The Causes of Japan's Economic Slowdown and Necessary Policies: An Analysis Based on the Japan Industrial Productivity Database 2018[1]

YoungGak Kim (Senshu University)

HyeogUg Kwon (Nihon University / Research Institute of Economy, Trade and Industry)

Kyoji Fukao (Hitotsubashi University / Research Institute of Economy, Trade and Industry / Institute of Developing Economies, JETRO)

March 2021

Abstract

Using the recently completed Japan Industrial Productivity Database (JIP) 2018 and the EU KLEMS Database 2017, we compare the sources of economic growth of Japan, the U.S., Germany, France, and the U.K. for the period 1995–2015 using growth accounting. We find that the reasons why Japan's economic growth during the 2005–2015 period was much slower than that of the other major economies are the decline in the working-age population and sluggish investment in capital services. Among the five countries, Japan was the only one whose growth rate of the capital stock was lower than the natural growth rate. Moreover, comparing the composition of factor inputs in Japan and the U.S. shows that although inputs of information and communication technology (ICT) and research and development (R&D) capital services in Japan are not particularly low compared to the input of other capital goods, capital accumulation in general has been extremely small. Moreover, investment in economic competencies (worker training and organizational structure), which are thought to be complementary to ICT and R&D capital, has been much smaller than in other countries. Finally, in addition to demographic factors and sluggish capital investment, another reason for the slowdown in Japan's economic growth in 2005–2015 compared to the preceding decade was the decline in TFP growth, which was caused by a drop in productivity growth in a handful of industries, including electronic data processing machines, digital and analog computer equipment and accessories, motor vehicles (including motor vehicle bodies), electricity, and wholesale trade.

[1] The majority of the empirical analysis in this study was conducted as part of a project at the Research Institute of Economy, Trade and Industry. The research was also supported by the project "Service Sector Productivity in Japan: Determinants and Policies" (Japan Society for the Promotion of Science Grant-in-Aid for Scientific Research No. 16H06322). We would like to express our deepest gratitude for the support.

1. Introduction

With Japan's two lost decades (Fukao, 2018a) turning into three lost decades, what the economy needs most to escape from sluggish growth is to raise productivity growth. Against this background, the present study explores productivity developments in the Japanese economy and the causes of its long-term sluggish growth, and then considers policies necessary to overcome this sluggish growth.

In order to offer the correct prescription, it is necessary to accurately understand the disease. To this end, we will focus on macro- and industry-level productivity and its determinants using the Japan Industrial Productivity (JIP) Database 2018 (October 2019 Revision) by the Research Institute of Economy, Trade and Industry and Hitotsubashi University.[2] Compared with its predecessor, the 2015 version of the JIP Database, the JIP Database 2018 has been completely revised and, reflecting changes in the 2008 SNA, for example treats research and development (R&D) expenditure as capital formation. This makes it possible to make comparisons using recent data from the EU KLEMS database (EU KLEMS 2017 Release, Revised July 2018), which already reflects the 2008SNA.[3] We will therefore also conduct various comparisons between Japan and other major advanced economies.

This study is organized as follows. In the next section, using growth accounting, we examine the sources of economic growth in recent years for Japan's economy as a whole and for the manufacturing and the non-manufacturing sector. Moreover, focusing on the market economy, we compare the sources of growth for the Japanese economy with the economies of the U.S., the U.K., Germany, and France. The results indicate that not only Japan but also the U.S., France, and the U.K. experienced a slowdown in total factor productivity (TFP) in 2005–2015 compared to 1995–2005, and that the main reason for the extremely slow growth rate of Japan's market economy compared to the other major economies during 2005–2015 was not sluggish TFP growth but the slowdown in hours worked due to demographic trends as well as a substantial slowdown in capital accumulation. Section 3 therefore considers why capital accumulation in Japan has been so slow from the perspective of neoclassical growth theory. Next, Section 4 examines whether Japan's investment in information and communication technology (ICT) and intangible assets has been particularly low by comparing it with the other major economies. Further, in Section 5, we then use the JIP Database 2018 to examine which industries in particular were responsible for the slowdown in Japan's TFP growth in 2005–2015

[2] The JIP Database 2018 can be downloaded at: https://www.rieti.go.jp/en/database/JIP2018/index.html.
[3] The EU KLEMS data can be downloaded at: http://www.euklems.net/index.html.

compared to the preceding decade. Finally, Section 6 summarizes the findings of this study and considers what policies are necessary for Japan to emerge from its long-term economic stagnation.

2. Sources of economic growth in Japan and major economies: An international comparison using growth accounting

Table 1 shows the growth accounting results for Japan using the JIP Database 2018. Since production-side statistics in Japan's National Accounts corresponding to the 2008 SNA are available only for 1994 onward, the JIP Database 2018 also covers only the period from 1994 onward. The following analysis therefore concentrates on the period from 1994 or 1995 to 2015.

As shown by Fukao et al. (2007), under certain assumptions, such as constant returns to scale and perfectly competitive markets for factors of production, real gross domestic product (GDP) growth and real value-added growth in each industry can be decomposed into the contribution of labor input growth (which is equal to the sum of the contribution of increases in hours worked and the contribution of improvements in labor quality through the accumulation of education and skills), the contribution of capital services input growth, and the contribution of TFP growth, which is calculated as the residual. Table 1 presents such a decomposition for Japan's market economy (excluding housing and activities not elsewhere classified), manufacturing sector, and non-manufacturing sector (market economy only, excluding housing and activities not elsewhere classified).

The term "market economy" refers to the entirety of economic activity excluding the non-market economy (e.g., general government, education, nursing and medical care, imputed rent, etc.), where changes in product prices and real output as well as productivity growth are difficult to measure because suppliers are not compensated for their services, as in the case of government services, or services are not traded at market prices, as in the case of many medical services and imputed rent. Not only is it difficult to measure real output growth and TFP growth for the non-market economy, the way that real output is measured also differs across countries, making international comparisons difficult (for details, see Fukao et al., 2017). Therefore, growth accounting for a particular country and international growth accounting comparisons are usually limited to the market economy. This applies to preceding growth accounting studies based on the EU KLEMS Database, which will be used later for international comparison,[4] as well our growth accounting for Japan, so that throughout this study we will focus on the market economy only.

Table 1. The sources of Japan's economic growth from the supply side

	Market economy (excluding housing and activities not elsewhere classified)		Manufacturing		Non-manufacturing (Market economy only; exlcuding housing and actitivities not elsewhere classified)	
	1995-2005	2005-2015	1995-2005	2005-2015	1995-2005	2005-2015
Real value added growth rate	1.04%	0.15%	1.35%	0.77%	0.92%	-0.09%
Contribution of hours worked	-0.74%	-0.59%	-1.55%	-0.94%	-0.45%	-0.48%
Contribution of labor quality	0.36%	0.28%	0.35%	0.24%	0.36%	0.29%
Contribution of capital services	0.65%	0.10%	0.52%	0.13%	0.71%	0.08%
Contribution of TFP	0.77%	0.38%	2.04%	1.34%	0.30%	0.02%

Source: JIP Database 2018 (September 2019 Revision).

