DP/08-03

経済財政分析ディスカッション・ペーパー

Intangible Investment in Japan: New Estimates and Contribution to Economic Growth

Kyoji Fukao
Tsutomu Miyagawa
Kentaro Mukai
Yukio Shinoda
Konomi Tonogi

Economic Research Bureau

CABINET OFFICE

内閣府政策統括官室（経済財政分析担当）

DP/08-03
2008 年 11 月

Intangible Investment in Japan:
New Estimates and Contribution to Economic Growth

Content

Intangible Investment in Japan: New Estimates and Contribution to Economic Growth

November 2008

Kyoji Fukao
(Hitotsubashi University)

Tsutomu Miyagawa
(Gakushuin University)

Kentaro Mukai
(Cabinet Office, Government of Japan)

Yukio Shinoda
(Cabinet Office, Government of Japan)

Konomi Tonogi
(Hitotsubashi University)

***** This paper is a revised version of RIETI Discussion Paper 07-E-034. We thank Dr. Paul Schreyer of the OECD, Dr. Carol Corrado of the Conference Board, Professor Jonathan Haskel of Queen Mary College, University of London, and the participants of the OECD workshop on Measurement of Intellectual Assets in National Accounts, the 2007 NBER/CRIW Summer Institute and the National Academies conference on Intangible Assets for their excellent comments. We are grateful to Professors Bart van Ark and Marcel Timmer of the University of Groningen and Mr. Yoshiaki Tojo of the OECD for valuable comments on earlier drafts. Thanks are also due to Mr. Takayuki Sumita of the Ministry of Economy, Trade and Industry and participants of the seminar at the Research Institute of Economy, Trade, and Industry (RIETI). We appreciate the excellent research assistance provided by Mr. Sumio Hamagata (Central Research Institute of Electric Power Industry), Dr. Shoichi Hisa (Takachiho University of Commerce) and Professor Miho Takizawa (Toyo University). The views expressed in this paper are those of authors and should not be attributed to any of the organizations which the authors belong to.

Abstract

The purpose of this paper is to measure intangible assets, to construct the capital stock of intangible assets, and to examine the contribution of intangible capital to economic growth in Japan. We follow the approach of Corrado, Hulten, and Sichel (2005, 2006) to measure intangible investment using the 2008 version of the Japan Industry Productivity Database. We find that the ratio of intangible investment to GDP in Japan has risen during the past 20 years and now stands at 11.6%, which is lower than the ratio estimated for the United States in the early 2000s. The ratio of intangible to tangible investment in Japan is also lower than equivalent values estimated for the United States. In addition, we find that, in stark contrast with the United States, where intangible capital grew rapidly in the late 1990s, the growth rate of intangible capital in Japan declined from the late 1980s to the early 2000s. In order to examine the robustness of our results, we also conducted a sensitivity analysis and found that the slowdown of the contribution of intangible capital deepening to economic growth and the recovery in MFP growth from the second half of the 1990s observed in our base case remain unchanged even if we take on-the-job training and Japanese data with respect to investment in firm-specific resources into account.

Keywords: intangible investment, labor productivity, growth accounting.

JEL Classification Code: E22, O32, O47.

Corresponding author:

Tsutomu Miyagawa

Professor of Economics, Department of Economics, Gakushuin University

1-5-1, Mejiro, Toshima-ku, Tokyo, 171-8588, Japan

E-mail: tsutomu.miyagawa@gakushuin.ac.jp

1. Introduction

In the 1990s, the United States enjoyed rapid rates of productivity growth. A major contributing factor was the revolution in information and communication technology (ICT). The resurgence of US productivity growth led governments of other developed countries such as the UK, Germany, France, the Netherlands, and Japan to promote ICT investment in order to catch up with US productivity levels. In Japan, ICT investment has shown steady growth, increasing at an annual average rate of 8.6% from 1995 to 2005 and reaching 23.5 trillion yen in 2005 (in 2000 constant prices), which is equivalent to 18% of total investment. Yet, the increase in ICT investment in Japan so far has failed to close the productivity gap with the US.[1]

Examining the reasons for the productivity gap, we find that a major factor is the low multi-factor productivity (MFP) growth in services that use ICT, such as distribution services, finance and business services, etc., as shown in Table 1. The table also indicates that in the case of the European Union (EU) countries, too, the productivity gap vis-à-vis the US is due to the low productivity growth in ICT-using services.

