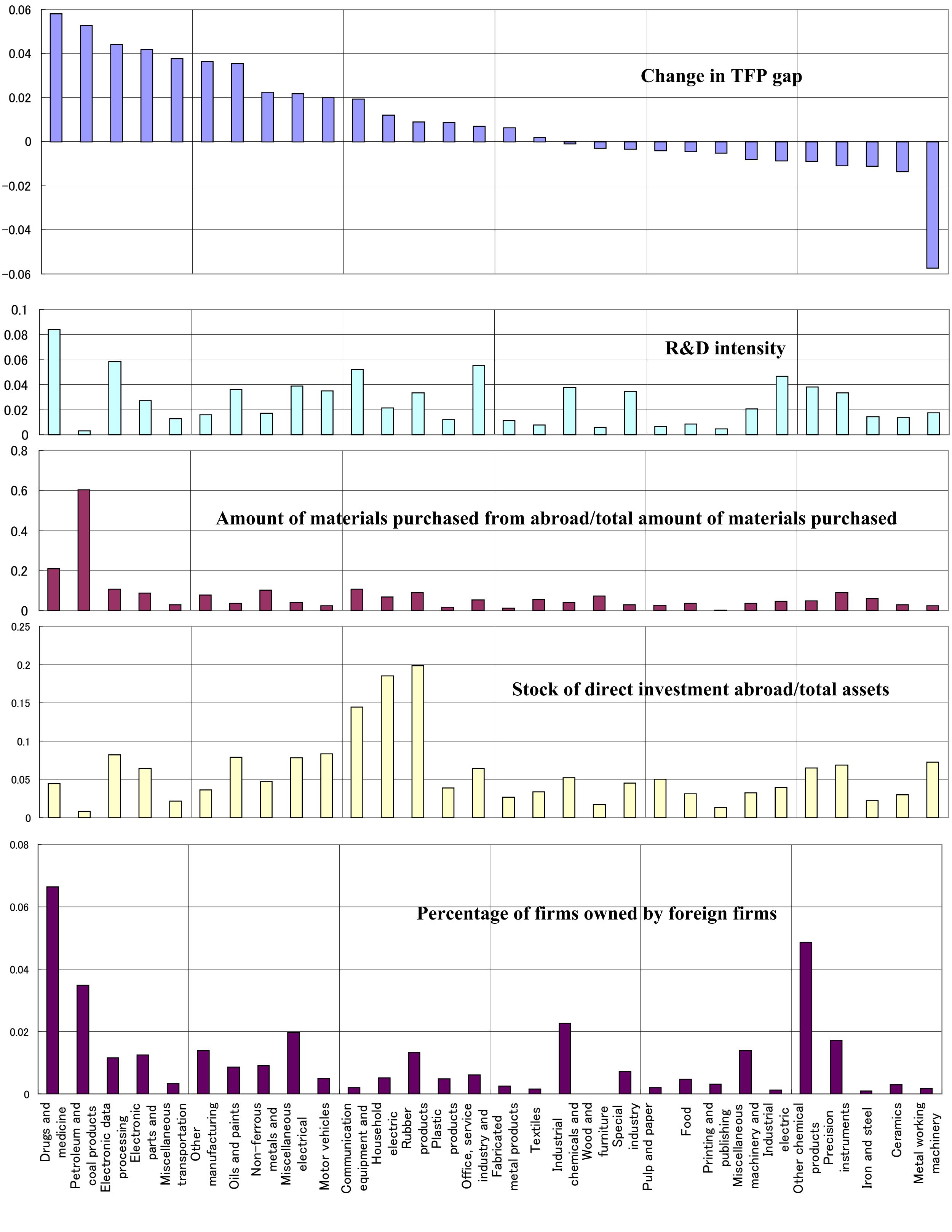


Table 4.2. Panel A. Comparison of Firms' Average Characteristics between the Top Firm Group and the Bottom Firm Group: All Manufacturing Firms

