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

Kyoji Fukao, Tomohiko Inui, Hiroki Kawai, and Tsutomu Miyagawa

6.1 Introduction

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

From the viewpoint of growth accounting, Japan's low economic growth in the 1990s can be explained by the following three factors. The first factor is a slowdown of the labor supply caused by structural changes, such as population aging and a reduction of the work week. The second factor is a slowdown of total factor productivity (TFP) growth. The third factor is a lack of effective demand and deflation. Many economists agree on the importance of the first factor. But they are not unanimous in their view on the signifi-

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The JIP Database was compiled as part of the Economic and Social Research Institute, Cabinet Office, Government of Japan (ESRI) research project "Japan's Potential Growth." The authors are grateful to Kazuyoshi Nakata (ESRI), Naoki Okumura (ESRI), and the other members of the project for their coordination. The previous version of this paper was presented at the NBER Thirteenth Annual East Asian Seminar on Economics. The authors are grateful for the comments by Takatoshi Ito, Andrew Rose, Peter Drysdale, Keiko Ito, other conference participants, and two anonymous referees, one from the NBER and the other from the University of Chicago Press.

cance of the other two factors, which are the subject of continuing controversy. Based on a growth accounting of the Japanese economy, Hayashi and Prescott (2002) argue that the economic stagnation in Japan in recent years can be explained by the first and second factors, while the demand factor, in their view, does not play an important role. In contrast, M. Fukao (2003) and Yoshikawa (2003) hold that the scarcity of demand is the most important cause of the present stagnation. They also point out the possibility that the recent slowdown of Japan's TFP growth is caused by the decline of capacity utilization and labor hoarding as a result of the recession.

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

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

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

The paper is organized as follows: In the succeeding section, we conduct growth accounting at macro level. In the analysis we will take account of the quality of labor and capacity utilization. We also compare our results with preceding studies on this issue, such as Hayashi and Prescott (2002) and Jorgenson and Motohashi (2003). In section 6.3, we analyze sectoral TFP growth. We show that in the 1990s, TFP growth slowed down in the manufacturing sectors but accelerated in several service sectors. In section

1. The JIP Database has been compiled by us (the four authors of this paper), several economists at ESRI, and graduate students from Keio, Hitotsubashi, Tsukuba, and other universities as part of an ESRI research project. The result of this project is reported in K. Fukao, Miyagawa et al. (2003). The database contains annual information on eighty-four sectors, including forty-nine nonmanufacturing sectors, from 1970 to 1998. These sectors cover the whole Japanese economy. The database includes detailed information on factor inputs, annual nominal and real input-output tables, and some additional statistics, such as research and development (R&D) stock, capacity utilization rate, Japan's international trade statistics by trade partner, inward and outward FDI, and so on at the detailed sectoral level. An Excel file version (in Japanese) of the JIP Database is available at <http://www.esri.go.jp/en/archive/bun/abstract/bun170index-e.html>.

6.4, we examine possible structural factors that have contributed to recent changes in sectoral TFP growth by reviewing recent researches on sectoral productivity. In section 6.5, we will summarize our main results.

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

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

6.2.1 Growth Accounting at the Macro Level

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

$$Y_t = F(K_t, L_t, T_t), \tag{1}$$

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

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

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

where w_K/p and w_L/p denote real service price of capital and real wage rate.

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

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

where $d\ln Y_t$, $d\ln K_t$, and $d\ln L_t$ denote $\ln Y_t - \ln Y_{t-1}$, $\ln K_t - \ln K_{t-1}$, and $\ln L_t - \ln L_{t-1}$ respectively.

And

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

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

Similarly,

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

denotes the average of the cost share of labor at time $t - 1$ and time t. The last term on the right-hand side of equation (2), $d \ln A_t$, denotes the contribution of technology improvement $\ln T_t - \ln T_{t-1}$ to the increase in production at the macro level.

$$d \ln A_t = \frac{\partial \ln F}{\partial \ln T} d \ln T_t$$

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

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

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

$$d \ln Y_t - d \ln N_t = \bar{s}_{Kt}(d \ln K_t - d \ln N_t) + \bar{s}_{Lt}(d \ln \mathrm{MH}_t - d \ln N_t) + \bar{s}_{Lt}(d \ln L_t - d \ln \mathrm{MH}_t) + d \ln A_t, \quad (4)$$

where $d \ln \mathrm{MH}_t$ denotes the growth rate of man-hours worked. The left-hand side of equation (4) denotes real gross domestic product (GDP) growth per working-age population. The four terms on the right-hand side denote the contribution of capital deepening, the contribution of the increase of man-hour input per working-age population, the contribution of the improvement of labor quality,[3] and the contribution of TFP growth respectively.

Panel A of table 6.1 summarizes the result of our growth accounting. Following Hayashi and Prescott (2002), we divided our data into three subperiods, 1973–83, 1983–91, and 1991–98. 1973 is the year of the first oil shock, and 1983 is when recovery from the second oil shock began. This period was followed by the boom of the "bubble economy," which lasted until 1991. Finally, the years from 1991 to 1998 represent the period of economic stagnation. Panel B of table 6.1 shows the growth rate of each production factor in each of the three periods. By comparing panel A and panel B we can derive the cost share of each factor. For example, the average cost share of capital in 1991–98 was 0.33 (=0.96/2.88).

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

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

Table 6.1 **Sources of Economic Growth: 1973–1998 (annual rate %)**

							Contribution of Growth of (Labor Input/Working Age Population)	
	Growth Rate of Real GDP (a) = (c) + (b)	Growth Rate of Working Age Population (b)	Growth Rate of (Real GDP/ Working Age Population) (c)	Growth Rate of TFP (d) = (c) – (e) – (f)	Contribution of Growth of (Real Capital/ Working Age Population) (e)	Subtotal (f) = (g) + (h)	Contribution of Growth of (Manhour Input/ Working Age Population) (g)	Contribution of Improvement of Labor Quality (h)
	A. Growth Accounting without Adjustment of Capacity Utilization Rates							
1973–83	3.56	0.88	2.68	–0.27	1.83	1.12	0.46	0.65
1983–91	3.94	0.84	3.09	0.54	1.47	1.08	0.62	0.46
1991–98	1.25	0.06	1.19	0.11	0.96	0.12	–0.10	0.21
	Growth Rate of (Real Capital/ Working Age Population)	Growth Rate of (Manhour Input/Working Age Population)	Growth Rate of Labor Quality Index					
	B. Growth Rates of Factor Inputs							
1973–83	6.35	0.65	0.92					
1983–91	4.31	0.95	0.70					
1991–98	2.88	–0.14	0.32					

Note: Working age population is defined as persons aged 15–64.

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

- slowdown of the growth of the working-age population: 0.79 percentage points
- slowdown of TFP growth: 0.43 percentage points
- slowdown of the growth of capital stock per working-age person: 0.51 percentage points
- slowdown of the growth of man-hour per working-age person: 0.72 percentage points
- slowdown of the improvement of labor quality: 0.25 percentage points

All these changes contributed to the decline in Japan's economic growth in the period from 1991 to 1998. From a theoretical viewpoint, these changes can be grouped—as argued in section 6.1—into the following three major factors.

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

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

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

Table 6.2 compares the result of the growth accounting of the U.S. economy by Jorgenson, Ho, and Stiroh (2002) with our result on Japan.[4] Fol-

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

Table 6.2 **Sources of Economic Growth: United States-Japan Comparison (annual rate; %)**

	Real GDP Growth (a)	Manhour Growth (b)	Labor Productivity (GDP/Manhour) Growth (c) = (a) – (b)	TFP Growth (d) = (c) – (e) – (f)	Contribution of Labor Quality Growth (e)	Subtotal (f) = (g) + (h)	Contribution of Capital Services/Manhour Growth: Contribution of IT Capital (g)	Contribution of Capital Services/Manhour Growth: Contribution of Non-IT Capital (h)
A. The Result of Growth Accounting for the US Economy: 1973–2000								
1973–95	2.78	1.44	1.33	0.26	0.27	0.80	0.37	0.43
1995–2000	4.07	1.99	2.07	0.62	0.21	1.24	0.87	0.37
B. The Result of Growth Accounting for the Japanese Economy: 1973–1998								
1973–83	3.56	1.53	2.03	–0.30	0.65	1.68	0.16	1.52
1983–91	3.94	1.79	2.15	0.40	0.46	1.29	0.37	0.92
1991–98	1.25	–0.08	1.34	0.03	0.21	1.10	0.33	0.76
1995–98							0.52	0.63

Sources: Information pertaining to U.S. economy from Jorgenson et al. (2002). Information pertaining to Japanese economy from JIP Database.

lowing Jorgenson et al., we have treated information technology (IT) capital and non-IT capital as different factor inputs.[5] Compared with the United States, Japan's TFP growth and labor input growth were significantly lower in the 1990s. On the other hand, there was no large gap in the contribution of labor quality growth and capital deepening. Like the United States, Japan has experienced a rapid increase in the contribution of IT capital deepening in the latter half of the 1990s.

To sum up our Japan–United States comparison, it is confirmed that the three factors—the structural decline in labor input growth, the slowdown in TFP growth, and the scarcity of demand—caused Japan's "lost decade."

6.2.2 Growth Accounting with Adjustment of Capacity Utilization

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

The JIP Database contains sectoral capacity utilization rates, which are based on the Ministry of Economy, Trade, and Industry (METI) Index of Operating Ratio in the case of the manufacturing and mining sectors and on the intermediate input-capital ratio and the Bank of Japan (BOJ) Excess Capacity D.I. (Diffusion Index) in the case of the other sectors.[6] We used these data for the adjustment of TFP growth. Figure 6.1 shows the average capacity utilization rate of the manufacturing and primary sectors and that of other sectors. The average capacity utilization rate of the manufacturing and primary sectors has declined by 9.5 percentage points from 1991 to 1998. In the case of the other sectors, the decline was negligible (0.5 percentage points). The decline of the average capacity utilization rate of the macro economy was relatively small (2.4 percentage points).

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

5. Because of this difference, the estimated TFP growth in table 6.2 is slightly different from the TFP growth in table 6.1.

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

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

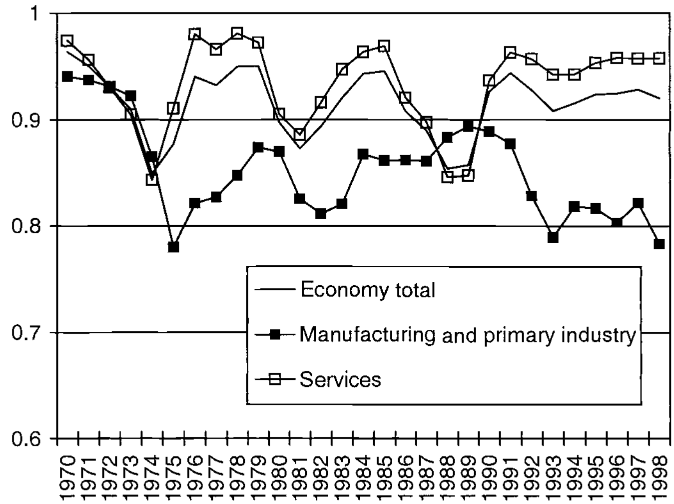

Fig. 6.1 Movement of capacity utilization rate: 1970–1998
Source: JIP Database.