(Insert Table 1)

Examining the slow productivity growth in EU countries, van Ark (2004) suggested that the difference with the US might be explained by differences in the accumulation of intangible assets which play a complementary role to ICT capital. Studies that have addressed the role of intangible assets include those by McGrattan and Prescott (2005), who took intangible investment at the macro level into account in order to explain the solid growth of the US economy during the 1990s, and Corrado, Hulten, and Sichel (2005, 2006) , who measured intangible investment in the United States and showed the significant contribution of intangible capital to US productivity growth.

The aim of this paper is to measure intangible investment and to examine its contribution to economic growth in Japan. We have two reasons for focusing on the measurement of intangible investment. The first is

[1] Discussions of recent developments in productivity growth in the US and the role of ICT investment can be found in Corrado, Lengerman, Bertelsman and Beaulieu (2007), Stiroh and Botsch (2007), and Oliner, Sichel and Stiroh (2007).

that we want to check whether trends in intangible investment can explain the productivity gap between the United States and Japan in the 1990s. The second is that to date practically no studies have been carried out on intangible capital in Japan. The Japanese government has made an acceleration of economic growth the cornerstone of its economic policy, and given the economic challenges facing Japan, it is crucial to understand why productivity growth has lagged behind that in the United States. The role of intangible capital potentially is one key factor, and understanding if and why this is the case may make an important contribution to policy design.

Our paper consists of four sections. In the next section, we estimate time series of intangible investment following the methodology developed by Corrado, Hulten, and Sichel (2005, 2006). We find that the ratio of intangible to tangible assets is lower in Japan than in the United States. We also estimate intangible investment by sector and find that the intangible investment/value added ratio in the service sector is much lower than that in the manufacturing sector. In Section 3, we construct intangible capital by using the intangible investment series and conduct a growth accounting exercise. The results of the growth accounting with intangible capital show that the contribution of intangible capital to economic growth is small because the share of intangible capital in total capital is also relatively small. However, this result does not mean that the potential role of intangible capital is not important for economic growth. If intangible capital in Japan were to contribute to economic growth at the same rate as it does in the United States, labor productivity growth in Japan would be 0.2 percentage points higher than it actually is. In Section 4, we conduct a sensitivity analysis focusing on the parameters used for estimating investment in firm-specific resources. We find that when we take Japanese data concerning firm-specific human resources and organizational structure into account, the intangible investment/GDP ratio is higher than that estimated in the base case. On the other hand, the effect of intangible capital deepening becomes smaller than that estimated in the base case, because the growth in firm-specific human capital in the alternative case is slower than that estimated in the base case. The last section summarizes our results and their policy implications and discusses future tasks.

2. Measurement of intangible investment in Japan

In this section, we describe how we measure intangible investment in Japan and look at the major trends in intangible investment. In order to measure intangible investment, we follow the approach of

Corrado, Hulten, and Sichel (2005, 2006) (abbreviated as CHS hereafter), who classify intangibles into three major types of assets: computerized information, innovative property, and economic competencies. Computerized information consists of, for example, software and databases. Innovative property includes scientific and nonscientific research and development (R&D), where the latter refers to, for example, mineral exploitation, copyright and license costs, and other product development, design, and research expenses. Economic competencies, finally, include brand equity, firm-specific human capital, and organizational structure.[2]

2.1 Computerized information

We take data on investment in computerized information from the 2008 version of the Japan Industrial Productivity Database (JIP Database).[3] This database was constructed by us and other economists and provides data on the output, intermediate input, and labor and capital input of 108 industries from 1970 to 2005. In the JIP 2008 Database, investment in custom software and packaged software is estimated using sales data for the information service industry from the *Survey on Selected Service Industries* and data from the *Input-Output Tables*. The *Survey on Selected Service Industries* is conducted annually by the Ministry of Economy, Trade, and Industry (METI) and includes information on the sales, number of workers, assets, operating costs, and year of establishment about 7000 firms in the service sector, including the information service industry.

We measure in-house software investment using the *ICT Workplace Survey* and the *Population Census*.. The *ICT Workplace Survey*, which is also conducted annually by METI and provides information on enterprises and organizations which heavily use ICT equipment with regard to their labor costs, other expenditure, and number of employees categorized by job type such as programmers, systems engineers, and network managers. As The *ICT Workplace Survey* does not cover all workers who are involved in making in-house software in Japan, we employ the following estimation procedures. From this survey, we take two types of costs: the first is wages for workers in divisions which are specialized in in-house software

[2] A detailed description of the measurement of intangible investment is provided in Appendix 1.
[3] The construction of the Japan Industrial Productivity (JIP) Database is described in Fukao et al. (2007). The database is available from the website of the Research Institute of Economy, Trade and Industry (http://www.rieti.go.jp/en/database/d05.html). A correspondence table for industry classifications in the JIP Database and the ISIC code is provided in Appendix 2.

development and the second is other expenditures in these divisions. Using these values, we calculate the cost of in-house software investment per engineer and programmer. We then multiply the result by the total number of engineers and programmers in the market economy, which is available from the *Population Census*, and derived in-house software investment in the market economy. The estimates for in-house software investment we arrive at are largely consistent with those obtained by Nomura (2005). Finally, investment in databases is estimated using sales data for the information service industry from the *Survey on Selected Service Industries* and data from the *Establishment and Enterprise Census*.