Downloaded from: https://www.rieti.go.jp/en/database/JIP2018/index.html.

Note: GDP is based on the Laspeyres chain index, while labor and capital inputs are based on the Divisia index. The growth contribution of production factors is calculated based on cost shares.

Starting with the market economy as a whole, Table 1 indicates that the real value added growth rate (annual rate; the same applies to growth rates below) declined from 1.04% in 1995–2005 to 0.15% in 2005–2015. During the same period, the growth rate of the economy overall including the non-market economy, i.e., GDP growth, fell from 1.11% to 0.39%. The fact that the growth rate of the economy overall is slightly higher than that of the market economy, and the decline in the growth rate is smaller, likely is due to the expansion of the non-market economy such as nursing care and medical care during this period.

The main reason for the slowdown in the growth of Japan's market economy in 2005–2015 vis-à-vis 1995–2005 is the slowdown in capital services input growth. In 2005–2015, Japan saw a downturn in capital investment due to the global financial crisis triggered by the collapse of Lehman Brothers in 2008, the subsequent appreciation of the yen, and the Tohoku earthquake in 2011. Although the economy has recovered as a result of the depreciation of the yen and the rise in asset prices due to

[4] For a definition of the market economy in the EU KLEMS Productivity Accounts, see Jäger (2018). The EU KLEMS Productivity accounts exclude the entire real estate industry, not just imputed rent, from the market economy.

Abenomics since 2012, the 2005–2015 period as a whole was a period of extremely sluggish capital accumulation.

A second reason for the slowdown in economic growth was the slowdown in TFP growth. As will be discussed later, not only did TFP growth turn negative during the period 2005–2010, including the global financial crisis, it also did not recover very much after 2010.

These two factors alone explain all of the 0.89 percentage point decline in the annual rate of growth of the market economy from the 1995–2005 period to the 2005–2015 period.

In addition, the contribution of labor quality improvements also declined slightly in the latter period. This reflects the fact that while many of the baby boomer generation retired during 2005–2015, many of the jobs created during the period were low-wage jobs taken up by women, whose labor force participation rose, and re-employed elderly workers (Fukao, 2018). As we will see later, the contribution of labor quality improvements has declined substantially, especially since 2010. On the other hand, the increase in the employment rate of women and the elderly counteracted the decline in hours worked due to demographic factors, i.e., the aging and shrinking of Japan's population, which as a result was less pronounced than it otherwise would have been.

To examine this latter point in more detail, Table 2 shows the pace of decline in Japan's working-age population (those aged 15–64 years old), where figures from 2016 onward are based on the population projections of the National Institute of Population and Social Security Research. Specifically, the table shows the average annual rate of change in the working-age population for five-year intervals. As can be seen from the table, the decline in Japan's working age population accelerated from -0.46% in 2000–2005 to -0.65% in 2005–2010 and -1.12% in 2010–2015. In contrast, the rates of decline in hours worked were -0.42%, -0.55%, and -0.04%, respectively – considerably lower than the decline in the working-age population.

Table 2. Rate of decline in Japans' working-age population (those aged 15–64; annual rate, %)

	2000-05	2005-10	2010-15	2015-20	2020-25	2025-30	2030-35	2035-40
Rate of change in working age population (those aged 15-64)	-0.46%	-0.65%	-1.12%	-0.85%	-0.65%	-0.84%	-1.14%	-1.66%

Source: Authors' calculations. Population data for 2000–2015 are obtained from the Statistics Bureau, Ministry of Internal Affairs and Communications (https://www.stat.go.jp/english/data/jinsui/2.html).

Population estimates for 2016–2040 are the medium-fertility, medium-mortality projections by the National Institute of Population and Social Security Research (http://www.ipss.go.jp/pp-zenkoku/e/zenkoku_e2017/pp_zenkoku2017e.asp).

Returning to Table 1 and looking at the growth accounting results when the market economy is divided into the manufacturing and the non-manufacturing sector, these also show that the main reasons for the slowdown in growth in the latter period were the deceleration in capital services input growth and TFP growth. In the manufacturing sector, the negative growth contribution of the decline in hours worked became smaller in the 2005–2015 period. This is likely the result of the recovery of the manufacturing sector due to the depreciation of the yen.

In summary, the results of the growth accounting analysis for Japan indicate that the main causes of the slowdown in economic growth from the 1995–2005 period to the 2005–2015 period were sluggish capital accumulation and the decline in TFP growth.

Next, let us compare the growth of the market economy in Japan with that in the U.S., Germany, France, and the U.K. from a growth accounting perspective. The results are presented in Table 3. For the U.S., Germany, France, and the U.K., we use data from EU KLEMS 2017. Like the JIP Database 2018, EU KLEMS 2017 is based on the 2008 SNA and therefore can be said to be compiled based on almost identical standards.

Table 3. Sources of growth in the market economy from the supply-side: Japan, U.S., Germany, France, U.K. comparison

	Japan					
	1995-2000	2000-2005	2005-2010	2010-2015	1995-2005	2005-2015
Real value added growth rate	1.19%	0.89%	-0.51%	0.82%	1.04%	0.15%
Contribution of hours worked	-0.58%	-0.90%	-0.88%	-0.31%	-0.74%	-0.59%
Contribution of labor quality	0.34%	0.37%	0.33%	0.22%	0.36%	0.28%
Contribution of capital services	0.92%	0.39%	0.17%	0.02%	0.65%	0.10%
Contribution of TFP	0.51%	1.03%	-0.13%	0.89%	0.77%	0.38%

	U.S.					
	1998-2000	2000-2005	2005-2010	2010-2015	1998-2005	2005-2015
Real value added growth rate	4.29%	2.06%	-0.07%	1.79%	2.70%	0.86%
Contribution of hours worked	0.69%	-0.52%	-1.00%	0.87%	-0.18%	-0.07%
Contribution of labor quality	0.13%	0.24%	0.24%	0.13%	0.21%	0.18%
Contribution of capital services	1.94%	1.00%	0.53%	0.71%	1.26%	0.62%
Contribution of TFP	1.54%	1.36%	0.17%	0.08%	1.41%	0.12%

	Germany					
	1995-2000	2000-2005	2005-2010	2010-2015	1995-2005	2005-2015
Real value added growth rate	1.89%	0.52%	1.11%	1.79%	1.20%	1.45%
Contribution of hours worked	-0.21%	-0.84%	0.17%	0.45%	-0.53%	0.31%
Contribution of labor quality	-0.09%	0.32%	-0.06%	0.16%	0.12%	0.05%
Contribution of capital services	1.54%	0.74%	0.78%	0.33%	1.14%	0.56%
Contribution of TFP	0.65%	0.30%	0.21%	0.85%	0.48%	0.53%