Table 6.3 Growth Accounting with Adjustment of Capacity Utilization: 1973–1998 (annual rate; %)

	Growth Rate of (Real GDP/Working Age Population) (a)	Growth Rate of TFP (b) = (a) – (c) – (d)	Contribution of Growth of (Real Capital · Capacity Utilization Rate/ Working Age Population) (c)	Contribution of Growth of (Labor Input/Working Age Population) (d)
1973–83	2.68	–0.30	1.87	1.12
1983–91	3.09	0.43	1.58	1.08
1991–98	1.19	0.23	0.84	0.12

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

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

Table 6.3 shows the result of this growth accounting. According to the new growth accounting with adjustment of capacity utilization, the decline in TFP growth for the period 1983–91 to the 1991–98 period is 0.20 percentage points, which is 0.23 percentage points smaller than the corresponding result without the adjustment (table 6.1). This difference derives from the fact that the capacity utilization rate was at its peak in 1991. Without the adjustment of capacity utilization, the TFP growth before (after) 1991 is overestimated (underestimated).

Table 6.4 The Result of Growth Accounting: 1973–1998 (annual rate; %)

	Growth Rate of (Real GNP/ Working Age Population) (a)	Growth Rate of TFP (b) = (a) – (c) – (d)	Contribution of Growth of (Real Capital/Working Age Population) (c)	Contribution of Growth of (Manhour/Working Age Population) (d)
1960–73	7.2	4.1	4.1	–1.0
1973–83	2.2	0.5	2.1	–0.4
1983–91	3.6	2.4	1.4	–0.3
1991–2000	0.5	0.2	1.1	–0.8

Source: Hayashi and Prescott (2002).
Note: Working age population is defined as persons aged 20–69.

6.2.3 Comparison between Preceding Researches and Our Results

Let us compare our result with preceding growth accounting studies of the Japanese economy. Table 6.4 shows the result of Hayashi and Prescott (2002). Similar to ours, their result shows that the decline in Japan's economic growth is jointly caused by a slowdown of TFP growth, a slowdown of capital accumulation, and a decline in labor input. But compared with our result, their estimated decline in capital and labor inputs is much more moderate, and as a result their estimated decline in TFP growth (2.2 percentage-point decline) is much larger.

Probably we can explain this difference by the following factors.

First, Hayashi and Prescott do not take account of changes in the quality of labor. As panel B of table 6.1 shows, the improvement of labor quality has slowed down in recent years. They overestimate the decline in TFP growth by neglecting changes in labor quality.

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

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

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

in the 1990s, the contribution of capital deepening in the 1990s, and, as a result, the decline in Japan's TFP growth from the 1980s to the 1990s.

Another important study is that by Jorgenson and Motohashi (2003). They found that Japan's TFP growth rate declined from 0.96 percent in 1975–90 to 0.61 percent in 1990–95 but accelerated to 1.04 percent during 1995–2000. This optimistic result is mainly based on their assumption on the deflator of IT products.[9] They assumed that the relative price of IT products compared with non-IT products in Japan has declined in a similar way as in the United States. They used their own IT product deflator, which is calculated as ([U.S. IT product price]/[U.S. 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 United States than in Japan, this procedure raises their estimation of the GDP growth rate and the TFP growth rate.[10]

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

6.3 Sectoral Productivity Growth in Japan

In the previous section we saw that the decline of Japan's TFP growth in the 1990s was not large when we make adjustments of the capacity utilization. In this section, we analyze Japan's TFP growth over the last three decades at a detailed sectoral level, which was almost impossible before the compilation of the JIP Database.[12]

6.3.1 TFP Growth at the Three-Digit Industry Level

First, let us explain our methodology. For the growth accounting of eighty-four sectors we use the following equation:

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

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

11. Colecchia and Schreyer (2002) adopted similar approach in their comparative analysis of Organization for Economic Cooperation and Development (OECD) countries.

12. Probably the Keio Database (KDB) is the best-known database on Japan's sectoral productivity. The database covers forty-two sectors (including twenty nonmanufacturing sectors). Compared with the KDB, the JIP Database contains information on a detailed sectoral basis, especially in the case of nonmanufacturing sectors. In order to obtain access to the KDB, scholars need to get permission from Keio University.

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

where $d\ln A_{j,t}$ denotes the TFP growth rate from time $t-1$ to t in sector j, while $d\ln Q_{j,t}$ denotes the growth rate of real gross output. $K_{j,t}$, $L_{j,t}$, and $M_{j,t}$ denote the capital, labor, and real intermediate input in sector j at time t. $M_{j,t}$ is a composite index of eighty-four commodities and services, which is based on the annual real input-output (IO) tables of the JIP Database. $Z_{j,t}$ denotes the capacity utilization rate. s_{Kt}, s_{Lt}, and s_{Mt} with upper bars denote the average of cost share of the capital, labor, and intermediate input in sector j at time $t-1$ and time t. In a similar way as in table 6.3, we made adjustments of changes in capacity utilization here.

As Domar (1961) has shown, the contribution of TFP growth in each sector to macro TFP growth is given by that sector's TFP growth rate multiplied by the Domar weight.[13] Table 6.5 shows each industry's TFP growth and its contribution to the macro TFP growth rate for the three subperiods.[14] This result is summarized in figures 6.2 and 6.3 at the two-digit industry level. The correspondence between the three-digit JIP classification and our two-digit classification is reported in table 6.5.

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

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

14. In table 6.5, each industry's contribution for period (T, T') is calculated as a chain index:

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

where $\mathrm{DW}_{j,t}$ denotes the Domar weight for industry j in period t. On the other hand, in the case of our macro growth accounting in table 6.3, we directly compare factor inputs at the beginning and the end period.

$$(\ln Y_{T'} - \ln Y_T) - \left\{\frac{s_{K,T'} + s_{K,T}}{2}\left(\ln\left(\sum_j Z_{j,T'}K_{j,T'}\right) - \ln\left(\sum_j Z_{j,T}K_{j,T}\right)\right) + \frac{s_{L,T'} + s_{L,T}}{2}(\ln L_{T'} - \ln L_T)\right\}$$

Because of this difference, the total of all industries' contribution to macro TFP growth in table 6.5 is not identical with the result in table 6.3.

15. Based on growth accounting at the two-digit industry level, Nishimura et al. (2002) concluded that there was a decline in the rate of technical progress in the 1990s in Japan, and this decline occurred in both manufacturing and nonmanufacturing industries.

Table 6.5 **Sources of Japan's TFP Growth by Industry: 1973–1998 (annual rate; %)**

		TFP Growth (a)			Industry Contributions to Macro TFP Growth (Domar weight) · (a)		
JIP Industry Code	Industry Name (two digit classification)	1973–83	1983–91	1991–98	1973–83	1983–91	1991–98
1 Rice, wheat production	Agriculture, forestry, and fishery	–3.570	–1.418	–3.034	–0.070	–0.020	–0.020
2 Other cultivation and seed planting	Agriculture, forestry, and fishery	0.865	–2.267	–0.122	0.016	–0.034	–0.001
3 Livestock, poultry	Agriculture, forestry, and fishery	2.066	1.830	0.821	0.030	0.019	0.007
4 Veterinary, farming services	Agriculture, forestry, and fishery	–1.974	–0.497	–1.821	–0.004	–0.001	–0.002
5 Forestry	Agriculture, forestry, and fishery	–0.422	–0.931	2.769	–0.008	–0.004	0.009
6 Marine products	Agriculture, forestry, and fishery	0.728	0.136	0.379	0.006	–0.001	0.003
7 Coal, lignite mining	Mining	–5.699	–1.211	–3.425	–0.009	–0.002	–0.001
8 Metal mining	Mining	–0.489	7.249	–9.659	0.000	0.002	0.000
9 Crude oil, natural gas exploration	Mining	–6.924	4.206	–4.385	–0.003	0.001	–0.001
10 Quarry, gravel extraction, other mining	Mining	1.896	0.116	0.046	0.015	0.000	0.000
11 Livestock products	Food processing	–0.452	0.142	0.112	–0.009	0.000	0.001
12 Processed marine products	Food processing	3.407	–4.024	0.014	0.040	–0.061	0.000
13 Rice polishing, flour milling	Food processing	–1.075	–2.787	1.073	–0.022	–0.028	0.011
14 Other foods	Food processing	0.090	0.005	–0.356	0.009	–0.005	–0.011
15 Beverages	Food processing	–0.503	–0.012	–0.113	–0.007	–0.002	–0.001
16 Tobacco	Food processing	0.905	6.678	–6.131	0.003	0.021	–0.019
17 Silk	Textile, apparel and leather products	3.053	0.106	0.084	0.024	0.000	0.000
18 Spinning	Textile, apparel and leather products	1.638	0.782	–1.529	0.004	0.001	–0.001
19 Fabrics and other textile products	Textile, apparel and leather products	0.732	–1.267	–0.286	0.016	–0.024	–0.003
20 Apparel and accessories	Textile, apparel and leather products	–2.083	2.339	–0.439	–0.053	0.043	–0.007
21 Lumber and wood products	Wood, paper and printing	4.068	–0.865	–0.047	0.114	–0.010	0.000
22 Furniture	Wood, paper and printing	1.123	–0.135	–0.855	0.014	–0.001	–0.008
23 Pulp, paper, paper products	Wood, paper and printing	0.362	0.505	0.253	0.009	0.013	0.005

(*continued*)

Table 6.5 (continued)

JIP Industry Code	Industry Name (two digit classification)	TFP Growth (a)			Industry Contributions to Macro TFP Growth (Domar weight) · (a)		
		1973–83	1983–91	1991–98	1973–83	1983–91	1991–98
24 Publishing and printing	Wood, paper and printing	0.685	–0.819	–0.537	0.020	–0.022	–0.013
25 Leather and leather products	Textile, apparel and leather products	0.685	0.766	–0.154	0.002	0.003	–0.001
26 Rubber products	Chemicals	0.137	2.856	–1.582	0.001	0.025	–0.012
27 Basic chemicals	Chemicals	0.447	1.023	0.874	0.017	0.035	0.024
28 Chemical fibers	Chemicals	3.343	0.250	–0.106	0.014	0.000	0.000
29 Other chemicals	Chemicals	1.972	2.256	0.256	0.063	0.071	0.008
30 Petroleum products	Petroleum and coal products	–0.053	2.061	–1.326	0.021	0.039	–0.012
31 Coal products	Petroleum and coal products	0.494	0.707	–1.351	0.009	0.003	–0.003
32 Stone, clay & glass products	Other manufacturing	0.239	0.577	0.689	0.004	0.015	0.015
33 Steel manufacturing	Metal	–0.368	2.926	0.548	–0.001	0.061	0.005
34 Other steel	Metal	–1.133	0.437	–0.299	–0.116	0.019	–0.010
35 Non-ferrous metals	Metal	0.834	0.643	1.201	0.014	0.017	0.017
36 Metal products	Metal	1.068	–0.844	–0.222	0.030	–0.032	–0.006
37 General machinery equipment	General and precision machinery	1.767	0.778	–0.897	0.167	0.075	–0.081
38 Electrical machinery	Electronic and electric equipment	0.091	–0.229	0.190	0.000	–0.003	0.001
39 Equipment and supplies for household use	Electronic and electric equipment	1.730	3.235	–0.334	0.070	0.132	–0.014
40 Other electrical machinery	Electronic and electric equipment	3.079	4.427	1.714	0.105	0.304	0.130
41 Motor vehicles	Transportation equipment	0.624	0.104	–0.170	0.052	0.009	–0.013
42 Ships	Transportation equipment	0.481	1.828	–2.512	0.018	0.018	–0.007
43 Other transportation equipment	Transportation equipment	0.637	–0.538	–0.785	0.008	–0.005	–0.006
44 Precision machinery & equipment	General and precision machinery	1.788	1.787	–0.195	0.024	0.021	–0.004
45 Other manufacturing	Other manufacturing	–0.095	0.273	–0.302	–0.009	0.010	–0.011
46 Construction	Construction and civil engineering	–1.691	0.899	–1.999	–0.248	0.110	–0.221
47 Civil engineering	Construction and civil engineering	0.048	0.885	–0.814	0.013	0.061	–0.067