2.2 Innovative property

For data on investment in science and engineering R&D, we use the *Survey of Research and Development*. The *Survey of Research and Development* is conducted by the Ministry of Internal Affairs and Communications and includes information on research expenditures categorized by several types of research expenses such as material costs, labor costs and depreciation costs for about 19,000 enterprises, universities, and research institutions. We use the expenses on materials and labor costs for R&D activities from this survey as our data on investment in science and engineering R&D. Data on investment in mineral exploitation were obtained from the *Handbook of the Mining Industry* and the *Annual Report on Natural Gas*. Next, for copyright and license costs, we take data from the JIP 2008 Database, using the nominal output data of JIP 2008 industry no. 92 (publishing and newspaper industry) and JIP 2008 industry no. 93 (video picture, sound information, character information production and distribution industry).

As for the measurement of other product development, design, and research expenses, CHS (2005) summed the following three items: (1) new product development costs in financial services and other service industries such as book publishing, motion picture production, sound recording production, and broadcasting (such costs account for 20 percent of intermediate purchases in these industries); (2) new architectural and engineering designs which roughly account for half of industry purchased services (CHS (2005) estimated this value from the revenues of architectural and engineering design industries reported in the Census Bureau's *Services Annual Survey*); and (3) R&D in social sciences and humanities which is estimated as twice industry purchased services to include own-account expenses on R&D in social sciences and humanities (this item is also estimated from the revenues of the Census Bureau's *Services Annual Survey*).

Here, we estimate investment in (1) using data on intermediate purchases in JIP 2008 industries no. 69 (finance industry) and no. 70 (insurance industry). To measure investment in (2), we use the nominal output data of the design, display, and machinery design industries from the Input-Output Tables as investment in new architectural design, while for investment in engineering design, we use data from METI's *Survey on Selected Service Industries*. As for (3), we are unable to find suitable data.

2.3 Economic competencies

With regard to investment in brand equity, we follow the approach adopted by CHS (2005), taking 60 percent of the nominal output purchased by other industries from the advertising industry (JIP 2008 industry no. 85).

Firm-specific human capital is accumulated through both on-the-job and off-the-job training. Following CHS (2005), we only estimate off-the-job training costs here and assume that these costs consist of two types of expenses: (1) direct firm expenses for off-the-job training of employees; and (2) opportunity cost (the wage and salary costs of employees' time spent in getting off-the-job training). In our sensitivity analysis in Section 4, we estimate on-the-job training costs and examine how our results on Japan's intangible investment change when such costs are included.

As for the first item, direct firm expenses, we use data on vocational education costs per worker from the *General Survey on Working Conditions* (*Shugyo Joken Sogo Chosa*) conducted by the Ministry of Health, Labour and Welfare. The purpose of this survey is to statistically review the wage system, fringe benefits, and retirement system of Japanese firms. It covers about 5,000 Japanese firms and asks these about training costs, including the wage and salary costs of employees who teach workers in an off-the-job mode or employees who support the off-the-job training processes.

As for the second item, opportunity cost, we use the results obtained by Ooki (2003). Using micro-data of The Japan Institute for Labour Policy and Training's *Survey on Personnel Restructuring and Vocational Education/Training Investment in the Age of Performance-based Wage Systems* (*Gyoseki-shugi Jidai no Jinji Seiri to Kyoiku/Kunren Toshi ni Kansuru Chosa*), Ooki calculated the average opportunity cost ratio of off-the-job training to direct firm expenses for training in 1998 for the whole business sector. The value was 1.51. We use this value to estimate the opportunity cost.

CHS (2005) argue that investment in organizational structure consists of a purchased "organizational" or "structural" component (such as management consultant fees) and an own-account component, which can be measured in terms of the value of executive time.