	France					
	1995-2000	2000-2005	2005-2010	2010-2015	1995-2005	2005-2015
Real value added growth rate	3.77%	1.74%	0.66%	1.02%	2.75%	0.84%
Contribution of hours worked	0.88%	0.17%	0.23%	0.13%	0.52%	0.18%
Contribution of labor quality	0.30%	0.38%	0.28%	0.62%	0.34%	0.45%
Contribution of capital services	1.04%	1.05%	0.66%	0.40%	1.05%	0.53%
Contribution of TFP	1.54%	0.15%	-0.50%	-0.13%	0.84%	-0.31%

	U.K.					
	1997-2000	2000-2005	2005-2010	2010-2015	1997-2005	2005-2015
Real value added growth rate	3.86%	2.62%	0.11%	2.17%	3.09%	1.14%
Contribution of hours worked	0.65%	-0.12%	-0.57%	1.27%	0.17%	0.35%
Contribution of labor quality	0.29%	0.45%	0.37%	0.33%	0.39%	0.35%
Contribution of capital services	1.46%	0.90%	0.24%	0.55%	1.11%	0.40%
Contribution of TFP	1.46%	1.39%	0.06%	0.02%	1.42%	0.04%

Source: Authors' calculations based on the JIP Database 2018 (September 2019 Revision) for Japan and EU KLEMS 2017 (Revised July 2018) for the other countries. The EU KLEMS data were downloaded from http://www.euklems.net/index.html.

Note: To calculate the growth contribution of each production factor, factor cost shares are used for Japan, while for the other countries the ex post income shares are used. Due to data limitations in the EU KLEMS data, our growth accounting for the U.S. and the U.K. starts from 1998 and 1997, respectively.

The first interesting fact that emerges from this table is that since 2005 TFP growth has been sluggish not only in Japan but also in most of the other countries included in the comparison. As already mentioned, Japan's TFP growth declined in the 2005–2015 period; however, what our results show is that, apart from Germany, TFP growth has fallen to an even greater extent in the other countries. As a result, Japan, which had the second lowest TFP growth rate (after Germany) in the 1995–2005 period, had the second highest TFP growth rate (again after Germany) in the 2005–2015 period. On the other hand, TFP growth fell substantially in the U.S., France, and the U.K. during the 2005–2015 period. The growth accounting for five-year intervals suggests that not only did TFP growth in these countries fall during 2005–2010, likely reflecting the global financial crisis, it also failed to improve during 2010–2015, which includes the recovery from the global financial crisis. As pointed out by Gordon (2012), Summers (2013), and others, there may have been a global slowdown in technological innovation, particularly in the U.S., which might explain this decline in TFP growth.

Although Japan's TFP growth rate during 2005–2015 was much lower than in the preceding decade, it was still higher than that for the U.S., France, and the U.K. Nevertheless, the growth rate of Japan's market economy remained the lowest of the five countries. In addition to the decline in hours worked due to demographic factors, the reason for this is that the contribution of capital services input growth was remarkably low.

Therefore, to improve Japan's growth prospects, it will be necessary to tackle the other two sources of Japan's economic slowdown, namely, the slowdown in capital accumulation and TFP growth. It is unlikely that much can be done to substantially mitigate the decline in the number of hours worked brought about by the shrinking of Japan's working-age population shown in Table 2. For example, the working-age population is expected to decrease by 5.3 million between 2020 and 2030. It will be difficult to offset this decline simply by accepting more foreign workers or by further increasing the employment rate of women and the elderly.

3. The slowdown in capital accumulation in Japan

Let us consider the slowdown in capital accumulation in Japan. When a country's economic growth heavily relies on capital accumulation, the diminishing marginal returns to capital will cause the rate of return on capital to fall, which in turn will reduce capital accumulation and slow economic growth. However, if labor input increases, or if technological progress has the same effect as an increase in labor input, this will counteract the diminishing marginal returns to capital and a high rate of capital accumulation may be maintained. We therefore examine whether the slowdown in capital accumulation in Japan in recent years is sufficiently severe to be explained by the shrinking of Japan's population and low TFP growth.

Let us examine this question from the perspective of neoclassical growth theory. According to standard neoclassical growth theory, in an advanced economy that has accumulated sufficient capital, assuming that technological progress is Harrod-neutral, under steady-state growth in which the marginal productivity of capital does not diminish (balanced growth), the rate of capital accumulation is equal to the rate of GDP growth (natural growth rate), which is defined as the sum of the rate of labor input growth and the Harrod-neutral rate of technological progress (Acemoglu, 2009, Chapter 2). According to neoclassical growth theory, if the rate of capital accumulation exceeds the natural growth rate, the rate of return on capital declines due to diminishing marginal returns, so that the rate of capital accumulation declines. When the rate of capital accumulation falls below the natural growth rate, capital becomes scarce, the rate of return on capital rises, and the rate of capital accumulation rises. Thus, there is a mechanism based on which the economy returns to a balanced growth path once it deviates from it.

Based on this neoclassical growth theory perspective, we calculate the natural growth rate (and the rate of capital accumulation in balanced growth, which equals the natural growth rate) for the five countries (Japan, U.S., Germany, France, and U.K.) and compare it with the actual rate of increase in the capital stock.[5] As in Tables 1 and 3, we exclude the non-market economy, for which TFP is difficult to measure, and examine TFP, labor input, and capital accumulation for the market economy only.

Assuming Harrod-neutral technological progress, the rate of technological progress equals the TFP growth rate divided by the income share of labor.[6] The natural growth rate in Table 4 (which in

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[5] In Tables 1 and 3, following the standard method of KLEMS-type growth accounting, we measure the growth rate of capital inputs in terms of capital service input. Capital services input is an index constructed by measuring the growth rate of capital services input overall as a weighted average of the growth rate of each asset using the nominal services input of assets (price of the capital good × (nominal interest rate + capital depreciation rate + capital loss due to the fall in the price of the capital good) × real stock of each asset) as weights (see Fukao et al., 2007 for details). In contrast, Table 4 uses data on the real capital stock (the total of the real stock of each asset), which is used in standard neoclassical growth theory. Since the prices of capital services and the composition of assets did not change substantially during this period, the main results are the same even if we were to use capital services inputs in Table 4.

balanced growth is equal to the rate of increase in the capital stock) is calculated as the sum of the rate of Harrod-neutral technological progress calculated as described and the rate of change in labor input. The labor input growth rate in the table is the sum of changes in hours worked and labor quality improvements.

In Table 4, in row (e) for each country, the growth rate of the capital stock on a balanced growth path (which is equal to the natural growth rate) is calculated from the actual growth rate of labor input and TFP. According to this table, Japan's natural growth rate (for the market economy) was the lowest among the five countries, at 0.11% per year during 2005–2015. Germany had the highest natural growth rate, followed by the U.K., France, and the U.S., in that order. While Japan, as mentioned earlier, had the second highest TFP growth rate after Germany during this period of slowing TFP growth worldwide, Japan's natural growth rate was much lower than that of the other countries due to the decline in labor input reflecting demographic trends.