48 Electricity	Electric, gas, and water supply	–1.824	1.399	–0.136	–0.060	0.041	–0.003
49 Gas, heat supply	Electric, gas, and water supply	–0.619	2.706	0.991	–0.002	0.012	0.005
50 Waterworks	Electric, gas, and water supply	–1.329	0.719	–1.841	–0.010	0.003	–0.011
51 Water supply for industrial use	Electric, gas, and water supply	–1.346	–0.209	–1.850	0.000	0.000	–0.001
52 Waste disposal	Electric, gas, and water supply	–9.904	0.178	–4.630	–0.038	0.003	–0.019
53 Wholesale	Wholesale and retail	3.091	–3.450	3.137	0.360	–0.426	0.390
54 Retail	Wholesale and retail	–1.737	–0.147	0.069	–0.169	–0.028	0.007
55 Finance	Finance, insurance, and real estate	–0.684	3.129	0.015	–0.026	0.173	0.000
56 Insurance	Finance, insurance, and real estate	3.123	2.361	3.574	0.054	0.055	0.065
57 Real estate	Finance, insurance, and real estate	–3.923	–4.634	–0.472	–0.120	–0.155	–0.017
58 Housing	Imputed housing rent	–3.621	0.434	1.559	–0.260	0.031	0.139
59 Railway	Transport	–0.137	–0.134	–4.035	–0.008	–0.006	–0.055
60 Road transportation	Transport	–0.382	–0.633	–1.631	–0.015	–0.027	–0.068
61 Water transportation	Transport	–2.079	–1.198	–1.125	–0.057	–0.013	–0.014
62 Air transportation	Transport	–2.257	1.112	1.804	–0.010	0.007	0.010
63 Other transportation, packing	Transport	0.260	–0.882	–2.003	0.001	–0.010	–0.019
64 Telegraph, telephone	Communication and broadcasting	–0.723	3.465	6.481	–0.016	0.062	0.137
65 Mail	Communication and broadcasting	–5.717	5.370	–2.653	–0.021	0.021	–0.011
66 Education (private, nonprofit)	Public services, general government, and misc. sectors	–1.480	1.146	1.570	–0.014	0.014	0.021
67 Research	Public services, general government, and misc. sectors	3.861	2.027	3.762	0.006	0.005	0.010
68 Medical, hygiene (private)	Public services, general government, and misc. sectors	3.004	–1.565	–1.851	0.099	–0.060	–0.074
69 Other public services	Public services, general government, and misc. sectors	–2.582	0.711	–0.598	–0.020	–0.013	–0.002
70 Advertising	Business services	3.001	0.783	–2.361	0.029	0.011	–0.030
71 Rental of office equipment and goods	Business services	2.080	–11.249	1.367	0.023	–0.183	0.035
72 Other services for businesses	Business services	–4.500	3.091	–0.390	–0.175	0.169	–0.031
73 Entertainment	Private services	–2.826	–1.170	–1.681	–0.061	–0.036	–0.045

(*continued*)

Table 6.5 (continued)

		TFP Growth (a)			Industry Contributions to Macro TFP Growth (Domar weight) · (a)		
JIP Industry Code	Industry Name (two digit classification)	1973–83	1983–91	1991–98	1973–83	1983–91	1991–98
74 Broadcasting	Communication and broadcasting	–0.126	–2.800	0.284	–0.002	–0.014	0.001
75 Restaurants	Private services	0.197	–0.675	1.136	0.010	–0.033	0.057
76 Inns	Private services	–0.542	–2.686	1.992	–0.008	–0.038	0.027
77 Laundry, hair-cutting, public bath	Private services	–3.787	2.719	–0.489	–0.036	0.031	–0.005
78 Other services for individuals	Private services	–1.658	4.421	–0.733	–0.015	0.047	–0.009
79 Education (public)	Public services, general government, and misc. sectors	–3.205	1.076	–0.255	–0.119	0.040	–0.010
80 Medical, hygiene (public)	Public services, general government, and misc. sectors	2.197	–1.891	–0.156	0.025	–0.022	–0.006
81 Public administration	Public services, general government, and misc. sectors	–1.000	–1.574	0.440	–0.073	–0.107	0.034
82 Medical, hygiene (nonprofit)	Public services, general government, and misc. sectors	2.179	–0.652	–1.156	0.017	–0.007	–0.016
83 Others (nonprofit)	Public services, general government, and misc. sectors	0.911	–1.449	2.314	0.010	–0.018	0.031
84 Activities not elsewhere classified	Public services, general government, and misc. sectors	n.a.	n.a.	n.a.	0.000	0.000	0.000
Manufacturing subtotal					0.655	0.743	–0.028
Total					–0.307	0.403	0.197

Note: n.a. = not available.

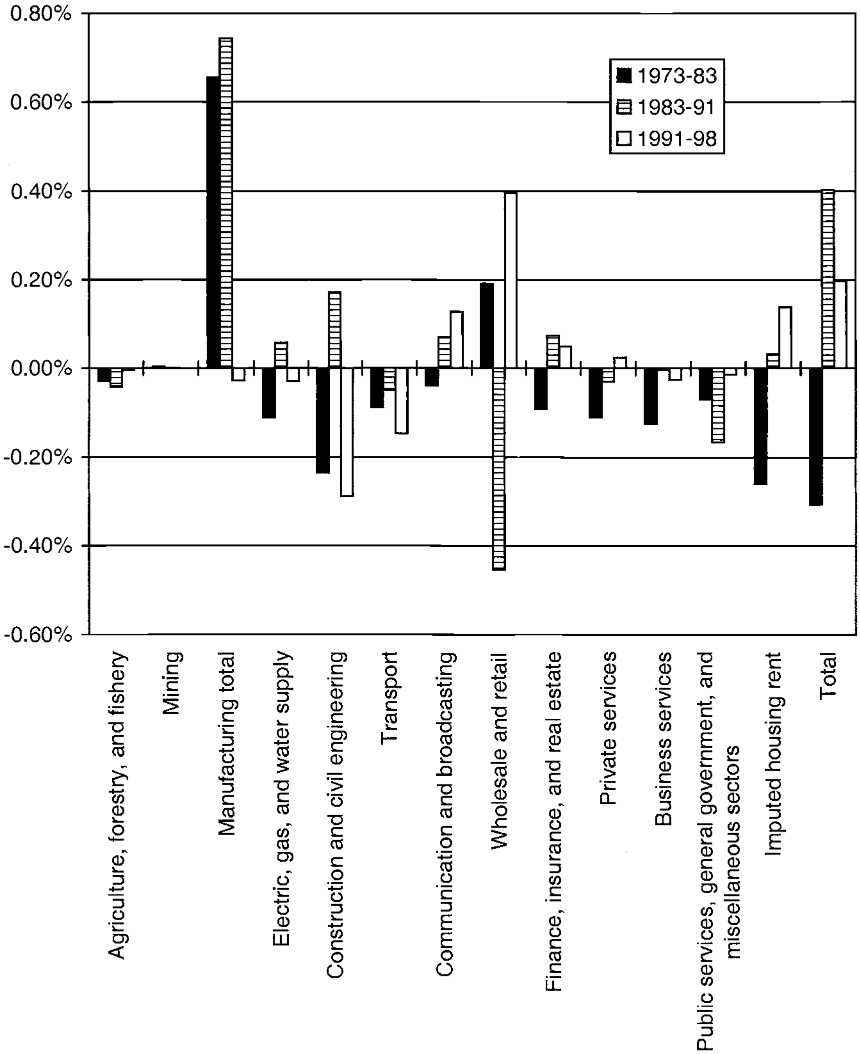

Fig. 6.2 Industry contributions to aggregate TFP growth

from –0.34 percentage points in 1983–91 to 0.22 percentage points in 1991–98.[16]

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

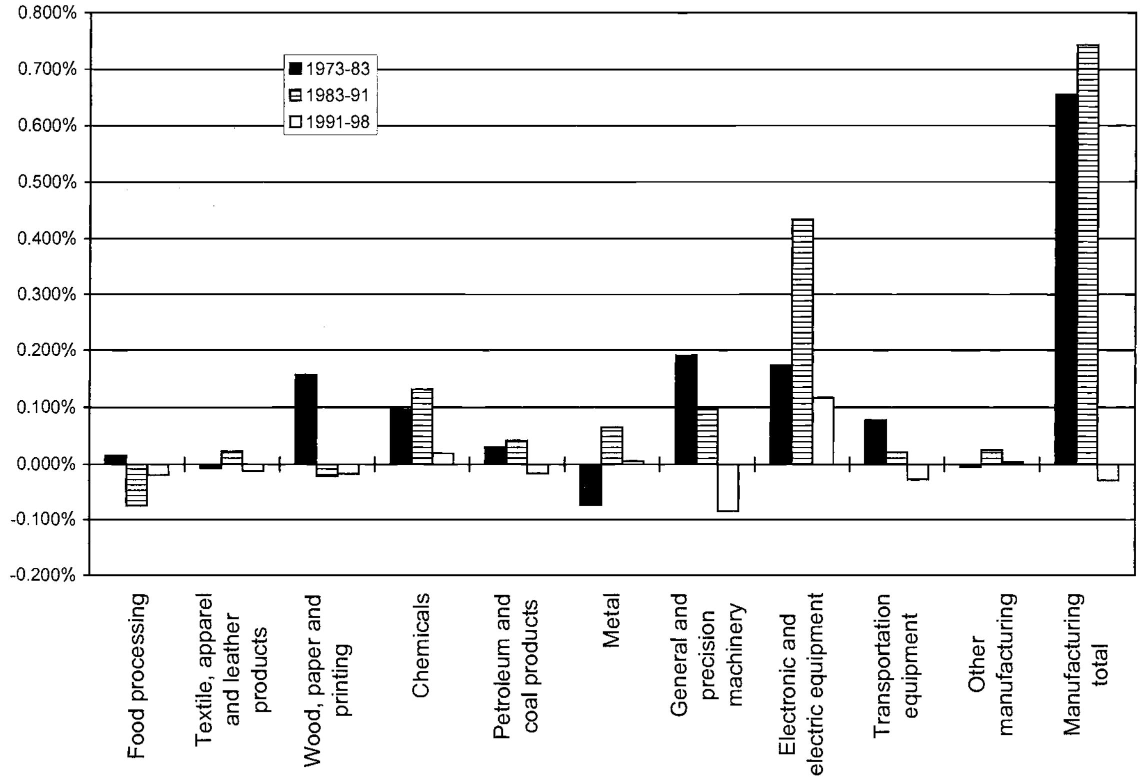

Fig. 6.3 Industry contributions to aggregate TFP growth: Manufacturing industry

6.4 Possible Structural Factors behind the Recent Change in Sectoral TFP Growth

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

6.4.1 Deregulation and the Acceleration of TFP Growth in the Nonmanufacturing Sector

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

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

Telecommunication: Privatization of Nippon Telegraph and Telephone Corporation (NTT, 1985), introduction of the competition principles in all market areas (1985), liberalization of public-leased-public interconnections (1996), abolition of foreign capital regulations (excluding NTT and Kokusai Denshin Denwa Corporation [KDD]), complete privatization of KDD (1998)

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

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

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

Employment placement: Expansion of occupations (mainly nonmanufac-

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

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

Table 6.6 **Frequency Measure of Deregulation: 1970, 1980, 1990, and 1998**

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

Source: Nakanishi and Inui (2003).

turing occupations) to be covered by fee-charging employment placement agencies (1990, 1997)

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

Using the JIP Database, Nakanishi and Inui (2003) have tested whether Japan's deregulations have contributed to TFP growth. For this study they prepared a panel data set of a sectoral deregulation index for sixty-eight industries and for every five-year period from 1970 onward. This index is a frequency measure. A value of industry *i* and year *t* denotes the percentage of regulations abolished by year *t* in relation to the total number of regulations that existed in the starting year 1970.[19] The chronology of Japan's deregulation is taken from Sumitomo-Life Research Institute (1999) and Ministry of Public Management, Home Affairs, Posts and Telecommunications (2000). Table 6.6 shows their deregulation index at a relatively aggregated level. We can see that the manufacturing sector was not regulated even in 1970, whereas deregulation in the nonmanufacturing sector accelerated in the 1990s. The increase in the deregulation index was particularly large—more than 20 percentage points—in communication, wholesale and retail trade, and finance, insurance, and retail from 1980 to 1998. This finding is consistent with our result of rapid TFP growth in these industries.