With regard to the first component, CHS (2005), Marrano and Haskel (2006), and Marrano, Haskel and Wallis (2007) use sales data for consulting firms. However, we are not able to find suitable data for the consulting industry in Japan. As an alternative, we therefore use the nominal output of law firms and accounting offices. Law firms and accounting offices fall into the business service industry (JIP 2008 industry no. 88), and we separate their nominal output from the total output in the business service industry using the *Input-Output Tables.* For the measurement of the second component, own-account investment in organizational structure, we use the *Survey on Financial Statements of Business Enterprise*s. This survey is conducted annually by the Ministry of Finance and gathers the financial statements of enterprises whose capital is above 2 million yen. Following CHS (2005), we approximate this component by taking 20 percent of the salaries and bonuses for executives from this survey.

2.4 Measurement results for intangible investment in Japan

Our measurement results are shown in Table 2. Our estimates suggest that the annual average amount of intangible investment in Japan from 2000-2005 was 56 trillion yen. The share of intangible investment in GDP in the same period was 11.5 percent, which is similar to the estimate for the US by CHS (2006) and larger than that for the UK by Marrano and Haskel (2006). However, the figure for the US obtained by CHS (2006) is for the period from 1998-2000, and more recent, but as yet unpublished estimates by Dr. Corrado suggest that the intangible investment/GDP ratio in the US in the early 2000s had reached 13.8 percent, meaning that the equivalent ratio for Japan is lower than that for the US. However, it should be noted that our measurement of intangible investment in Japan is likely to be an underestimation due to the lack of reliable data for the estimation of investment in other product development, design, and research, firm-specific human capital, and organizational structure.

(Insert Table 2)

Moreover, comparing the relative levels of intangible and tangible investment in Japan and the United States, other significant differences emerge. For example, CHS (2006) found that in the United States, intangible investment was 1.2 times the level of tangible investment. However, according to our estimation, the ratio of intangible to tangible investment in Japan was only 0.6.

Given that the share of intangible investment in GDP in Japan is similar to that in the US, the low ratio of intangible to tangible investment in Japan indicates not that investment in intangibles is small, but that investment in tangibles is exceptionally large. Figure 1 shows the ratios of tangible and intangible investment to GDP in Japan and the US. We find that in Japan, the GDP ratio of intangible investment is still much smaller than that of tangible investment, while in the US, intangible investment has exceed tangible investment since 2000. We suspect that the difference in investment behavior between Japan and the US is at least partially due to differences in the financial system. In Japan, financial institutions such as banks play a major role in the provision of corporate funds, and they typically require tangible assets as collateral to provide financing. As a result, Japanese firms have preferred to accumulate tangible assets which can be used as collateral. In addition, small firms have been hampered in their growth because they often possess insufficient tangible assets to increase borrowing. These mechanisms as a result of Japan's financial system are likely to be important reasons why the ratio of intangible to tangible investment is low in Japan.

(Insert Figure 1)

The share of each type of intangible investment is shown in Table 3. The largest component of intangible investment in Japan is innovative property with a share of nearly 51 percent in the early 2000s. The share of computerized information has increased during the past 20 years. Table 4 presents the ratio of intangible investment to GDP by category. The table shows that all categories contributed to the increase in the ratio of total intangible investment to GDP. The investment/GDP ratios for computerized information and innovative property are larger than those estimated for the US and the UK. However, the GDP ratio of economic competencies is much smaller than those estimated for the US and UK due to the low GDP ratio of investment in firm-specific human capital and organizational structure..

(Insert Tables 3 and 4)

2.5 Intangible investment by sector

As discussed in Section 2.1, our measurement of intangible investment mainly relies on the JIP 2008 Database. Because this database includes data on output, intermediate input, labor input, and capital services in 108 industries, we are able to measure intangible investment by sector. Table 5 shows intangible investment in the manufacturing sector and the service sector.[4]

(Insert Table 5)

In Table 5, we find that intangible investment in the service sector is larger than that in the manufacturing sector. However, as for the ratio of intangible investment to value added, the ratio is higher in the manufacturing than in the service sector due to the high ratio of investment in R&D to value added in the former. As can be seen in the table, although the total amount of intangible investment in the service sector is greater than that in the manufacturing sector, the ratio to value added is lower. Moreover, given that the ratio of intangible investment to value added in Japan's manufacturing sector exceeds the equivalent ratio for the US economy as a whole in the early 2000s, it becomes clear that it is the service sector which is responsible for dragging the ratio for Japan's economy as a whole below that of the US. The intangible/tangible investment ratio is also slightly higher in the manufacturing than in the service sector. We suspect that the reason why firms in the service sector accumulate more tangible than intangible assets is that they are more dependent on debt finance.