Table 4. Natural growth rate and capital growth rate for the market economy:

Japan, U.S., Germany, France, U.K. comparison

		Japan		U.S.		Germany	
		1995-2005	2005-2015	1998-2005	2005-2015	1995-2005	2005-2015
Labor input growth	a	-0.69%	-0.58%	0.05%	0.18%	-0.57%	0.52%
TFP growth	b	0.77%	0.38%	1.41%	0.12%	0.48%	0.53%
Harrod-neutral technological progress	c=b/d	1.39%	0.69%	2.22%	0.20%	0.67%	0.77%
Labor income share	d	55.40%	54.87%	63.45%	60.00%	71.38%	68.61%
Natural growth rate=Growth rate of capital stock on balance	e=a+c	0.70%	0.11%	2.27%	0.38%	0.10%	1.30%
Actual capital stock growth rate	f	1.34%	0.01%	5.32%	2.36%	3.10%	1.80%
Actual capital stock growth rate minus growth rate on balan	g=f-e	0.64%	-0.09%	3.05%	1.98%	3.00%	0.51%

		France		U.K.	
		1995-2005	2005-2015	1997-2005	2005-2015
Labor input growth	a	1.22%	0.86%	0.81%	0.99%
TFP growth	b	0.84%	-0.31%	1.42%	0.04%
Harrod-neutral technological progress	c=b/d	1.19%	-0.42%	2.06%	0.06%
Labor income share	d	70.63%	73.41%	68.92%	70.85%
Natural growth rate=Growth rate of capital stock on balance	e=a+c	2.41%	0.44%	2.87%	1.04%
Actual capital stock growth rate	f	3.10%	1.80%	5.17%	1.92%
Actual capital stock growth rate minus growth rate on balan	g=f-e	0.69%	1.37%	2.30%	0.88%

Source: See Table 3. Data for the market economy are used.

[6] As mentioned earlier, the growth accounting analysis for Japan uses information on cost shares rather than income shares. However, in the calculations in Table 4, for the comparison with the other countries, the labor income share is used for calculating Harrod-neutral technological progress. Since the cost share of labor in Japan, at 0.67 in 1995–2005 and 0.68 in 2005–2015, was higher than the income share (i.e., on average, firms' operating surplus was higher than their cost of capital), using cost shares results in a rate of Harrod-neutral technological progress for Japan that is lower than that shown in Table 4, and its natural growth rate is lower than in Table 4. If income shares are used in the growth accounting analysis for Japan in Tables 1 and 3, as in the EU KLEMS Database, the TFP growth rate calculated as the residual will be somewhat smaller since the negative contribution of changes in labor input to growth will be smaller.

Next, we compare the actual capital stock growth rate (row (f)) with the natural growth rate of each country's market economy calculated as described above (row ((e)) with. Looking at the period 2005–2015, we find that unlike in other countries, where the capital stock growth rate (row (f)) was around 2%, in Japan the actual capital stock growth rate during that period was only 0.01% and thus below the natural growth rate, which itself was already lower than in the other countries.

While further research is needed to understand why Japan's capital accumulation between 2005 and 2015 was so much lower than in other major economies, possible reasons include the following: (1) While other major industrialized countries embarked on large-scale monetary easing after the global financial crisis to stimulate capital accumulation, in Japan there was little room to stimulate capital accumulation through further monetary easing, since the Bank of Japan had already been pursuing monetary easing for many years to get the economy out of its long-term stagnation. (2) Until 2012, when Abenomics was launched, the yen continued to appreciate against the U.S. dollar and other currencies reflecting monetary easing in other major economies, hurting the manufacturing sector. (3) Having transferred production overseas, large firms have tended to use their corporate savings to increase their investment and lending overseas rather than investing them at home; in addition, in recent years, they have also increasingly tended to spend profits on dividend payouts rather than investment (Fukao et al., 2019).

Against this background, let us examine developments in capital accumulation in Japan, including more recent years not covered in the JIP Database 2018, which only goes up to 2015. We therefore use data from the Cabinet Office to show developments in the real capital coefficient (real fixed capital stock divided by real GDP, both denominator and numerator in 2015 prices) in Figure 1.

Figure 1. Developments in the real capital coefficients for Japan: 1994Q1–2020Q3

Source: The denominator for each variable is quarterly real GDP (seasonally adjusted, 2015 benchmark year) from the "Quarterly Estimates of GDP for Jul.-Sep. 2020 (The Second Preliminary Estimates)," Cabinet Office, Government of Japan. The numerators are the quarterly fixed capital stock series from the "Quarterly Estimates of Net Capital Stocks of Fixed Assets, Jul.-Sep. 2020" (2015 benchmark year; 2008 SNA), Cabinet Office, Government of Japan. The data were downloaded from: https://www.esri.cao.go.jp/en/sna/menu.html.

The figure indicates that the real capital coefficient for total fixed assets rose considerably from 1994, the first year for which data are available, to the early 2000s. However, since then it has been on a rapidly declining trend, with the exceptions of a spike around 2009, when real GDP fell precipitously due to the collapse in exports triggered by the global financial crisis, and another spike after the second quarter of 2020, when real GDP fell due to the outbreak of COVID-19. Breaking down total fixed assets into private non-residential fixed assets (including intellectual property products accumulated through research and development, etc.), public fixed assets, and private residential fixed assets, we find that whereas the GDP ratios of public fixed assets and private residential fixed assets have continued to fall, the GDP ratio of private non-residential fixed assets, which corresponds to the capital stock of the market economy, stopped falling in 2015. As mentioned in passing earlier, the share of the market economy in GDP has been declining due to the expansion of non-market sectors such as health care and nursing care. This is likely the reason why the capital coefficient for private non-residential fixed assets – i.e., the market economy alone – has increased slightly from 2016 to the outbreak of COVID-19. Since Japan's working-age population is declining rapidly, in order to accelerate economic growth, it is essential for Japan to raise the growth rate of the capital stock to the level of the natural growth rate or higher in addition to achieving a recovery in TFP growth.

4. Input of information and communication technology and intangible assets

One of the reasons for Japan's sluggish productivity growth that has been frequently highlighted is weak investment in information and communication technology (ICT) and intangible assets (see Fukao et al., 2009, and Fukao et al., 2016). In this section, we examine this issue primarily through comparisons of ICT inputs and intangible asset investment between Japan and the United States