The main results of Nakanishi and Inui's regression analysis are reported in table 6.7. The dependent variable is each industry's TFP growth. As explanatory variables they used the deregulation index, the growth rate of R&D stock, the growth rate of IT stock, the spillover effect of IT capi-

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

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

Table 6.7 Result on Determinants of Sectoral TFP Growth (fixed effect modal)

Explanatory Variables	Coefficients	*t*-statistics
Growth rate of deregulation index	0.071	2.314
Growth rate of own R&D stock	0.010	1.506
Growth rate of IT capital	–0.002	–0.199
Spillover effect of the growth of IT capital in other industries	0.000	0.000
Subsidiaries paid by the government/production of that industry	0.001	0.972
Time trend	–0.001	–2.499

Source: Nakanishi and Inui (2003).

Notes: Dependant variable is sectoral TFP growth. Number of observations = 340. Adjusted $R^2 = 0.080$.

tal growth in other industries, the subsidiaries-production ratio, and a time trend. They pooled data for sixty-eight industries for every five-year period from 1980 to 1998 and estimated a fixed effects model. They found that the increase in the deregulation index has a significant positive effect on that industry's TFP growth.

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

Table 6.8 compares the TFP growth rates during the 1990s in major service sectors in Japan, Australia, and the United States.[20] Total factor productivity growth rates in Australia are taken from McLachlan, Clark, and Monday (2002). Total factor productivity growth rates in the United States are taken from Yoshikawa and Matsumoto (2001). In these studies value added is used as a measure of output. For this international comparison we calculated Japan's value added based TFP growth rate of the service industries from the JIP Database. Compared with Australia, Japan's TFP growth rate in the 1990s was lower in six out of nine industries. Compared with the United States, Japan's TFP growth rate in the 1990s was lower in five out of eight industries. And in the case of average of service industries, Japan's TFP growth is still lower than that of the other countries.

The most developed economies have experienced a shift in the production structure from manufacturing to services. Hence, in order to maintain

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

Table 6.8 International Comparison of (Value Added Based) TFP Growth (annual rate; %)

Source	Australia (1993–200)	United States (1990~1999)	Japan 1990~1998)
Electricity, gas and water	1.6	1.0	–0.1
Construction	1.1	–0.7	–3.8
Wholesale	5.2	3.6	5.1
Retail	1.1	2.0	0.4
Restaurants	0.3	n.a.	1.6
Transportation	1.8	2.3	–3.0
Communication	4.0	2.4	6.0
Finance and insurance	1.2	1.5	1.8
Entertainment	–3.7	0.5	–4.5
Service sector average	2.2	1.8	0.9

Sources: Information for Australia from McLachlan, Clark, and Monday (2002). Information for the United States from Yoshikawa and Matsumoto (2001). Information for Japan from JIP Database.

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

the pace of TFP growth in the economy as a whole, an acceleration of TFP growth in the service industries is very important.

6.4.2 Decomposition Analysis of TFP Growth in the Manufacturing Sector

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

As Baily, Hulten, and Campbell (1992) and Foster, Haltiwanger, and Krizan (1998) have shown in their productivity decomposition analysis, the start-up of productive establishments and the closure of unproductive establishments substantially contributed to U.S. TFP growth. As figure 6.4 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 United States in the 1980s. Moreover, the gap has widened in the 1990s. In particular, the start-up rate in Japan's manufacturing sector has declined to about 2 percent in recent years. Probably this factor has contributed to the slowdown in TFP growth in Japan's manufacturing sector.

Using firm-level data from the Ministry of International Trade and Industry's Kigyo Katsudo Kihon Chosa (Basic Survey on Business Activities by Enterprises), K. Fukao and Kwon (2003) studied this issue.[21] Adopting

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

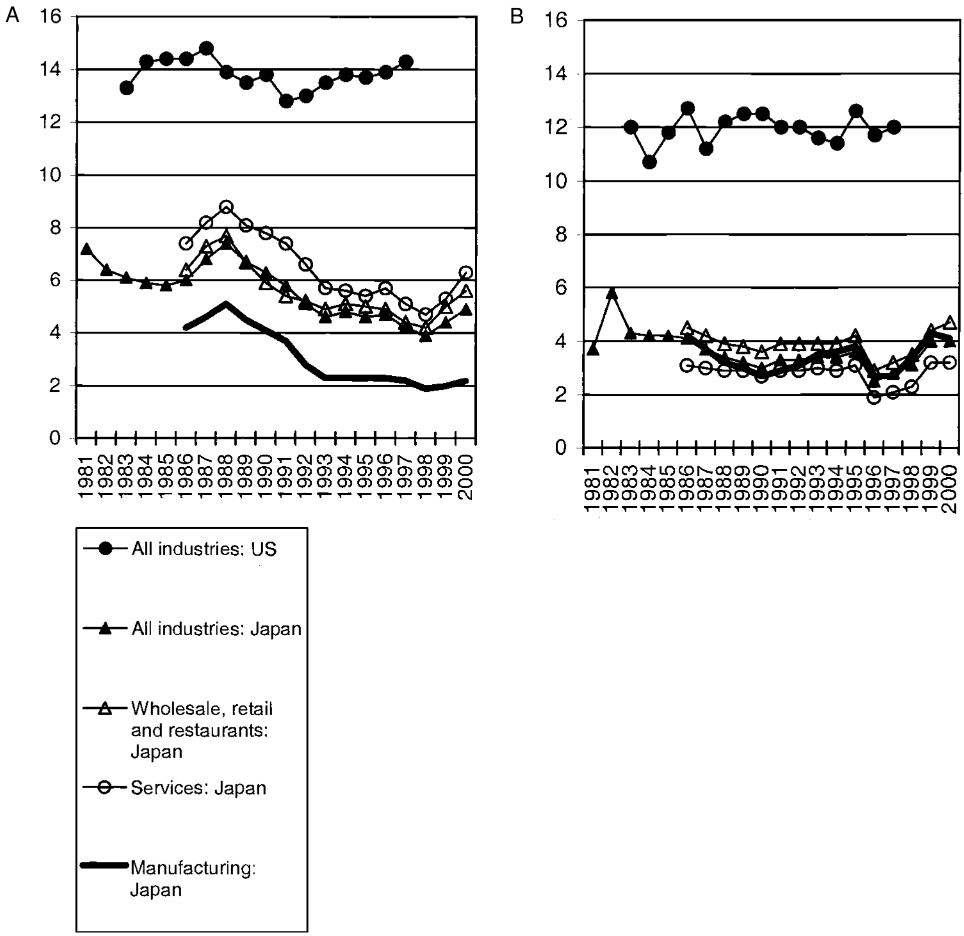

Fig. 6.4 Start-up and closure rate of establishments: Japan–United States comparison: *A*, start-up rate (%); *B*, closure rate (%)

Sources: Small Business Administration, U.S. 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, Japan (2002).

Note: Both the U.S. and the Japanese data are based on statistics of employment insurance program.

the methodology used by Baily, Hulten, and Campbell (1992) and Foster, Haltiwanger, and Krizan (1998), they decomposed the manufacturing sector's TFP growth of the 1994–98 period into the following five factors.[22]

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

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

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

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

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

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

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

Fukao and Kwon's (2003) decomposition result is reported in tables 6.9 and 6.10.[24] Following preceding studies, they conducted a decomposition for the upturn period (1994–96) and for the downturn period (1996–98) separately. Table 6.11 compares their results with those of preceding studies for the United States and South Korea.

Their major findings are as follows.

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

The foregoing results seem to indicate that the promotion of new entries and making both the exit process and the reallocation process of resources more efficient are very important for an acceleration of TFP growth in Japan's manufacturing sector. These factors, moreover, are closely related

23. Because of the limitation of the data they could not take account of the change in labor quality in their TFP analysis. Probably because of this difference, their estimate of TFP growth is higher than our results in sections 6.2 and 6.3. They also assume that working hours and the capacity utilization rate at each firm are identical with those of the industry average. They divide the manufacturing firm data into fifty-eight sets of different industries and evaluate each firm's relative TFP level in relation to the industry average.

24. Switch-in and switch-out effect in table 6.9 and 6.10 denote contribution of the firms that moved from one industry to another industry to the industry average of TFP level.

Table 6.9 **Decomposition of Sectoral TFP Growth: Upturn Period, 1994–1996 (growth in two years)**

	Within Effect (a)	Between Effect (b)	Covariance Effect (c)	Total Effect among Stayers (d) = (a) + (b) + (c)	Entry Effect (e)	Exit Effect (f)	Switch-in Effect (g)	Switch-out Effect (h)	Net-entry Effect (i) = (e) + (f) + (g) + (h)	Industry Total (j) = (d) + (i)
Livestock products	–.006	–0.002	0.001	–0.007	–0.003	–0.001	–0.001	0.003	–0.002	–0.010
Seafood processing	0.011	0.002	0.001	0.014	0.010	–0.007	0.009	0.002	0.014	0.028
Manufacture of flour and grain mills products	0.030	0.003	–0.004	0.030	0.010	–0.013	–0.001	0.000	–0.003	0.027
Manufacture of miscellaneous food and related products	0.098	0.002	–0.012	0.088	0.014	–0.001	0.002	–0.003	0.013	0.100
Soft drinks, carbonated water, alcoholic beverages, tea and tobacco manufactures	0.003	0.001	0.000	0.004	0.001	–0.003	0.000	0.000	–0.001	0.003
Prepared animal foods and organic fertilizers	–0.049	–0.003	0.003	–0.049	–0.009	–0.001	–0.007	0.004	–0.013	–0.062
Silk reeling plants and spinning mills	–0.071	0.008	0.007	–0.056	–0.026	0.001	0.012	–0.013	–0.026	–0.081
Woven fabric and knitting mills	0.060	–0.003	0.009	0.066	0.009	–0.015	0.007	0.004	0.004	0.070
Dyed and finished textiles	–0.190	–0.001	0.001	–0.189	–0.027	0.009	–0.003	–0.010	–0.031	–0.220
Miscellaneous textile mill products	0.072	–0.001	0.005	0.075	0.022	0.004	0.017	–0.004	0.039	0.114
Apparel	0.041	0.000	–0.004	0.037	0.042	–0.002	0.000	0.002	0.042	0.079
Manufacture of miscellaneous textile apparel and accessories	0.066	–0.005	0.000	0.061	0.024	–0.012	0.027	–0.004	0.035	0.096
Sawing, planning mills and plywood products	0.010	0.010	0.021	0.042	0.000	0.005	0.000	0.000	0.005	0.047
Miscellaneous manufacture of wood products	0.023	0.006	0.004	0.033	0.023	–0.014	0.047	0.043	0.099	0.133
Manufacture of furniture and fixture	0.146	–0.001	0.005	0.150	0.047	0.000	0.002	–0.004	0.045	0.196
Pulp and paper	0.016	0.001	0.000	0.017	0.003	–0.003	0.003	–0.001	0.002	0.018
Coated and glazed paper	0.032	–0.005	0.020	0.047	0.011	0.007	–0.002	0.002	0.018	0.065
Newspaper industries	0.021	–0.002	0.005	0.024	0.010	–0.001	0.002	0.001	0.012	0.036
Publishing industries	0.031	–0.002	0.002	0.032	0.005	0.000	0.002	0.002	0.008	0.040
Publishing and allied industries	0.043	–0.008	–0.001	0.034	0.013	0.003	0.001	0.001	0.018	0.052