rms' Average Characteristics between the Top Firm Group and the Bottom Firm Gr	1994－2001				1994－1997				1998－2001			
	Below the 25 percentile	Above the 75 percentile	t-test	Gap	Below the 25	Above the 75	t-test	Gap	Below the 25 percentile	Above the 75 percentile	t-test	Gap
	A	B		B-A	C	D		D-C	E	F		F-E
Amount of materials purchased from abroad/total amount of materials purchased	0.019	0.044	***	0.025	0.021	0.043	***	0.022	0.018	0.046	***	0.028
Stock of direct investment abroad/total assets	0.004	0.010	***	0.006	0.004	0.009	***	0.005	0.005	0.012	***	0.007
Number of non-production workers/number of all workers	0.277	0.390	***	0.112	0.285	0.403	***	0.118	0.269	0.378	***	0.109
R&D intensity (R&D investment/total sales)	0.006	0.013	***	0.007	0.006	0.013	***	0.007	0.006	0.014	***	0.008
Number of years passed since being established	35.383	36.901	***	1.517	33.964	35.973	***	2.009	36.824	37.692	***	0.868
ln(number of workers)	4.906	5.484	***	0.577	4.932	5.471	***	0.539	4.880	5.498	***	0.618
Total liability/total asset	0.803	0.642	***	-0.161	0.821	0.654	***	-0.167	0.784	0.631	***	-0.154
Number of firms majority-owned by a single foreign firm/total number of firms	0.004	0.019	***	0.015	0.005	0.018	***	0.014	0.003	0.020	***	0.017
Firms majority-owned by a single domestic firm/total number of firms	0.218	0.356	***	0.138	0.221	0.323	***	0.102	0.215	0.389	***	0.173
TFP growth rate	0.034	-0.021	***	-0.055	0.045	-0.017	***	-0.061	0.025	-0.025	***	-0.050
Growth rate of real sales	0.020	-0.015	***	-0.035	0.044	0.013	***	-0.031	0.001	-0.038	***	-0.038
Growth rate of employment	-0.031	-0.001	***	0.030	-0.020	0.006	***	0.027	-0.040	-0.007	***	0.033
Return on asset (ROA)	0.013	0.083	***	0.070	0.016	0.087	***	0.071	0.011	0.081	***	0.070

Notes: *P=.10, **P=.05, ***P=0.01. In the *t*-tests heteroscedasticity among different percentile groups were taken account of.

Table 4.2. Panel B. Comparison of Firms' Average Characteristics between the Top Firm Group and the Bottom Firm Group: by Industry

Drugs and Medicine

Variable	1994－2001				1994－1997				1998－2001			
	Below the 25 percentile	Above the 75 percentile	t-test	Gap	Below the 25 Percentile	Above the 75 Percentile	t-test	Gap	Below the 25 percentile	Above the 75 percentile	t-test	Gap
	A	B		B-A	C	D		D-C	E	F		F-E
Amount of materials purchased from abroad/total amount of materials purchased	0.027	0.177	***	0.151	0.034	0.216	***	0.181	0.027	0.168	***	0.141
Stock of direct investment abroad/total assets	0.002	0.013	***	0.011	0.002	0.010	***	0.008	0.002	0.013	***	0.012
Number of non-production workers/number of all workers	0.474	0.664	***	0.190	0.487	0.662	***	0.176	0.450	0.681	***	0.232
R&D intensity (R&D investment/total sales)	0.036	0.071	***	0.035	0.042	0.067	***	0.026	0.029	0.075	***	0.045
Number of years passed since being established	42.719	49.184	***	6.465	41.423	43.357		1.934	44.730	51.526	***	6.796
ln(number of workers)	5.083	6.716	***	1.634	5.171	6.579	***	1.408	4.928	6.841	***	1.913
Total liability/total asset	0.689	0.436	***	-0.253	0.684	0.474	***	-0.210	0.708	0.411	***	-0.298
Number of firms majority-owned by a single foreign firm/total number of firms	0.017	0.149	***	0.132	0.023	0.146	***	0.122	0.009	0.161	***	0.152
Firms majority-owned by a single domestic firm/total number of firms	0.182	0.229	*	0.047	0.178	0.169		-0.009	0.180	0.275	**	0.095
TFP growth rate	0.032	0.003	***	-0.029	0.019	0.010	***	-0.009	0.042	-0.003	***	-0.045
Growth rate of real sales	0.027	0.033		0.006	-0.002	0.033	*	0.036	0.050	0.033		-0.017
Growth rate of employment	-0.008	0.008		0.016	-0.012	0.008		0.020	-0.005	0.008		0.014
Return on asset (ROA)	0.027	0.127	***	0.100	0.029	0.129	***	0.100	0.023	0.129	***	0.106