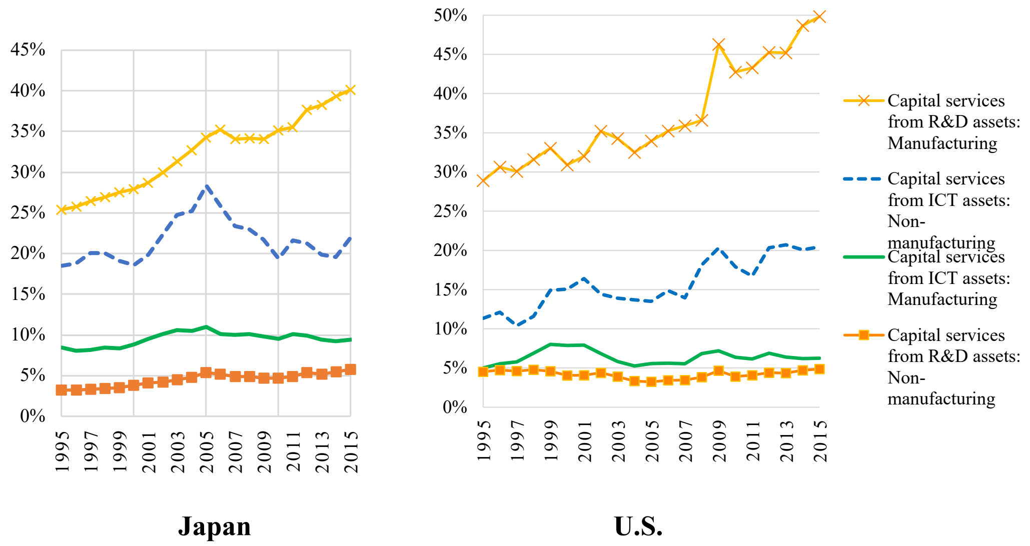
We start by comparing the share of ICT assets (including software), R&D assets, which form part of intangible assets, and other assets (total capital services input minus the services input of ICT and R&D assets) in total capital services input in the manufacturing and non-manufacturing market economy in Japan and the United States. In particular, we want to know whether the U.S. tends to have a higher share of ICT and R&D assets while Japan tends to have a higher share of other assets.[7]

[7] Capital services input by type of capital good for the U.S. was obtained based on EU KLEMS 2017 as follows:
Capital services input = Capital goods prices × (Nominal interest rate + Capital depreciation rate + Capital loss due to fall in price of capital goods) × Real capital stock
where for the nominal interest rate we use the annual average of 10-year Treasury yields, while for the capital depreciation rate, capital goods prices, and the real capital stock we use data from EU KLEMS 2017. In EU KLEMS 2017, capital goods for the U.S. are categorized into computing equipment, communications equipment, computer software and databases, transport equipment, and other machinery and equipment, total non-residential investment, residential structures, research and development, and other intellectual property protected assets. ICT assets are the total of the following three of these categories: computing equipment, communications equipment, and computer software and databases.

As shown in Figure 2, the share of R&D capital services in total capital services input is higher in the U.S. than in Japan in the manufacturing sector, but in the case of the non-manufacturing market economy, the shares in Japan and the U.S. are almost identical. On the other hand, the share of ICT capital services is higher in Japan than in the U.S. both in the manufacturing and the non-manufacturing sector. However, in the non-manufacturing sector the gap has recently narrowed. These results suggest that the U.S. is not necessarily more ICT-intensive in its production activities than Japan. In addition, comparing the manufacturing and the non-manufacturing sector indicates that both in Japan and the U.S. the share of R&D capital services is higher in the manufacturing than the non-manufacturing sector; on the other hand, the reverse is the case for the share of ICT capital services, which is higher in the non-manufacturing than the manufacturing sector.

Figure 2. Share of R&D and ICT capital services in total capital services input (market economy):

Japan-U.S. comparison, 1995–2015



Sources: See Table 3.

Several comments are in order regarding the comparison between Japan and the U.S. based on Figure 2. First, in Japan, both the ratio of R&D expenditures to sales and the ratio of ICT capital services input to gross value added tend to be much lower for small and medium-sized enterprises (SMEs) than for large firms (see Yamaguchi et al., 2019, for R&D and Fukao et al., 2016, for ICT). Therefore, for SMEs, especially those in the non-manufacturing sector market economy, Japan likely lags behind the United States in the adoption of ICT.

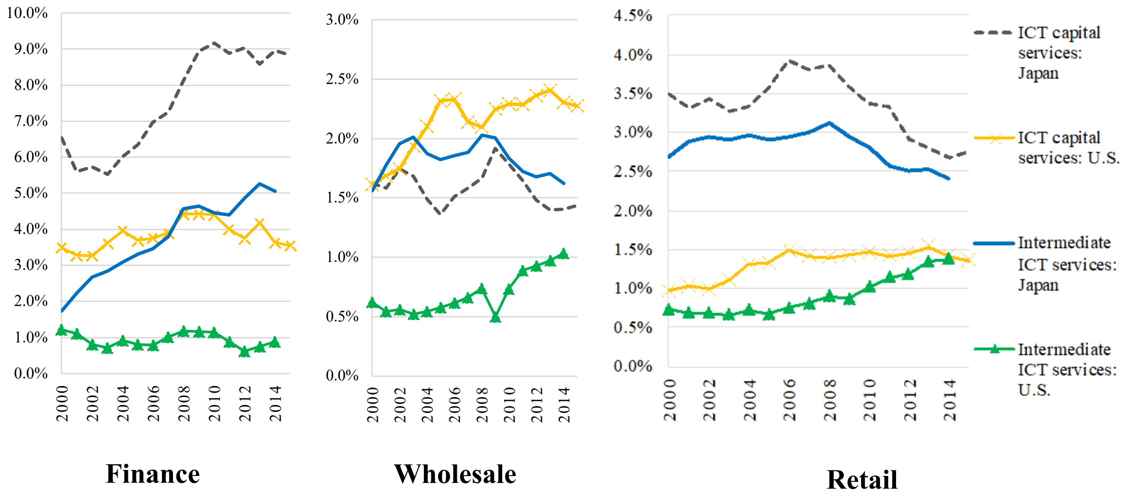
Second, it has been pointed out that the prices of ICT assets and ICT services differ between Japan and the U.S. As highlighted by Fukao et al. (2016), the prices of ICT assets and services tend to be higher in Japan. For example, according to a survey by the Ministry of Economy, Trade and Industry (METI, 2013), in 2012, the price of packaged software in Japan was 2.27 times higher than in the U.S. While price differentials at market prices likely have shrunk due to the depreciation of the yen since 2012, this depreciation is insufficient to offset such price differentials. While Figure 2 suggests that the share of ICT capital services is higher in Japan than the U.S., in real terms the share may be lower once price differences are adjusted for.[8]

Third, as highlighted, for example, by van Ark (2016), there has recently been a growing tendency not only to invest in ICT assets outright but also to purchase ICT services from ICT service vendors, including the use of cloud services. In the U.S., the use of ICT services is widespread, so that the input of intermediate ICT services may be higher than in Japan. In order to examine this point, Figure 3 compares the value added ratios of ICT capital services input and intermediate ICT services input in the finance, wholesale, and retail sectors, which can be regarded as ICT-intensive industries, in Japan and the U.S.

Figure 3. ICT capital services input and intermediate ICT services input in Japan and the U.S.:

Finance, wholesale, and retail, 2000–2015

[8] That is, if the elasticity of substitution between production factors is smaller than one, it is possible that the real price-adjusted input share of ICT capital services is lower in Japan than in the U.S. because the price of ICT capital is higher in Japan than in the U.S., while the input share of ICT capital services in nominal terms is higher in Japan.



Sources: See Table 3 for the sources for ICT capital services and the denominator, value added. Intermediate ICT services were obtained from the 2016 release of the World Input-Output Database (WIOD; http://www.wiod.org/database/wiots16). Due to data limitations in the WIOD, this figure only covers the period from 2000.