(*continued*)

Table 6.9 (continued)

	Within Effect (a)	Between Effect (b)	Covariance Effect (c)	Total Effect among Stayers (d) = (a) + (b) + (c)	Entry Effect (e)	Exit Effect (f)	Switch-in Effect (g)	Switch-out Effect (h)	Net-entry Effect (i) = (e) + (f) + (g) + (h)	Industry Total (j) = (d) + (i)
Industrial inorganic chemicals	0.059	–0.092	0.009	0.066	0.021	0.005	0.016	–0.007	0.034	0.100
Industrial organic chemicals	0.023	0.001	–0.002	0.022	0.017	0.000	0.000	0.003	0.020	0.042
Chemical fiber	–0.001	0.000	0.000	–0.001	–0.004	0.006	–0.003	0.000	0.000	–0.001
Oil and fat products, soaps, synthetic detergents, surface-active agents and paints	–0.015	0.003	0.005	–0.008	–0.008	–0.006	–0.001	0.002	–0.012	–0.020
Drugs and medicines	0.055	0.000	0.000	0.055	0.017	–0.007	0.001	0.000	0.011	0.066
Miscellaneous chemical and allied products	–0.061	–0.006	0.004	–0.063	–0.006	0.010	–0.009	0.002	–0.003	–0.066
Petroleum refining	0.004	0.000	0.000	0.004	0.000	–0.002	0.000	0.000	–0.003	0.002
Miscellaneous chemical and allied products	0.101	0.017	–0.054	0.064	0.000	–0.058	0.008	0.009	–0.041	0.023
Manufacture of plastic products	0.025	0.000	0.004	0.029	0.010	0.002	0.001	–0.003	0.010	0.038
Tires and inner tubes	–0.001	–0.001	0.000	–0.001	0.000	0.010	–0.001	–0.001	0.008	0.007
Miscellaneous rubber products	0.006	–0.004	0.002	0.005	–0.004	–0.003	–0.002	0.000	–0.008	–0.004
Manufacture of leather tanning, leather products and fur skins	0.104	–0.006	0.044	0.142	0.056	0.003	0.000	–0.008	0.051	0.193
Glass and its products	0.009	0.001	0.005	0.016	–0.003	–0.003	0.000	0.002	–0.004	0.012
Cement and its products	0.017	–0.004	0.005	0.018	0.009	–0.004	0.005	–0.001	0.009	0.027
Miscellaneous ceramic, stone and clay products	0.036	–0.002	–0.002	0.031	0.002	0.003	0.000	0.000	0.006	0.037
Pig iron and steel	0.012	–0.001	0.000	0.012	0.002	0.000	0.000	–0.004	–0.002	0.010
Miscellaneous iron and steel	0.055	–0.008	0.015	0.062	0.010	–0.001	0.009	0.005	0.023	0.085
Smelting and refining of non-ferrous metals	0.027	–0.008	–0.001	0.018	0.003	0.004	0.003	–0.003	0.006	0.025
Miscellaneous non-ferrous processing metal products	0.042	–0.001	0.010	0.051	0.013	–0.002	0.005	0.002	0.018	0.069
Fabricated constructional and architectural metal products	0.036	–0.001	0.000	0.035	0.008	–0.003	0.007	–0.006	0.006	0.042

Miscellaneous fabricated metal products	0.027	–0.002	0.003	0.028	0.004	–0.004	0.015	0.002	0.018	0.046
Metal working machinery	0.145	–0.023	0.028	0.151	0.028	0.008	0.032	–0.037	0.031	0.182
Special industry machinery	0.036	–0.001	0.001	0.036	0.004	–0.001	0.013	0.000	0.015	0.051
Office, service industry and household machines	0.018	0.001	0.002	0.021	0.008	0.006	0.002	–0.006	0.009	0.030
Miscellaneous machinery and machine parts	0.023	–0.002	0.003	0.023	0.009	–0.001	0.004	0.001	0.013	0.037
Industrial electric apparatuses	0.006	–0.003	0.002	0.005	0.000	0.003	–0.002	–0.001	0.000	0.005
Household electric appliances	0.012	0.005	0.016	0.033	0.005	–0.001	0.004	0.009	0.017	0.050
Communication equipment and related products	–0.001	0.000	0.005	0.003	0.000	–0.003	0.002	0.002	0.002	0.005
Electronic data processing machines and electronic equipment	0.005	0.001	–0.001	0.005	0.001	0.003	–0.001	–0.001	0.002	0.007
Electronic communication equipment and related products	0.076	0.000	0.002	0.078	0.010	0.002	0.015	0.001	0.027	0.106
Miscellaneous electrical machinery equipment and supplies	–0.025	0.002	0.004	–0.018	–0.006	–0.002	–0.010	0.006	–0.012	–0.030
Motor vehicles, parts and accessories	0.007	–0.001	0.002	0.008	0.000	0.000	0.000	0.000	–0.001	0.007
Miscellaneous transportation equipment	0.011	–0.001	0.006	0.016	0.000	0.002	–0.002	–0.005	0.012	
Medical instruments and apparatuses	0.068	–0.004	0.008	0.072	0.034	0.007	0.006	–0.008	0.039	0.111
Optical instruments and lenses	0.046	–0.016	0.016	0.046	0.010	–0.033	–0.006	–0.004	–0.033	0.013
Watches, clocks, clockwork-operated devices and parts	–0.048	0.008	–0.017	–0.057	–0.006	0.012	–0.007	0.000	–0.001	–0.058
Miscellaneous precision instrument	0.073	–0.006	0.001	0.068	0.026	–0.002	0.004	–0.001	0.027	0.095
Miscellaneous manufacturing industries	0.007	–0.002	0.000	0.005	0.009	0.004	0.014	0.013	0.040	0.045
Weighted average of all the industries	0.029	–0.001	0.003	0.030	0.008	–0.002	0.006	0.002	0.014	0.044
Share of each factor in industry's TFP growth	0.65	–0.03	0.06	0.68	0.17	–0.04	0.14	0.04	0.32	1.00

Table 6.10 Decomposition of Sector TFP Growth: Downturn Period, 1996–1998 (growth in two years)

	Within Effect (a)	Between Effect (b)	Covariance Effect (c)	Total Effect among Stayers (d) = (a) + (b) + (c)	Entry Effect (e)	Exit Effect (f)	Switch-in Effect (g)	Switch-out Effect (h)	Net-entry Effect (i) = (e) + (f) + (g) + (h)	Industry Total (j) = (d) + (i)
Livestock products	–0.008	–0.002	0.001	–0.008	–0.006	0.001	–0.002	0.002	–0.005	–0.014
Seafood processing	0.016	–0.004	0.005	0.017	0.013	–0.009	0.000	–0.003	0.001	0.018
Manufacture of flour and grain mills products	0.032	0.003	0.000	0.035	0.051	–0.006	0.000	0.001	0.045	0.080
Manufacture of miscellaneous food and related products	0.000	0.001	0.003	0.004	0.009	–0.004	0.002	–0.001	0.007	0.011
Soft drinks, carbonated water, alcoholic beverages, tea and tobacco manufactures	–0.001	0.000	0.000	–0.001	–0.001	0.001	–0.001	0.000	–0.001	–0.001
Prepared animal foods and organic fertilizers	–0.013	–0.013	0.002	–0.013	–0.006	0.003	–0.004	0.005	–0.002	–0.015
Silk reeling plants and spinning mills	–0.040	0.003	0.013	–0.024	–0.015	0.027	0.032	–0.002	0.042	0.017
Woven fabric and knitting mills	–0.033	–0.002	0.003	–0.032	0.000	0.000	0.002	–0.005	–0.004	–0.036
Dyed and finished textiles	–0.002	–0.002	0.019	0.015	–0.002	–0.019	0.000	0.004	–0.017	–0.003
Miscellaneous textile mill products	–0.057	–0.001	0.011	–0.047	–0.026	–0.002	–0.008	–0.003	–0.039	–0.086
Apparel	–0.033	0.007	–0.007	–0.034	0.006	–0.015	–0.001	–0.002	–0.012	–0.046
Manufacture of miscellaneous textile apparel and accessories	–0.059	0.000	–0.007	–0.065	–0.013	0.001	0.008	0.006	0.001	–0.064
Sawing, planning mills and plywood products	–0.069	0.001	0.007	–0.061	–0.023	0.008	–0.013	–0.003	–0.031	–0.092
Miscellaneous manufacture of wood products	–0.015	–0.016	0.004	–0.027	–0.027	–0.015	–0.014	0.008	–0.049	–0.076
Manufacture of furniture and fixture	–0.049	–0.001	0.007	–0.043	–0.024	–0.006	–0.004	0.002	–0.032	–0.075
Pulp and paper	0.000	0.001	0.002	0.003	–0.004	0.004	0.003	–0.003	0.000	0.003
Coated and glazed paper	–0.021	–0.003	0.005	–0.019	–0.015	0.006	0.000	–0.001	–0.010	–0.029
Newspaper industries	–0.030	–0.001	0.003	–0.028	0.009	–0.005	–0.002	0.000	0.002	–0.026
Publishing industries	–0.026	–0.004	0.003	–0.026	0.000	–0.001	0.000	0.001	0.000	–0.026
Publishing and allied industries	–0.019	–0.001	0.003	–0.016	0.007	–0.001	–0.001	–0.001	0.004	–0.012
Industrial inorganic chemicals	0.036	0.003	0.004	0.043	0.004	0.002	0.003	–0.004	0.004	0.047