Notes: *P=.10, **P=.05, ***P=0.01 2. In the *t* -tests heteroscedasticity among different percentile groups were taken account of.

Non-ferrous Metals and Products

Variable	1994－2001				1994－1997				1998－2001			
	Below the 25 percentile	Above the 75 percentile	t-test	Gap	Below the 25 Percentile	Above the 75 Percentile	t-test	Gap	Below the 25 percentile	Above the 75 percentile	t-test	Gap
	A	B		B-A	C	D		D-C	E	F		F-E
Amount of materials purchased from abroad/total amount of materials purchased	0.028	0.061	***	0.033	0.025	0.067	***	0.042	0.030	0.057	**	0.027
Stock of direct investment abroad/total assets	0.007	0.012	***	0.005	0.007	0.011	**	0.004	0.007	0.014	**	0.007
Number of non-production workers/number of all workers	0.198	0.278	***	0.080	0.198	0.273	***	0.075	0.198	0.283	***	0.085
R&D intensity (R&D investment/total sales)	0.006	0.010	**	0.003	0.004	0.009	***	0.004	0.009	0.010		0.002
Number of years passed since being established	36.302	37.576		1.274	34.337	36.783	**	2.446	38.794	37.925		-0.869
ln(number of workers)	4.924	5.374	***	0.450	4.915	5.490	***	0.575	4.930	5.282	***	0.352
Total liability/total asset	0.768	0.661	***	-0.107	0.787	0.677	***	-0.110	0.745	0.635	***	-0.110
Number of firms majority-owned by a single foreign firm/total number of firms	0.012	0.018		0.006	0.009	0.015		0.006	0.016	0.022		0.006
Firms majority-owned by a single domestic firm/total number of firms	0.285	0.475	***	0.190	0.286	0.440	***	0.154	0.280	0.514	***	0.234
TFP growth rate	0.028	-0.024	***	-0.052	0.034	-0.028	***	-0.063	0.024	-0.020	***	-0.044
Growth rate of real sales	0.004	-0.019	**	-0.023	0.032	0.008		-0.024	-0.018	-0.040		-0.022
Growth rate of employment	-0.034	0.002	***	0.035	-0.019	0.009	***	0.028	-0.045	-0.005	***	0.041
Return on asset (ROA)	0.012	0.080	***	0.067	0.021	0.078	***	0.057	0.003	0.082	***	0.079

Communication Equipment and Related Products

Variable	1994－2001				1994－1997				1998－2001			
	Below the 25 percentile	Above the 75 percentile	t-test	Gap	Below the 25 Percentile	Above the 75 Percentile	t-test	Gap	Below the 25 percentile	Above the 75 percentile	t-test	Gap
	A	B		B-A	C	D		D-C	E	F		F-E
Amount of materials purchased from abroad/total amount of materials purchased	0.027	0.050	***	0.023	0.022	0.035		0.013	0.016	0.057	***	0.041
Stock of direct investment abroad/total assets	0.007	0.014	***	0.006	0.007	0.013	**	0.006	0.008	0.015	*	0.007
Number of non-production workers/number of all workers	0.221	0.415	***	0.194	0.216	0.431	***	0.215	0.214	0.424	***	0.209
R&D intensity (R&D investment/total sales)	0.008	0.021	***	0.013	0.008	0.024	***	0.016	0.007	0.023	***	0.015
Number of years passed since being established	29.724	36.618	***	6.894	29.627	35.917	***	6.290	32.075	36.599	***	4.524
ln(number of workers)	4.996	5.841	***	0.845	4.950	5.861	***	0.911	4.835	5.990	***	1.155
Total liability/total asset	0.820	0.682	***	-0.138	0.814	0.656	***	-0.158	0.782	0.685	***	-0.096
Number of firms majority-owned by a single foreign firm/total number of firms	0.000	0.005	*	0.005	0.000	0.003		0.003	0.000	0.010	*	0.010
Firms majority-owned by a single domestic firm/total number of firms	0.340	0.478	***	0.137	0.309	0.436	***	0.127	0.295	0.527	***	0.233
TFP growth rate	0.092	0.019	***	-0.074	0.091	0.018	***	-0.072	0.094	0.019	***	-0.075
Growth rate of real sales	0.090	0.052	**	-0.038	0.132	0.070	**	-0.062	0.056	0.037		-0.019
Growth rate of employment	-0.034	-0.004	***	0.029	-0.012	-0.003		0.009	-0.052	-0.005	***	0.046
Return on asset (ROA)	0.019	0.077	***	0.059	0.015	0.105	***	0.090	0.015	0.065	***	0.050