The figure indicates that while in wholesale the value added ratio of ICT capital services is higher in the U.S., in finance and retail it is about twice as high in Japan as the U.S. On the other hand, the value added ratio of intermediate ICT services is about twice as high in Japan as in the U.S. in all three industries. Adding up the two ratios, we find that the sum of the ICT capital services and intermediate ICT services ratios is higher in the U.S. in the case of wholesale, but it is considerably higher in Japan than the U.S. in finance and retail. However, according to the survey of goods and services prices by METI cited earlier, ICT services are also much more expensive in Japan, with payroll processing fees and market research fees being 2.56 and 3.20 times higher, respectively. Therefore, as in the case of ICT assets, Japan may only appear to be more ICT-intensive due to such price differences.

Summarizing the analysis on ICT inputs, there is no evidence that Japan's ICT inputs are clearly lower than those of the U.S., although the issue of price differences between Japan and the U.S. in terms of ICT capital services and intermediate ICT services needs to be borne in mind. However, as we saw in the previous section, Japan lags behind other major countries in terms of capital accumulation, and it may also be lagging behind in terms of the accumulation of R&D and ICT assets.

To examine this point, Table 5 compares the growth rates of real capital stock by type of assets and sector in Japan and the U.S. The table shows that, as in the U.S., the ICT capital stock and R&D capital stock in Japan have been growing at faster rates than the total capital stock. However, the growth rates of both the ICT and the R&D capital stock are much lower in Japan than in the U.S.

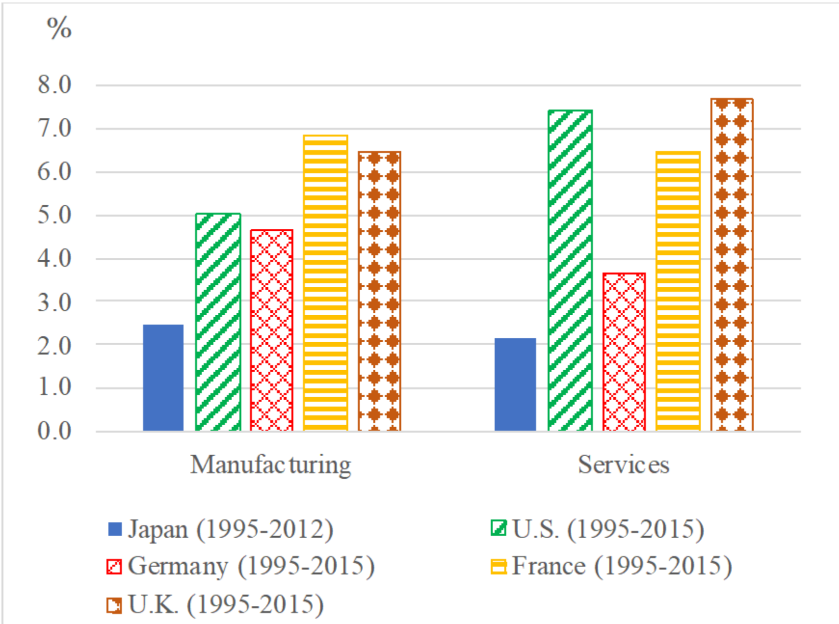
Table 5. Real capital stock growth rates: Japan-U.S. comparison by type of assets and sector (annual rate, %)

	Japan				U.S.			
	1995-2000	2000-2005	2005-2010	2010-2015	1995-2000	2000-2005	2005-2010	2010-2015
Total capital stock								
Market economy	1.94%	0.73%	0.04%	-0.01%	6.13%	4.90%	2.40%	2.33%
Manufacturing	1.15%	0.62%	0.39%	-0.16%	4.39%	2.24%	1.73%	1.69%
Services	2.26%	0.77%	-0.09%	0.04%	6.70%	5.65%	2.57%	2.48%
ICT capital stock								
Market economy	10.14%	5.34%	2.18%	1.12%	15.12%	6.48%	5.82%	3.89%
Manufacturing	8.43%	5.72%	1.98%	0.70%	13.69%	0.74%	5.22%	3.05%
Services	10.62%	5.24%	2.24%	1.23%	15.34%	7.21%	5.88%	3.97%
R&D capital stock								
Market economy	3.02%	1.81%	1.42%	0.70%	5.02%	3.17%	3.66%	3.10%
Manufacturing	2.80%	1.84%	1.77%	0.88%	5.11%	3.81%	4.13%	3.04%
Services	3.88%	1.66%	0.02%	-0.09%	4.76%	1.16%	1.98%	3.32%

Source: See Table 3.

Intangible assets can be broadly classified into innovative property based, for example, on past R&D expenditure, computerized assets such as software, and economic competencies such as investment in advertising and branding, organizational structure, and off-the-job training of workers. Since we have already examined R&D expenditures and software purchases, let us make an international comparison of economic competencies. Figure 4 compares the gross value added ratio of investment in economic competencies by sector for the same five countries as above. The figure indicates that investment in economic competencies in Japan is also extremely low compared to the other major economies.

Figure 4. Gross value added ratio of investment in economic competencies by sector: International comparison



Source: Authors' calculations based on data from the JIP Database 2015 and INTAN-Invest (http://www.intaninvest.net).

Japan's accumulation of ICT and R&D capital has been very slow in recent years. However, we found that the share of ICT and R&D investment in total investment is not particularly low when compared with the U.S. What is concerning for Japan's future growth is not that the technologies employed by firms are not ICT- or R&D-intensive, but that firms do not invest in general to begin with.

5. In which industries did TFP growth fall?

As shown in Table 1 in Section 3, TFP growth in Japan's manufacturing and non-manufacturing sectors decelerated in 2005–2015 from already low growth in the preceding 10-year period from 1995–2005. To examine this slowdown in TFP growth, this section, using detailed industry-level data from the JIP Database 2018, examines which industries in particular were responsible for this decline in TFP growth. It should be noted that while Japan experienced a sharp fall in TFP growth around 1990, we cannot examine the reasons for this here, since the JIP Database 2018 covers only the period from 1994 onward. A detailed analysis of the slowdown in TFP growth around 1990 using long-term data from the JIP Database 2015 covering the period 1970–2012 can be found in Fukao (2018b) for the non-manufacturing sector and Fukao (2018c, d) for the non-manufacturing sector.

Figure 5 shows each industry's contribution to TFP growth in the manufacturing sector as a whole for the periods 1995–2005 and 2005–2015. The contribution of each industry was calculated by multiplying the TFP growth of that industry on a value-added basis by its share in the value added of the manufacturing sector overall.[9] The figure is read as follows: A value of 0.10 along the horizontal axis means that an industry contributed 0.10 percentage points to the 2.04% TFP growth in the manufacturing sector during 1995–2005. Similarly, a value of -0.10 along the vertical axis means that TFP growth in an industry was negative and reduced TFP growth in the manufacturing sector overall in 2005–2015 by 0.10 percentage points.