Industrial organic chemicals	0.012	–0.001	0.001	0.013	0.010	–0.009	0.003	–0.001	0.003	0.016
Chemical fiber	0.000	–0.002	0.000	–0.002	0.000	0.000	–0.003	0.003	0.000	–0.002
Oil and fat products, soaps, synthetic detergents, surface-active agents and paints	–0.008	0.001	0.003	–0.005	0.001	0.000	–0.001	–0.001	0.000	–0.005
Drugs and medicines	0.005	0.000	0.001	0.006	0.002	–0.013	0.001	0.000	–0.010	–0.004
Miscellaneous chemical and allied products	0.004	–0.001	0.007	0.010	0.002	0.009	0.001	0.007	0.018	0.028
Petroleum refining	0.001	–0.002	0.003	0.003	0.002	0.000	0.000	0.000	0.002	0.004
Miscellaneous chemical and allied products	0.015	–0.003	0.003	0.016	0.008	–0.002	0.006	0.008	0.019	0.035
Manufacture of plastic products	–0.038	0.002	0.005	–0.036	0.000	–0.001	–0.003	0.001	–0.003	–0.039
Tires and inner tubes	0.00	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.001
Miscellaneous rubber products	–0.048	0.002	–0.003	–0.048	–0.003	0.007	–0.001	0.003	0.006	–0.042
Manufacture of leather tanning, leather products and fur skins	–0.072	–0.006	0.011	–0.067	–0.016	–0.004	0.001	–0.001	–0.021	–0.088
Glass and its products	–0.011	0.002	0.005	–0.004	0.001	0.003	0.001	0.003	0.008	0.004
Cement and its products	0.011	–0.006	0.007	0.012	0.009	–0.013	–0.003	–0.001	–0.008	0.004
Miscellaneous ceramic, stone and clay products	0.013	0.003	0.012	0.029	0.013	–0.005	0.006	0.005	0.018	0.047
Pig iron and steel	–0.003	0.000	0.002	–0.001	0.004	–0.003	0.001	–0.001	0.001	0.000
Miscellaneous iron and steel	–0.034	0.002	0.000	–0.033	–0.006	–0.002	–0.007	0.002	–0.013	–0.046
Smelting and refining of non-ferrous metals	–0.008	0.00	–0.001	–0.009	–0.002	0.003	0.006	–0.016	–0.009	–0.017
Miscellaneous non-ferrous processing metal products	0.018	0.000	0.000	0.018	0.008	–0.005	0.009	–0.003	0.009	0.027
Fabricated constructional and architectural metal products	–0.033	0.001	–0.003	–0.034	0.003	–0.005	–0.002	–0.003	–0.007	–0.041
Miscellaneous fabricated metal products	–0.009	–0.001	0.004	–0.006	0.003	0.004	–0.001	–0.012	–0.006	–0.012
Metal working machinery	–0.004	–0.007	0.012	0.001	0.000	–0.010	0.006	–0.003	–0.007	–0.006
Special industry machinery	–0.023	0.000	0.005	–0.018	0.001	–0.003	–0.004	–0.002	–0.009	–0.026
Office, service industry and household machines	–0.015	–0.003	0.007	–0.012	0.004	–0.009	–0.003	0.000	–0.007	–0.019

(*continued*)

Table 6.10 (continued)

	Within Effect (a)	Between Effect (b)	Covariance Effect (c)	Total Effect among Stayers (d) = (a) + (b) + (c)	Entry Effect (e)	Exit Effect (f)	Switch-in Effect (g)	Switch-out Effect (h)	Net-entry Effect (i) = (e) + (f) + (g) + (h)	Industry Total (j) = (d) + (i)
Miscellaneous machinery and machine parts	–0.004	0.001	0.003	0.000	0.001	–0.005	–0.001	0.001	–0.004	–0.004
Industrial electric apparatuses	–0.021	–0.001	0.002	–0.019	–0.005	–0.001	–0.001	0.002	–0.005	–0.025
Household electric appliances	0.023	–0.003	0.003	0.023	0.017	–0.010	0.017	0.002	0.027	0.050
Communication equipment and related products	0.010	–0.005	0.000	0.006	0.002	0.001	0.001	0.001	0.005	0.010
Electronic data processing machines and electronic equipment	–0.001	0.000	0.002	0.001	0.003	–0.003	0.001	0.000	0.001	0.002
Electronic communication equipment and related products	0.021	–0.009	0.010	0.022	0.010	–0.013	0.003	–0.002	–0.002	0.020
Miscellaneous electrical machinery equipment and supplies	0.047	–0.011	0.014	0.050	0.000	0.001	0.010	0.002	0.013	0.063
Motor vehicles, parts and accessories	–0.009	0.000	0.002	–0.007	0.000	–0.001	0.000	0.000	–0.001	–0.008
Miscellaneous transportation equipment	–0.004	–0.006	0.012	0.002	0.000	–0.002	–0.012	–0.003	–0.016	–0.014
Medical instruments and apparatuses	–0.055	0.003	0.007	–0.044	–0.009	–0.018	–0.004	0.000	–0.031	–0.076
Optical instruments and lenses	–0.032	0.004	0.020	–0.007	0.004	–0.008	–0.007	0.010	–0.001	–0.008
Watches, clocks, clockwork-operated devices and parts	–0.016	–0.003	0.009	–0.009	0.009	0.010	–0.004	0.010	0.025	0.015
Miscellaneous precision instrument	–0.073	–0.004	0.009	–0.067	–0.007	–0.004	–0.004	0.000	–0.015	–0.083
Miscellaneous manufacturing industries	–0.010	–0.005	0.008	–0.008	0.011	–0.007	–0.005	–0.005	–0.006	–0.014
Weighted average of all the industries	–0.008	–0.002	0.004	–0.005	0.002	–0.003	0.000	–0.001	–0.002	–0.007
Share of each factor in industry's TFP growth	1.17	0.22	–0.62	0.77	–0.31	0.46	0.00	0.08	0.23	1.00

Table 6.11 Comparison of Productivity Decompositions between Japan, the United States, and Korea

Source	Country	Unit of Analysis	Period	TFP Growth Total (%) (a) = (b) + (c) + (f)	Contribution of Each Effect: Within Effect (b)	Redistribution Effect Subtotal (c) = (d) + (e)	Share Effect (d)	Covariance Effect (e)	Net Entry Effect Subtotal (f) = (g) + (h)	Entry Effect (g)	Exit Effect (h)
Downturn											
Hahn (2000)	South Korea	Establishment	1995–98	4.7	–0.09	1.79			3.06		
					(–0.02)	(0.38)			(0.65)		
Baily, Hulten, and Campbell (1992)	U.S.	Establishment	1977–82	2.4	–1.10	2.54			0.96		
					(–0.46)	(1.06)			(0.40)		
Foster, Haltiwanger, and Krizan (1998)	U.S.	Establishment	1977–82	2.7	–0.24	2.24	–0.89	3.13	0.68		
					(–0.09)	(0.83)	(–0.33)	(1.16)	(0.25)		
Fukao and Kwon (2003)	Japan	Firm	1996–98 (fiscal year)	–0.7	–0.80	0.27	–0.15	0.42	–0.16	0.21	–0.37
					(1.17)	(–0.40)	(0.22)	(–0.62)	(0.23)	(–0.31)	(0.54)
Upturn											
Hahn (2000)	South Korea	Establishment	1990–95	23.0	13.11	–0.69			10.58		
					(0.57)	(–0.03)			(0.46)		
Baily, Hulten, and Campbell (1992)	U.S.	Establishment	1982–87	15.6	13.57	3.12			–1.09		
					(0.87)	(0.20)			(–0.07)		
Foster, Haltiwanger, and Krizan (1998)	U.S.	Establishment	1982–87	7.3	3.80	2.41	–1.31	3.72	1.02		
					(0.52)	(0.33)	(–0.18)	(0.51)	(0.14)		
Fukao and Kwon (2003)	Japan	Firm	1994–96 (fiscal year)	4.4	2.87	0.13	–0.13	0.26	1.08	1.36	0.00
					(0.65)	(0.03)	(–0.03)	(0.06)	(0.24)	(0.31)	0.00

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

with the allocation of funds through the financial system. Therefore, the problems in Japan's banking system are likely to have contributed to the slowdown of Japan's TFP growth, and their solution forms an integral part of any attempt to raising the TFP growth rate.[25]

6.5 Conclusions

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

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

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

Appendix A
Data Sources and Estimation Methods of the JIP Database

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

Estimation of Real Net Capital Stock by Industry and by Capital Goods

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

All real series are valued at 1990 prices. Our database consists of eighty-four industries based on the SNA input-output data published by ESRI. As for capital goods, we arrange thirty-seven capital goods in our database based on the commodity flow data in ESRI of the Japanese government. We name our own industry and capital goods classification as in the JIP classification. Our capital stock database covers not only the private sector but also the public enterprise sector and the government service sector. In addition, it includes residential stocks.

Estimation of Benchmark Capital Stock Data (for 1970)

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

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

Second, the sectoral classification in the National Wealth Survey of 1970 is rougher than the JIP industry classification. Therefore, we construct the benchmark stock data that correspond to the JIP industry classification by using the production data in the input-output table for 1970 or the employee data in the Establishment Census of 1969 and 1972.

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

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

Estimation of the Capital Formation Series

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

Estimation of Capital Formation Series by Industry

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

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

Estimation of the Capital Formation Series by Capital Goods

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

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

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

Estimation of the Annual Series of Fixed Capital Formation Matrix

As we have explained, we obtained annual capital formation data by industry or by capital goods. However, we do not have a fixed capital formation matrix for nonbenchmark years. We estimated the fixed capital formation matrix for the intermediate years by the RAS method.

Construction of Real Net Capital Stock for 1970–98

The fixed capital formation estimated in section 6.2 is expressed in nominal terms. We convert the series in nominal terms into 1990 prices by using deflators in the commodity flow data of ESRI.

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

Estimation of Information Technology Capital Stock

Information technology capital goods consist of two types: tangible assets (hardware) and intangible assets (software). Our definition of IT capital goods is similar to that used by the Bureau of Economic Analysis of the U.S. government. Tangible IT assets include office machines, computers, computer peripherals, communications equipment, optical instruments, and medical instruments.[26]

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

Aggregate IT investment including software investment in Japan increased by 12.4 percent per annum from 1970 to 1998 (fig. 6A.1), exceeding the average growth rate of total investment (3.2 percent). The ratio of IT investment to total investment increased from 2.8 percent in 1970 to 31.4 percent in 1998.

However, it did not increase uniformly like U.S. IT investment. In the early 1990s, its growth stagnated. Probably the stagnation was caused by the following two factors. First, investment in tangible IT assets except

26. Recently, many researchers have focused on the effects of IT investment on productivity growth. In the United States, Jorgenson and Stiroh (2000b) and Jorgenson (2001) showed that IT-related capital deepening contributed to the high economic growth rate in the late 1990s in the United States. Van Ark and Timmer (2000) examined output in IT industries and IT investment in developed and Asian countries. Miyagawa, Itoh, and Harada (2002) studied the effects of IT investment on Japan's economic growth using a sectoral database that is at a more aggregated level than the JIP Database.