Electronic Data Processing Machines and Electronic Equipment

Variable	1994－2001				1994－1997				1998－2001			
	Below the 25 percentile	Above the 75 percentile	t-test	Gap	Below the 25 Percentile	Above the 75 Percentile	t-test	Gap	Below the 25 percentile	Above the 75 percentile	t-test	Gap
	A	B		B-A	C	D		D-C	E	F		F-E
Amount of materials purchased from abroad/total amount of materials purchased	0.021	0.068	***	0.047	0.020	0.066	***	0.045	0.021	0.073	***	0.052
Stock of direct investment abroad/total assets	0.010	0.016	**	0.007	0.012	0.019	*	0.007	0.009	0.016		0.006
Number of non-production workers/number of all workers	0.297	0.485	***	0.188	0.303	0.459	***	0.155	0.287	0.504	***	0.217
R&D intensity (R&D investment/total sales)	0.014	0.026	***	0.012	0.012	0.028	***	0.016	0.016	0.025	**	0.008
Number of years passed since being established	28.483	28.846		0.363	27.995	28.044		0.049	29.412	28.422		-0.990
ln(number of workers)	5.033	6.032	***	1.000	5.088	6.185	***	1.097	4.973	5.897	***	0.924
Total liability/total asset	0.761	0.710	**	-0.050	0.764	0.715		-0.049	0.737	0.717		-0.020
Number of firms majority-owned by a single foreign firm/total number of firms	0.002	0.037	***	0.034	0.005	0.024		0.020	0.000	0.039	***	0.039
Firms majority-owned by a single domestic firm/total number of firms	0.243	0.574	***	0.331	0.244	0.541	***	0.298	0.216	0.627	***	0.412
TFP growth rate	0.019	-0.031	***	-0.051	0.042	-0.007	***	-0.049	0.002	-0.050	***	-0.052
Growth rate of real sales	0.084	0.050		-0.035	0.126	0.118		-0.008	0.052	-0.003	*	-0.055
Growth rate of employment	-0.030	0.000	***	0.030	-0.022	0.012	**	0.035	-0.037	-0.010		0.027
Return on asset (ROA)	0.012	0.074	***	0.063	-0.003	0.097	***	0.100	0.001	0.072	***	0.071