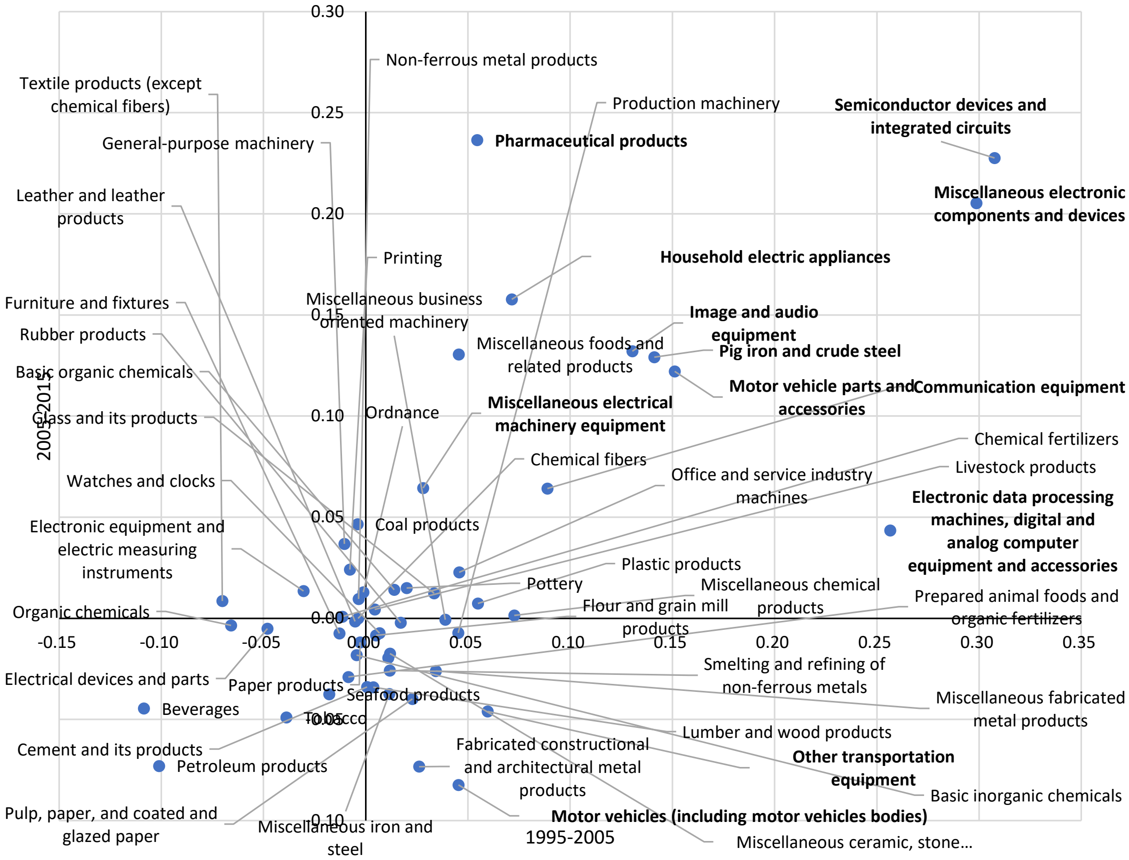
Figure 5 indicates that of the 54 manufacturing industries, 37 industries registered negative TFP growth in the latter period and therefore contributed to the drop in overall manufacturing TFP growth from 2.04% in 1995–2005 to 1.34% in 2005–2015. The figure further shows that in both periods most of the TFP growth in the manufacturing sector overall was produced by a small number of industries (i.e., those farther above and to the right of the origin). Specifically, of the 2.04% annual TFP growth in the manufacturing sector during 1995–2005 (Table 1), two-thirds was produced by seven industries: semiconductor devices and integrated circuits; miscellaneous electronic components and devices; electronic data processing machines, digital and analog computer equipment and accessories; motor vehicle parts and accessories; pig iron and crude steel; image and audio equipment; and communication equipment. Similarly, in 2005–2015, TFP in the manufacturing sector grew at an annual rate of only 1.34%, but the total contribution of the eight industries with the largest contribution, namely, pharmaceutical products, semiconductor devices and integrated circuits, miscellaneous electronic components and devices, household electric appliances, image and audio equipment, miscellaneous foods and related products, pig iron and crude steel, and motor vehicle parts and accessories, was 1.34 percentage points. All other industries either only made a very small contribution to TFP growth in the manufacturing sector overall or actually reduced overall TFP growth.

Figure 5 also shows that the decline in annual TFP growth in the manufacturing sector overall from

[9] Until the JIP Database 2015, for industry groups consisting of multiple industries, such as the manufacturing sector or the macroeconomy overall, the Törnqvist approximation of the Divisa index was used to create a chain index aggregating industries' output and value added, and growth accounting was conducted using this index (see Fukao et al., 2007). As a result, when aggregating industries' output-based TFP growth using Domar weights (Domar, 1961), this was more or less equal to the TFP growth of each aggregate on a value added basis. In the JIP Database 2018, in order to improve the comparability with Japan's national accounts, the value added-based output of industry groups, such as the manufacturing sector or the macroeconomy overall, is calculated as the simple sum of the (Laspeyres chain-linked) real value added for each industry. For this reason, aggregation errors using Domar weights, etc., are larger than in previous versions of the JIP Database (see Fukao, Makino, and Tahara, 2019).

2.04% in 1995–2005 to 1.34% in 2005–2015 was also mainly due to a small number of industries. The decline in the contribution to TFP growth in the manufacturing sector overall was particularly pronounced in the following industries: electronic data processing machines, digital and analog computer equipment and accessories; motor vehicles (including motor vehicles bodies); other transportation equipment; fabricated constructional and architectural metal products; miscellaneous electronic components and devices; and semiconductor devices and integrated circuits. These six industries alone account for almost all of the decline in overall manufacturing sector TFP growth. On the other hand, the contribution of pharmaceutical products, household and electric appliances, and miscellaneous foods and related products increased, but this increase was insufficient to reverse the deceleration in TFP growth in the manufacturing sector as a whole.

Figure 5. Industries' contribution to TFP growth in the manufacturing sector overall (annual rate, percentage points)