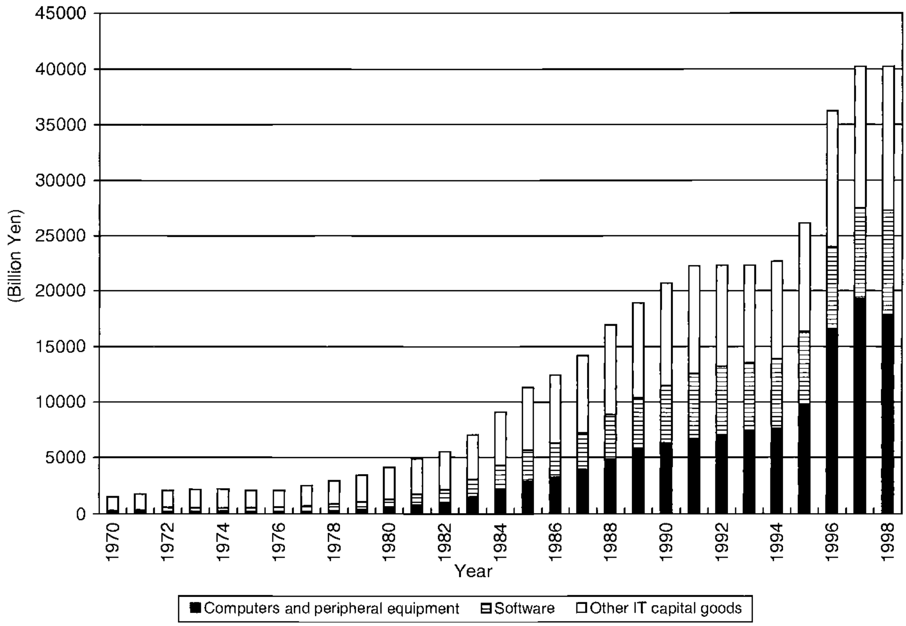

Fig. 6A.1 Aggregate IT investment in Japan (in 1990 prices)

computers and computer peripherals was strongly affected by business cycles. Second, investment in in-house software did not increase in the early 1990s, because Japanese firms had reduced costly in-house software and made an effort to increase outsourcing or utilize more standardized software since the bubble collapsed.

The IT capital stock also increased rapidly. In 1970, the IT capital stock at 1990 prices was only 5.6 trillion yen. In 1998, it reached 136 trillion yen. It grew at 11.4 percent per annum over this twenty-eight-year period. The real growth rate was similar to the nominal growth rate until 1990. However, the price fall in tangible IT capital goods contributed to the real growth of IT capital stock in the 1990s.

Estimation of Labor Input by Industry and Type of Labor

Data Description

Our measures of labor input in the JIP Database are constructed by combining the value estimates from the input-output table matrices and data from several labor force surveys. We constructed a detailed data set of the number of workers N_{ljt}, hours worked H_{ljt}, and the hourly wage W_{ljt} (l = type of worker, j = sector, t = year).

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

- Sex (2): Male, female
- Age (15): 15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85–
- Education (4): Junior high school, high school, college, university or more
- Status (2): Employed, self-employed
- Sectors (84): JIP classification
- Year: 1970–2000

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

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

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

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

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

Estimation of the Sectoral Labor Input

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

$$\mathrm{MH}_{ljt} = N_{kjt} H_{kjt}$$

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

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

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

$$v^{L}_{ljt} = \frac{w_{ljt} \, \mathrm{MH}_{ljt}}{\sum_{l} w_{ljt} \mathrm{MH}_{ljt}}$$

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

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

$$d \ln Q_{jt} = d \ln L_{jt} - \ln \mathrm{MH}_{jt},$$

where MH_{jt} is defined by

$$\mathrm{MH}_{jt} = \sum_{l} N_{kjt} H_{kjt}.$$

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

Estimation of Annual Input-Output Tables

Data Sources

Every five years, the relatively reliable linked input-output (IO) table is available. Therefore we chose the years 1970, 1975, 1980, 1985, 1990, 1995, and the final year 1998 as our benchmark years. Major data sources for our annual IO tables for the benchmark years are

1970–1975–1980: linked input-output tables, Management and Coordination Agency;
1980–1985–1990: linked input-output tables, Management and Coordination Agency;

1985–1990–1995: linked input-output tables, Management and Coordination Agency; and
1998: extended input-output tables, Research and Statistics Department, Economic and Industry Policy Bureau, Ministry of Economy, Trade and Industry.

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

Compilation Process

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

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

We compiled IO tables in real terms (1990 prices) in the following way. 1970–1975–1980 IO tables contain real IO tables at 1980 prices. Similarly, 1980–1985–1990 IO tables contain real IO tables at 1980 prices. We linked these two real IO tables at year 1980. The second and the third IO statistics are linked at year 1990. The third and the fourth IO statistics are linked at year 1995.

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

Estimation of the Supplementary Tables

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

1. Trade Statistics by Industry and Trade Partner Country: 1980, 1985, 1990, 1995, and 2000. Using the supplementary converter table of the input-output tables of the Management and Coordination Agency, we converted the trade statistics of the Harmonized Commodity Description and Coding System (HS) nine-digit level, which are available at http://www

.customs.go.jp, into 302 manufacturing sectors, which are classified by economic activities. Using the linked input-output tables of the Management and Coordination Agency and wholesale price statistics of the Bank of Japan, we also calculated the trade statistics in constant 1990 prices.

2. Inward- and outward-direct investment and service trade statistics by industry. The data are based on Ito and Fukao (2003).

3. Statistics on Japan's industrial structure: advertisement-sales ratio, land input per worker, Herfindahl index, top-four-firm concentration rate, share of firms belonging to vertical and horizontal keiretsu *firms, and so on.* The data are based on Ito and Fukao (2003).

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

In the case of the period after 1991, the Japanese economy stayed in stagnation and many firms answered to *The Short-Term Economic Survey of Enterprises in Japan (Tankan)* of the Bank of Japan that they had excess capacity even at Japan's official business cycle peaks of May 1997 and October 2000.[27] It seems inappropriate to assume that the capacity utilization rate was close to one around these peaks. Therefore we did not adopt the Wharton-type method for the period from 1991. For the nonmanufacturing and nonmining sectors in this period we estimated the capacity utilization rate using the Diffusion Index of Excess Capacity (Excess Capacity D.I.), which is reported in The Short-Term Economic Survey of Enterprises in Japan (Tankan).[28] We used the following procedures. First, we estimated a model in which METI's Index of Operating Ratio is the dependent variable and BOJ's Excess Capacity D.I. is a time trend, and industry dummies are the explanatory variables, using seasonally adjusted quarterly panel data of 112 quarters and twelve manufacturing sectors for which both METI's Index of Operating Ratio and the BOJ's Excess Capacity D.I. are available. Second, we calculated a theoretical value of the capacity utilization rate for each

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

28. The data are available at http://www.boj.or.jp.en/.

nonmanufacturing sector by substituting this sector's Excess Capacity D.I. in the estimated equation. Third, we linked this theoretical value for the period of 1991–98 with the capacity utilization rate for the period of 1970–91, which is derived by the Wharton-type method.[29]

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

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

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Comment Peter Drysdale

This is an important report on work in progress on the huge and substantial job of putting together a big new database (the Japan Industrial Productivity [JIP] Database) that includes detailed information on factor inputs, annual input-output data, price deflators, and R&D, trade, and FDI data at a sectoral level for the Japanese economy.

The objective is to provide a sectoral account of the impact of IT investment and R&D expenditure on TFP growth.

Most studies of these relationships are aggregative. Aggregative studies provide useful first insights but are open to many interpretations. Detailed sectoral study of TFP growth and its causes, or the influences upon it, are theoretically and practically more soundly based and valuable in the understanding of policy issues and the foundation of policy strategies.

The Japan team is to be congratulated on the first large step in their work. One hopes that the database that has been assembled can be made widely available so that its richness can be exploited by researchers everywhere in trying to understand the performance of the Japanese economy.

This is an important issue. The malaise of the Japanese economy over the last decade is alternatively attributed to macro policy failure and micro or productivity failure. Understanding the character and importance of the latter requires, first, accurate measures of it and, second, rigorous analysis of the influences upon it. Only then can policy settings and priorities be got right.

This study confirms the general view that TFP growth mirrors output growth in Japan and that it has been a relatively unimportant element in output growth over the last three decades, but that its relative importance increased in the 1990s, when it accounted for 0.2 percent (or one-third) of the average 0.6 percent growth in that decade. It is not reassuring that growth performance in this decade would have been worse but for TFP growth, perhaps, but, as the paper suggests, it would have been.

The more important point the paper makes is that aggregate TFP performance masks wide differences in TFP performance across sectors.

The paper does not draw out the reasons for these variations, or speculate upon them in a way that might be subject to empirical testing, as freely as it might. This is perhaps the next phase of this project.

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But a casual review of the data and results is suggestive.

The results suggest that among the sectors that have performed well are those that have been subject to deregulation and privatization (transportation, telecommunications in the 1980s, and finance in the 1990s) and that those that are consistently strong performers are those that are more open and subject to the intense competitive forces in the international marketplace (such as manufacturing, the most consistently positive performer).

TFP performance is also associated with price change (deflation) with significant variation across sectors.

The paper makes some curious observations about the effects of the sectoral distribution of TFP growth on the macro economy that can only be understood in the context of popular commentary about "hollowing out" in Japan. In discussing the hollowing-out phenomenon, defined as a declining share of manufacturing output relative to services sector output, the paper observes hollowing out between 1980 and 1998. What is this supposed to imply? The increased importance of the service sector is typically associated with increased specialization and efficiency in the provision of a range of service inputs, as well as increased consumption of service outputs, as incomes rise and economies become more sophisticated. Hollowing out is normally associated in Japan with the relocation of increasingly high-cost (labor-intensive) activities offshore. The connection is that they are the flip side (or part of the flip side) of the same structural change. But the connection is incomplete.

This leads the paper to hypothesize that the cause of declining TFP performance is the shift from high-performing manufacturing to low-performing services. At best this is simply a tautologous argument. At worst it is based on a profound analytical misconception and it is wrong. The best way to make this point is simply to ask, what about Australia or the United States, two economies that are more service-sector-oriented than Japan yet enjoyed strong productivity growth through the 1990s, when Japan's productivity performance was unimpressive?

The paper tries to establish its point by observing, at length, that the "reallocation effect" was negative in the 1990s. Indeed it was. But why in Japan and not in Australia, where the same sectoral shifts have been more pronounced?

The argument in the paper is "neo-physiocratic"—it represents the back-to-manufacturing movement (as distinct from the back-to-agriculture movement). This is a serious flaw in thinking about the issues raised in the paper.

The important question is what slows productivity growth in the services sectors. Regulatory systems and closedness, both of which affect the appreciation of R&D and new technologies, are obvious answers.

The paper does explore the impact of IT investment (even though within the wrong conceptual framework) on productivity performance. The correlation between IT investment and productivity performance is high and positive. There are strong capital-deepening effects of IT investment, but there appear to be weak network effects in Japan. Exploration of significant associations across sectoral performance would seem an obvious and necessary extension of the analysis.

The work of this paper is incomplete. But the study is highly prospective. The careful and detailed analysis of the impact of IT and R&D investments on sectoral performance that has been made possible by this project will be extremely valuable to policymakers. There are more conclusions in the paper in fact than have been drawn out and highlighted. One also hopes that the main conclusions can be simplified and made interpretable to a wider public audience, because wide understanding of the relationships will be crucial to successful policy change.

Comment Keiko Ito

This is a broad-ranging, analytically and empirically strong paper, which investigates the causes of Japan's economic stagnation in the 1990s. The study is based on a newly constructed comprehensive data set, combining macro-, sectoral-, and micro-level analyses. The authors first discuss Japan's productivity growth at the macro level, referring to various empirical results presented in preceding papers that have been hotly debated in Japan. The first issue of contention addressed is whether Japan's economic slowdown in the 1990s is attributable to a decline in total factor productivity (TFP) growth. Contrary to the controversial result obtained by Hayashi and Prescott (2002), the paper finds that the TFP growth slowdown in the 1990s was much more moderate than stipulated by these two authors. The second issue is in what sectors TFP growth has been high or low. The authors find that the slowdown in TFP growth mainly occurred in the manufacturing sector, while TFP growth in the nonmanufacturing sectors accelerated in the 1990s. Finally, they consider some possible structural factors that may have affected sectoral TFP growth. According to their discussion, progress in deregulation may have contributed to the acceleration of TFP growth in some nonmanufacturing sectors, while the exit of firms with a higher TFP level as well as limited new entries may have contributed to the low TFP growth in manufacturing.