Electronic Parts and Devices

Variable	1994－2001				1994－1997				1998－2001			
	Below the 25 percentile	Above the 75 percentile	t-test	Gap	Below the 25 Percentile	Above the 75 Percentile	t-test	Gap	Below the 25 percentile	Above the 75 percentile	t-test	Gap
	A	B		B-A	C	D		D-C	E	F		F-E
Amount of materials purchased from abroad/total amount of materials purchased	0.025	0.076	***	0.051	0.025	0.068	***	0.043	0.026	0.073	***	0.046
Stock of direct investment abroad/total assets	0.007	0.016	***	0.009	0.005	0.016	***	0.011	0.010	0.015	***	0.005
Number of non-production workers/number of all workers	0.175	0.288	***	0.113	0.184	0.290	***	0.106	0.162	0.290	***	0.128
R&D intensity (R&D investment/total sales)	0.008	0.014	***	0.006	0.008	0.014	***	0.006	0.008	0.014	***	0.006
Number of years passed since being established	24.865	28.387	***	3.522	23.870	27.216	***	3.346	25.834	28.380	***	2.546
ln(number of workers)	5.173	5.908	***	0.735	5.197	5.933	***	0.736	5.126	5.942	***	0.817
Total liability/total asset	0.861	0.694	***	-0.167	0.886	0.737	***	-0.148	0.833	0.687	***	-0.146
Number of firms majority-owned by a single foreign firm/total number of firms	0.013	0.025	**	0.012	0.016	0.026		0.010	0.012	0.018		0.006
Firms majority-owned by a single domestic firm/total number of firms	0.397	0.594	***	0.197	0.395	0.581	***	0.186	0.428	0.648	***	0.220
TFP growth rate	0.059	-0.013	***	-0.073	0.078	0.001	***	-0.077	0.046	-0.024	***	-0.069
Growth rate of real sales	0.092	0.028	***	-0.063	0.158	0.108	***	-0.050	0.045	-0.028	***	-0.073
Growth rate of employment	-0.031	0.006	***	0.037	-0.005	0.025	***	0.029	-0.050	-0.007	***	0.043
Return on asset (ROA)	0.012	0.102	***	0.090	-0.010	0.131	***	0.141	-0.008	0.108	***	0.116

Motor Vehicles

Variable	1994－2001				1994－1997				1998－2001			
	Below the 25 percentile	Above the 75 percentile	t-test	Gap	Below the 25 Percentile	Above the 75 Percentile	t-test	Gap	Below the 25 percentile	Above the 75 percentile	t-test	Gap
	A	B		B-A	C	D		D-C	E	F		F-E
Amount of materials purchased from abroad/total amount of materials purchased	0.011	0.015	*	0.004	0.011	0.013		0.002	0.009	0.017	**	0.008
Stock of direct investment abroad/total assets	0.006	0.023	***	0.017	0.004	0.019	***	0.015	0.007	0.027	***	0.020
Number of non-production workers/number of all workers	0.225	0.262	***	0.036	0.238	0.266	***	0.028	0.211	0.257	***	0.046
R&D intensity (R&D investment/total sales)	0.005	0.012	***	0.007	0.004	0.011	***	0.007	0.006	0.013	***	0.008
Number of years passed since being established	35.292	39.009	***	3.717	32.969	37.703	***	4.733	36.982	40.395	***	3.413
ln(number of workers)	5.015	6.011	***	0.996	5.044	5.933	***	0.889	4.973	6.096	***	1.122
Total liability/total asset	0.821	0.645	***	-0.177	0.846	0.665	***	-0.182	0.803	0.624	***	-0.179
Number of firms majority-owned by a single foreign firm/total number of firms	0.003	0.008	**	0.005	0.003	0.010	*	0.006	0.002	0.007		0.004
Firms majority-owned by a single domestic firm/total number of firms	0.262	0.319	***	0.057	0.260	0.294		0.034	0.252	0.344	***	0.092
TFP growth rate	0.019	-0.024	***	-0.043	0.012	-0.038	***	-0.050	0.025	-0.013	***	-0.038
Growth rate of real sales	0.028	-0.004	***	-0.032	0.029	0.001	***	-0.028	0.027	-0.007	***	-0.034
Growth rate of employment	-0.022	0.000	***	0.022	-0.013	0.003	*	0.016	-0.028	-0.002	***	0.026
Return on asset (ROA)	0.019	0.082	***	0.063	0.017	0.109	***	0.092	0.015	0.073	***	0.059

Table 4.3 Descriptive Statistics of the Variables Used for the Regression Analysis on the Determinants of TFP Growth