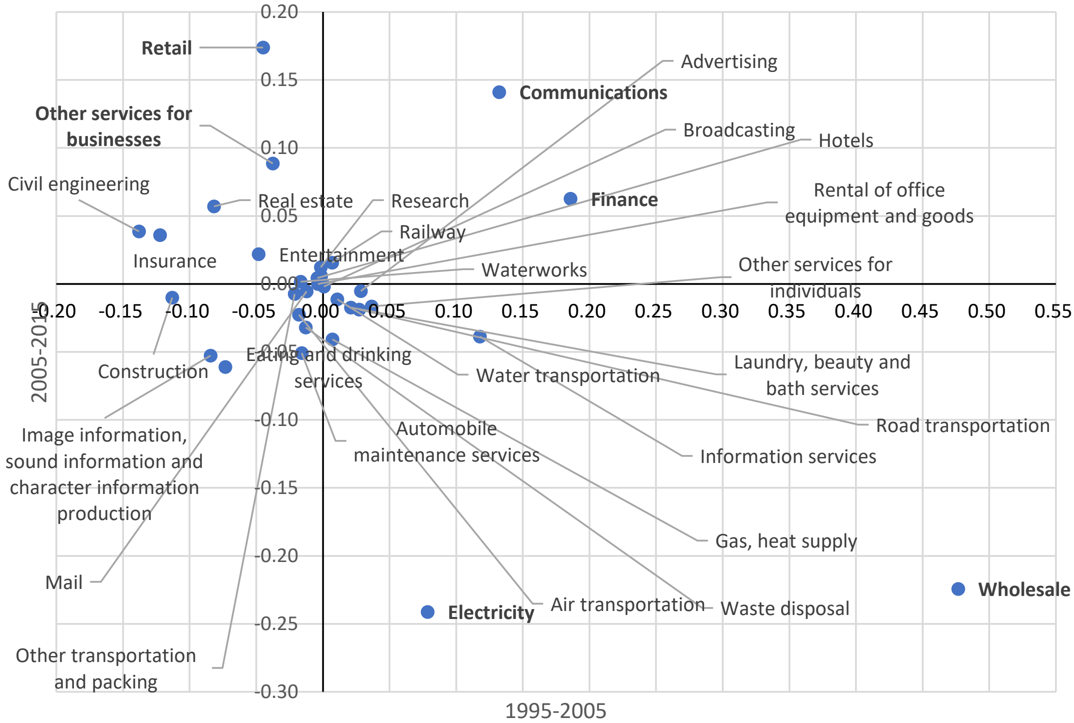
Source: Authors' calculations based on the JIP Database 2018.

The slowdown in TFP growth in electronic data processing machines, digital and analog computer equipment and accessories, miscellaneous electronic components and devices, and semiconductor devices and integrated circuits likely reflects the relocation of productive factories overseas and the relative decline of Japanese firms due to intensifying competition with newly industries economies such as South Korea, Taiwan, and China.

Next, Figure 6 shows each industry's contribution to TFP growth in the service sector (market economy) as a whole for the periods 1995–2005 and 2005–2015.

As in the case of manufacturing, in both periods most of the TFP growth in the service sector was produced by a small number of industries. In 1995–2005, the combined contribution of the four industries with the largest contributions, wholesale trade, finance, communications, and information services, reached 0.91 percentage points per year. Similarly, during 2005–2015, the sum of the contributions of the four industries with the largest contributions, retail trade, communications, other services for businesses, and finance, reached 0.47 percentage points per year.

Figure 6. Industry's contribution to TFP growth in the service sector overall (market economy; annual rate, percentage points)



Source: Authors' calculations based on the JIP Database 2018.

As seen in Table 1, TFP growth in the non-manufacturing sector as a whole (market economy, services plus agriculture, forestry, fisheries, and mining) fell from 0.30% per annum in 1995–2005 to -0.02% per annum in 2005–2015, and this decline can be attributed mainly to the slowdown in TFP growth in a small number of industries.[10] The contribution of the wholesale, electricity, and information services industries fell by 0.70, 0.32, and 0.16 percentage points, respectively. On the other hand, the contributions of the retail trade, civil engineering, insurance, and real estate industries increased, but not enough to reverse the decline in TFP growth for the non-manufacturing market economy as a whole.

The sharp decline in TFP growth in the wholesale industry and the sharp increase in TFP growth in the retail industry likely reflect structural changes in the wholesale and retail sector such as the development of private brands by major retailers and the increase in online sales. Meanwhile, the reason for the sharp fall in TFP growth in the electricity industry likely reflects the fact that all nuclear power plants were shut down in the wake of the Tohoku earthquake in 2011.

6. Conclusion

Using the Japan Industrial Productivity Database 2018 and the EU KLEMS Database 2017, we examined the sources of growth of the Japanese economy from a supply-side perspective and conducted comparisons with major industrialized economies. The main results of our analysis are as follows.

(1) During the period 2005–2015, which includes the global financial crisis and the Tohoku earthquake, Japan's economic growth slowed down much more than that of the other major industrialized countries, reflecting not only the decline in the working-age population but also sluggish growth in capital services input. In contrast, the U.S., the U.K., and France, where TFP growth was even slower than in

[10] The contribution of the primary sector, that is, agriculture, forestry, fisheries, and mining, to TFP growth in the non-manufacturing market economy was very small and relatively stable, at 0.03 percentage points in 1995–2005 and 0.02 percentage points in 2005–2015. Moreover, the value added share of the primary sector in Japan's GDP was also small. Therefore, TFP growth in the non-manufacturing market economy was mostly driven by TFP growth in market services.

Japan, saw relatively firm capital input growth, driving economic growth overall.

(2) Among the major industrialized countries, only Japan's capital stock growth rate was lower than the natural growth rate calculated based on standard neoclassical growth theory.

(3) Comparing the composition of factor inputs in Japan and the U.S., we found that although inputs of ICT and R&D capital services and intermediate ICT services in Japan are not particularly low compared to the input of other capital, capital investment in general has been extremely small. Moreover, investment in economic competencies (worker training and organizational structure), which are thought to be complementary to ICT and R&D capital, has been much smaller than in other countries.

(4) In addition to demographic factors and sluggish capital investment, another reason for the slowdown in Japan's economic growth in 2005–2015 compared to the preceding decade was the decline in TFP growth, which was caused by a drop in productivity growth in a handful of industries, including electronic data processing machines, digital and analog computer equipment and accessories, motor vehicles (including motor vehicle bodies), electricity, and wholesale trade.

A particularly unexpected result of our analysis is that economic growth in the U.S. and the other major industrialized countries after the global financial crisis was driven not by productivity growth but by increased capital input. From the 1990s, when Japan's prolonged stagnation began, to the early 2000s, authorities tried to maintain economic growth by promoting private investment through monetary easing and public investment. It appears as though the U.S. economy after the global financial crisis resembles Japan's economy during the 1990s.

However, it is also possible that although it has not yet resulted in higher TFP growth, the emergence of new technologies is generating vigorous investment. Fierce competition among companies trying to lead the so-called Fourth Industrial Revolution that is currently underway is triggering investment in R&D and ICT. For example, the total R&D investment of Apple, Amazon, Microsoft, Intel, and Google in 2016 was approximately 7.2 trillion yen. This is more than half of the 13.3 trillion yen R&D investment by all Japanese firms together (according to the 2017 Survey of Research and

Development). In order for Japan, which has already fallen behind in the ICT revolution, to avoid the mistake of falling behind in the Fourth Industrial Revolution as well, Japan needs to promote investment in human capital to support large-scale investment in new technologies such as electric vehicles, automated driving, robots, the internet of things, artificial intelligence, fintech, and big data. Moreover, in order for Japanese firms to redirect their enormous internal reserves to investment, the government needs to reduce policy uncertainty and proactively reform laws and institutions that inhibit new innovation. It is no exaggeration to say that the first requirement for Japan to ride the Fourth Industrial Revolution, which presents a major opportunity for the economy to escape from long-term stagnation, is to make new investments.

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