Interestingly, their results are not consistent with preceding studies for the first and second points of contention. In the following list, I point out some conspicuous differences between their estimation and that of previ-

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ous studies, which are definitely noteworthy and an important contribution of this paper:

1. The analyses are based on very comprehensive data on capital stock including IT (information technology) and R&D (research and development) capital stock at a detailed industry level.
2. The data include detailed information for the forty-nine nonmanufacturing sectors that will enable us to conduct in-depth and broad studies on the nonmanufacturing sectors as well.
3. In their growth accounting, they take account of labor quality and the capital utilization ratio. The former particularly affects their estimate of the TFP level and its growth rate.

Now I will go into some specific comments on each section. In section 6.2, the authors conduct a macro-level growth accounting and investigate the sources of the Japan's economic growth. Several other researchers have tried to examine this issue, and the estimated TFP growth rate obtained in each paper varies remarkably. As is well known, the weakest point of TFP estimation is that every TFP study offers a different estimate of TFP. As an example, here are some of the macro TFP studies in the 1990s and their estimated TFP growth rates for Japan:

- Hayashi and Prescott (2002): 1983–91 2.4 percent; 1991–98 0.2 percent. Note: using GNP data as value added and including Japan's net external assets in the capital stock.
- Jorgenson and Motohashi (2003): 1975–90 1.01 percent; 1990–95 0.74 percent; 1995–2000 1.13 percent. Note: adopting "internationally harmonized prices" calculated based on the U.S. price deflators for IT products and treating land as a production factor.
- Nakajima et al. (2002): 1985–89 –1.55 percent; 1990–94 –0.87 percent; 1995–99 0.06 percent. Note: The TFP growth rate is estimated by the output and input price changes.
- Miyagawa (2003): 1981–90 1.63 percent; 1991–95 0.56 percent; 1996–99 1.18 percent.
- Fukao et al. (this paper): 1983–91 0.54 percent; 1991–98 0.11 percent. Note: labor quality adjusted.

Given the differences in data and methodologies of TFP calculation,[1] I think that a substantial part of the difference between this study and others probably comes from the treatment of labor input. As can be seen in figure 6C.1, the estimated TFP levels were greatly lowered when labor quality was adjusted. As widely recognized, TFP levels that are calculated as "residuals" become smaller as inputs are calculated more rigorously and

1. The authors provide a detailed explanation of and critical comments on these differences in this paper. I mostly agree with their description.

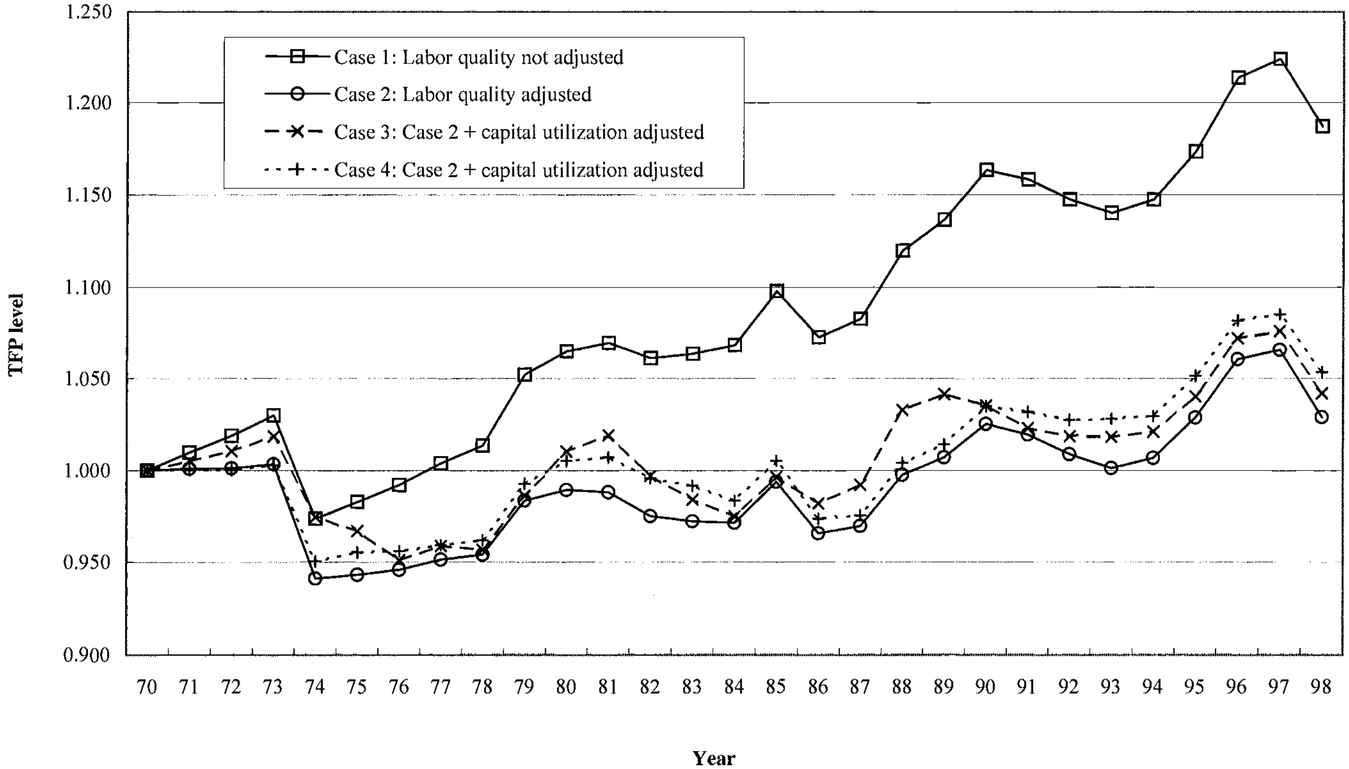

Fig. 6C.1 Trends of macro TFP level (1970 = 1.000)

Source: Fukao et al. (2003), figure 6-1-2, p. 385.

Note: In case 3, capital utilization ratio is calculated from trends of intermediate inputs. In case 4, capital utilization ratio is calculated from trends of output.

precisely. Therefore, given that the authors use the very carefully constructed data set and try to measure factor inputs as precisely as possible, their result seems to be quite convincing, and I appreciate their great contribution, which provides us with evidence that the slowdown of TFP growth was much smaller than estimated by Hayashi and Prescott. However, at the same time, the much smaller slowdown in the TFP growth rate only seems to be a logical conclusion of the much lower TFP levels they obtain. To be honest, the wildly differing results make me wonder about the empirical meaning of TFP. Many readers would also be puzzled by the various TFP growth rates presented previously.

As I already mentioned, whether or not labor quality was controlled greatly affected the TFP estimates, and I think that the labor quality adjustment should be one of the most crucial issues when we evaluate productivity growth in Japan. Their labor quality index is constructed following Jorgenson and Griliches's studies, and the methodology is theoretically and methodologically reasonable under the neoclassical framework. Although I would like to leave an in-depth discussion of labor market issues to labor economists, I would at least like to point out some issues of contention here. These include (1) whether wages reasonably reflect labor quality or productivity, (2) whether differences in educational attainment can be equated with differences in skill levels, (3) whether age differences are proportional to differences in working experience and skills, and so on.

In section 6.3, the authors analyze TFP growth rates by industry, and the detailed industry analysis on nonmanufacturing sectors is particularly interesting. They conclude that the manufacturing sector's contribution to macro TFP growth declined in the 1990s while that of the nonmanufacturing sector accelerated. However, this result is contrary to that of Nakajima et al. (2002) and Cabinet Office (2002). As the authors insist, this paper employs a more careful estimation methodology, and this result may be more reliable. According to their detailed description of the JIP Database construction process, which is reported in Fukao et al. (2003), the definition and price deflators of service output used in this paper seem to follow those used in Cabinet Office (2002) in principle. Therefore, again, I think a substantial part of the difference between the authors' result and that of Cabinet Office probably comes from the labor quality adjustment.[2] Nevertheless, this result seems to be reasonable, and I mostly agree with the authors that TFP growth accelerated in the nonmanufacturing sectors in the 1990s as a consequence of deregulation. Referring to Fukao et al. (2003), however, we should note that the TFP level of the services sector in the 1990s is lower than that in 1970, while the TFP level of the manufacturing sector in

2. Nakajima et al. (2002) use different data and employ a different approach in order to obtain more up-to-date results.

the 1990s is much higher than that in 1970. The widely observed fact in industrialized countries that productivity growth slows down as the share of the service sector in GDP expands implies an urgent need for an accurate measure of output and productivity in the service sector. As has been argued for a long time, measurement difficulties in service-sector output still present an important problem, which we empirical economists must continue to tackle.

In section 6.4, the authors try to interpret the estimated TFP growth, focusing on the deregulation process in the services sector and on the entry–exit behavior of firms in the manufacturing sector. As I already mentioned, I support the authors' view that the deregulation measures are probably the most important source of the observed TFP growth in the services sector. Although they refer to results by Nakanishi and Inui (2003) as empirical evidence on this issue, such studies are very limited, and a sufficient amount of empirical evidence has not been collected to evaluate the effects of deregulation on productivity growth. Further research on this issue would be desirable.

The authors' last analysis is to decompose TFP growth in the manufacturing sector and to investigate how much the entry and exit behavior of firms contributed to TFP growth. Their result is roughly consistent with that of Nishimura, Nakajima, and Kiyota (2003) and reveals that new entries are very limited in Japan and that the average TFP level of exiting firms was higher than that of staying firms. As argued by Nishimura et al., this might imply that natural selection mechanism in the market collapses or malfunctions. Moreover, as the authors mention, this might be related to the problems in Japan's banking system. The TFP decomposition analysis based on firm-level data is interesting in the sense that their result bring out these potential problems. However, as Nishimura et al. describe, we should note data constraints and the drawbacks of the firm-level data of the Ministry of Economy, Trade, and Industry's Basic Survey on Business Activities by Enterprises, which both Nishimura et al. and the authors use for their analyses. In the data set, we cannot accurately determine whether a firm really exited or was merged or acquired, or was dropped from the data set because of other statistical problems. Moreover, given the short time period of the analysis (1994–98), the decomposition result might only have captured a temporary shock or phenomenon.

Last but not least, and despite these criticisms, I would like to confirm again the tremendous contribution of this paper. Their newly constructed database will be extremely helpful for both academics and policymakers who are engaged in research on the Japanese economy and in pursuit of a solution for the economic problems of Japan. Moreover, this paper provides many interesting and insightful findings that should inspire many researchers to greater efforts to find a solution to the serious economic problems we are currently facing. In addition, the paper highlights the vulnerability of TFP estimation to data quality and variable definitions. To what extent do the TFP growth estimates reflect real productivity growth? May it not, to a large part, be reflecting improvements in the quality of the statistics at our disposal? Although the theoretical foundation of TFP estimation is already well established, we may need to develop a new or more sophisticated practical approach to its empirical estimation or to consider an alternative measure for productivity. However, I greatly appreciate the authors' earnest effort to accumulate more and more accurate facts based on carefully collected data sets in pursuit of more convincing policy recommendations.

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