	Sample size	Sample average	Standard deviation	Minimum value	Maximum value
TFP level	109,882	-0.029	0.134	-4.511	1.450
Growth rate of TFP level	84,923	0.004	0.091	-3.547	4.565
Domestic-affiliate dummy (majority-owned by a single domestic firm)	109,882	0.278	0.448	0	1
Foreign-ownership dummy (majority-owned by a single foreign firm)	109,882	0.008	0.089	0	1
Amount of materials purchased from abroad/total amount of materials purchased	108,193	0.028	0.110	0	1
Stock of direct investment abroad/total assets	109,882	0.007	0.027	0	0.792
Number of non-production workers/number of all workers	109,882	0.330	0.249	0	1
R&D investment/total sales	109,882	0.009	0.021	0	1.639
No. of years passed since being established	109,882	36.814	15.315	0	111
ln (no. of workers)	109,882	5.172	0.975	3.912	11.254
Total liability/total assets	109,882	0.726	0.302	0	11.653

Table 4.4 Determinants of TFP Growth: 1995-2001, All Manufacturing Firms

Dependent variable: ln(TFP)t-ln(TFP)t-1	(1)		(2)		(3)		(4)	
ln(TFP)t-1	-0.2935	***	-0.3022	***	-0.2964	***	-0.3024	***
	(-15.46)		(-15.38)		(-15.25)		(-15.42)	
(Domestic-affiliate dummy (majority-owned by a single domestic firm))t-1			0.0122	***			0.0125	***
			(12.44)				(13.29)	
(Foreign-ownership dummy (majority-owned by a single foreign firm))t-1			0.0229	***			0.0186	***
			(4.99)				(3.93)	
(Amount of materials purchased from abroad/total amount of materials purchased)t-1					0.0172	***	0.0160	***
					(5.29)		(4.76)	
(Stock of direct investment abroad/total assets)t-1					0.0191	*	0.0319	***
					(1.77)		(2.92)	
(Number of non-production workers/number of all workers)t-1	0.0180	***	0.0194	***	0.0166	***	0.0182	***
	(10.18)		(10.80)		(9.77)		(10.41)	
(R&D investment/total sales)t-1	0.1545	***	0.1504	***	0.1401	***	0.1440	***
	(3.36)		(3.28)		(3.03)		(3.12)	
(Dummy for firms which do not report R&D expenditure) t-1	-0.0039	***	-0.0042	***	-0.0035	***	-0.0039	***
	(-4.32)		(-4.71)		(-3.98)		(-4.40)	
(No. of years passed since being established)t-1	-0.0002	***	0.0000	**	-0.0002	***	0.0000	*
	(-7.20)		(-1.97)		(-7.73)		(-1.91)	
ln (no. of workers)t-1	0.0076	***	0.0069	***	0.0072	***	0.0065	***
	(15.41)		(15.08)		(15.34)		(14.60)	
(Total liability/total assets)t-1			-0.0094	***	-0.0076	***	-0.0095	***
			(-4.35)		(-3.71)		(-4.47)	
Intercept	-0.0305	***	-0.0270	***	-0.0219	***	-0.0248	***
	(-8.63)		(-8.86)		(-7.48)		(-8.29)	
Industry dummies	yes		yes		yes		yes	
Year dummies	yes		yes		yes		yes	
Number of observations	84923		84923		83494		83494	
R-squared	0.1858		0.1897		0.1871		0.1905	

Notes: The values in parentheses are heteroskedasticity-robust t-statistics .
*P=.10, **P=.05, ***P=0.01

Table 4.5 Estimated Values of Beta-convergence Coefficients: by Industry and by Period

Industry	(A) 1995－1997 Coefficient of convergence		(B) 1998－2001 Coefficient of convergence		(C) 1994-2001 Coefficient of convergence		Dummy for 1998-2001 period		Interaction term	
All manufacturing	-0.386	***	-0.235	***	-0.377	***	-0.004	**	0.137	***
Food	-0.242	***	-0.171	***	-0.239	***	-0.017	***	0.066	**
Textiles	-0.278	***	-0.132	***	-0.262	***	-0.022	***	0.116	*
Wood and furniture	-0.278	***	-0.320	***	-0.271	***	-0.019	***	-0.050	
Pulp and paper	-0.381	***	-0.382	***	-0.380	***	-0.005		0.000	
Printing and publishing	-0.566	***	-0.160	***	-0.540	***	-0.023	***	0.352	**
Industrial chemicals and chemical fiber	-0.228	***	-0.169	***	-0.227	***	-0.017	***	0.057	
Oils and paints	-0.462	***	-0.116	**	-0.567	***	0.008		0.407	***
Drugs and medicines	-0.066		-0.272	***	-0.079	*	-0.012		-0.169	***
Other chemical products	-0.187	***	-0.166	***	-0.186	***	-0.018	***	0.018	
Petroleum and coal products	-0.223	***	-0.070		-0.168	***	-0.045	***	0.069	
Plastic products	-0.672	***	-0.257	***	-0.654	***	-0.015	***	0.375	***
Rubber products	-0.173	***	-0.566	***	-0.200	**	-0.027	**	-0.344	*
Ceramics	-0.422	***	-0.324	***	-0.421	***	-0.016	**	0.097	
Iron and steel	-0.211	***	-0.191	***	-0.207	***	-0.017	***	0.013	
Non-ferrous metals and products	-0.639	***	-0.108	**	-0.611	***	0.031	***	0.488	***
Fabricated metal products	-0.555	***	-0.315	***	-0.543	***	-0.024	***	0.218	**
Metal working machinery	-0.395	***	-0.322	***	-0.402	***	-0.062	***	0.091	
Special industry machinery	-0.419	***	-0.379	***	-0.412	***	-0.036	***	0.029	
Office, service industry and household machine	-0.240	***	-0.310	***	-0.265	***	-0.021	**	-0.032	
Miscellaneous machinery and machine part	-0.476	***	-0.334	***	-0.471	***	0.011	**	0.132	***
Industrial electric apparatu	-0.369	***	-0.246	***	-0.358	***	-0.034	***	0.112	**
Household electric appliance	-0.340	***	-0.263	***	-0.347	***	0.006		0.090	
Communication equipment and related products	-0.492	***	-0.301	***	-0.467	***	0.028	***	0.141	
Electronic data processing machines and electronic equipmer	-0.169	***	-0.230	***	-0.180	***	-0.001		-0.039	
Electronic parts and devices	-0.447	***	-0.256	***	-0.434	***	-0.026	**	0.166	
Miscellaneous electrical machinery and supplie	-0.340	***	-0.309	***	-0.345	***	-0.055	***	0.040	
Motor vehicles	-0.328	***	-0.215	***	-0.321	***	0.015	***	0.102	*
Miscellaneous transportation equipmen	-0.353	***	-0.319	***	-0.337	***	0.019	***	0.018	
Precision instruments	-0.306	***	-0.293	***	-0.308	***	-0.042	***	0.017	
Other manufacturing	-0.253	***	-0.060		-0.235	***	-0.025	**	0.164	

Notes: *P=.10, **P=.05, ***P=0.01

We estimated specification (4) of Table 4.4 for each industry in order to obtain the convergence coefficients.

Table 4.6. Comparison of the Divergence and Convergence Effects: All Manufacturing Firms

Variable	1994-2001		1994－1997		1998－2001	
	(The estimated coefficient value)*gap	The gap between the top group and the bottom group	(The estimated coefficient value)*gap	The gap between the top group and the bottom group	(The estimated coefficient value)*gap	The gap between the top group and the bottom group
Amount of materials purchased from abroad/total amount of materials purchased	0.000	0.025	0.000	0.022	0.000	0.028
Stock of direct investment abroad/total assets	0.000	0.006	0.000	0.005	0.000	0.007
Share of non-production workers in total workers	0.002	0.112	0.003	0.118	0.001	0.109
R&D intensity	0.001	0.007	0.001	0.007	0.001	0.008
Number of years passed since being established	0.000	1.517	0.000	2.009	0.000	0.868
ln(number of workers)	0.004	0.577	0.003	0.539	0.004	0.618
Total liability/total asset	0.002	-0.161	0.003	-0.167	0.001	-0.154
Foreign-ownership dummy (majority-owned by a single foreign firm)	0.000	0.015	0.000	0.014	0.000	0.017
Domestic-affiliate dummy (majority-owned by a single domestic firm)	0.002	0.138	0.001	0.102	0.002	0.173
Summation of all the above divergence effects	0.011		0.013		0.010	
Convergence effect (the average difference of TFP level*the estimated coefficient value of the beta convergence)	-0.091	0.300	-0.114	0.295	-0.072	0.305
Standard error of the random shock	0.0797		0.0828		0.0758	

Notes: We used coefficients of specification (4) in Table 4.4.

Table 4.7 Transition Matrix of Firms' Rank: 1994-2001

		TFP-level group in 2001									
		Lowest TFP group	2nd TFP level group	3rd TFP level group	4th TFP level group	5th TFP level group	6th TFP level group	7th TFP level group	8th TFP level group	9th TFP level group	Top TFP level group
TFP-level group in 1994	Lowest TFP group	34.0%	17.3%	10.3%	9.0%	7.2%	6.8%	4.1%	4.1%	3.3%	3.9%
	2nd TFP level group	19.9%	18.8%	15.0%	12.8%	9.2%	7.3%	4.5%	5.1%	4.4%	3.0%
	3rd TFP level group	12.7%	15.4%	14.9%	13.3%	11.4%	8.6%	9.5%	4.6%	5.5%	4.1%
	4th TFP level group	9.3%	12.1%	14.1%	14.9%	13.2%	11.6%	9.3%	6.3%	5.1%	4.0%
	5th TFP level group	5.8%	9.8%	12.7%	13.3%	14.1%	11.7%	12.0%	9.1%	7.0%	4.5%
	6th TFP level group	4.2%	9.6%	10.2%	11.2%	11.7%	13.9%	13.1%	10.8%	8.6%	6.8%
	7th TFP level group	3.7%	5.4%	9.0%	10.5%	10.3%	13.1%	14.3%	13.2%	11.8%	8.7%
	8th TFP level group	3.9%	4.4%	4.9%	5.7%	9.1%	11.6%	14.5%	17.1%	17.3%	11.5%
	9th TFP level group	3.3%	4.4%	5.1%	5.0%	7.9%	9.6%	10.4%	16.3%	18.6%	19.5%
	Top TFP level group	2.4%	3.2%	3.6%	4.2%	6.2%	6.1%	7.9%	13.4%	18.2%	34.9%

Table 4.8 Comparison of Firms' Employment Growth and Firm "Exits" between the Top Firm Group and the Bottom Firm Group: All Manufacturing Firms

Fiscal year	Below the 25 percentile in each industry				Above the 75 percentile in each industry			
	Number of workers				Number of workers			
	All firms	Growth rate of the survivors' total workers	Firms "exited"	Percentage of workers in the firms "exited'	All firms	Growth rate of the survivors' total workers	Firms "exited"	Percentage of workers in the firms "exited'
	a		b	c=b/a	a		b	c=b/a
1994	825336		86358	10.5%	2475820		120704	4.9%
	(3396)		(556)		(3419)		(375)	
1995	759593	-3.3%	86344	11.4%	2734449	-0.9%	141268	5.2%
	(3559)		(536)		(3582)		(370)	
1996	694034	-2.2%	86792	12.5%	2743078	-1.1%	151256	5.5%
	(3519)		(523)		(3541)		(382)	
1997	728367	-0.8%	84792	11.6%	2620956	-0.6%	143750	5.5%
	(3491)		(533)		(3515)		(319)	
1998	696177	-5.2%	68078	9.8%	2418887	-1.5%	182579	7.5%
	(3479)		(503)		(3501)		(348)	
1999	679635	-3.0%	131938	19.4%	2381912	-1.5%	168144	7.1%
	(3423)		(768)		(3448)		(530)	
2000	644740	-1.7%	69637	10.8%	2214509	0.4%	104466	4.7%
	(3182)		(469)		(3206)		(303)	
2001	651308	-6.2%			2262099	-2.9%		
	(3329)				(3354)			
Average value		-3.2%		12.3%		-1.1%		5.8%

Notes: The values in parentheses denote the number of firms.