3. Growth accounting

Using the intangible investment data obtained in the previous section, we examine the contribution of intangible capital to Japan's economic growth. We obtain real investment series by using the deflators shown in Table 6. We then use the perpetual inventory method to construct the capital stock of intangible assets.

[4] The economy as a whole consists of the manufacturing sector, the service sector, and a range of other sectors that include agriculture, forestry, fishing, the mining and construction industries, and the public sector.

The depreciation rates for intangible assets are taken from CHS (2006) and are shown in Table 7. Since data on intangible investment at 1995 prices are available from 1973, we can use 1980 as the starting point for the construction of the capital stock of intangible assets.

(Insert Tables 6 and 7)

The value and growth rate of Japan's intangible capital stock are reported in Table 8. In 2005, the real intangible capital stock stood at 210 trillion yen. The growth rate of intangible capital has decreased drastically from 10.0 percent in the late 1980s to 2.0 percent in the early 2000s. This pattern – rapid growth during the 1980s but a slowdown during the 1990s and 2000s – is almost the exact opposite of that observed in the United States, where the accumulation of intangible assets accelerated around the middle of the 1990s.

(Insert Table 8)

In order to examine the contribution of intangible capital to Japan's economic growth, we conduct a growth accounting exercise. We assume the following Cobb-Douglas type production function:

(1) $Y_t = A_t (K_t^T)^{\alpha} (K_t^I)^{\beta} L_t^{1-\alpha-\beta}$

where Y_t represents GDP, A_t stands for multi-factor productivity (MFP), K_t^T is tangible capital, and K_t^I stands for intangible capital. From equation (1), we obtain:

(2) $\Delta y = \Delta a + \alpha \Delta k^T + \beta \Delta k^I + \Delta l$

where $\Delta x = \frac{\partial \ln X_t}{\partial t}$, and $x = \ln X_t$ $(x = y, k, l)$. Moreover, k^T and k^I are the logs of the ratios of capital stock to hours worked.

The data for all the variables, except for intangible capital and MFP in equation (1), are taken from the JIP 2008 Database. We calculate production factor shares on a cost basis. The labor share is calculated by dividing labor compensation by nominal total costs. By subtracting the labor share from 1, we obtain the

total capital share. The shares of tangible and intangible capital are calculated by using the share of each type of capital in total capital.[5]

The results of our growth accounting exercise based on equation (2) are shown in Table 9, which compares the results of our growth accounting with intangible capital with the results of a conventional growth accounting exercise without intangible capital. We find that the contribution of intangible capital to Japan's annual economic growth declined from 0.9 percent points in the second half of the 1980s to about 0.5 percentage points in the 1990s. The effect of intangible capital deepening continued to decline in the early 2000s, because intangible investment in Japan has stagnated since 2002. As a result, the total capital deepening effect was larger in the growth accounting with intangible capital than in the conventional growth accounting. Conversely, MFP growth has been slightly smaller in the growth accounting with intangible capital than in the conventional growth accounting without intangible capital except the second half of the 1990s.

(Insert Table 9)

When we conduct growth accounting by sector, the contribution of intangible capital service to labor productivity growth declined in both the manufacturing and the service sector in the 1990s. Although labor productivity growth subsequently recovered in both sectors, intangible capital deepening did not contribute to this recovery in either sector. When we compare growth accounting for Japan and the US, the contribution of intangible capital to labor productivity growth in Japan in the early 2000s was negative, while CHS (2006) found that the increase in intangible capital in the late 1990s and the early 2000s was responsible for 27 percent of labor productivity growth in the US. If the contribution of intangible capital to labor productivity growth were as large in Japan as in the United States, then Japanese labor productivity growth in the early 2000s would have been 0.2 percentage points higher than it actually was.

4. Sensitivity analysis

[5] As for labor and capital inputs, we took quality into account.

In Section 2, we measured intangible investment in Japan following CHS (2005). However, investment in firm-specific resources depends on the business customs of each country. Therefore, our results with regard to intangible investment in Japan in Section 2 may depend on our parameter assumptions for the measurement of investment in firm-specific resources in Section 2.3. To examine whether this is the case, we conduct a sensitivity analysis changing the parameters assumed in the measurement of firm-specific resources in the following two cases.

First, we examine what happens when we assume that the depreciation rate of firm-specific resources is 20 percent rather than the 40 percent assumed by CHS (2006) and used in the above analysis (see Table 7).

Second, we make the following assumptions with respect to firm-specific human capital and organizational structure:

(1) We take account of informal training costs. These are not included in the measurement of investment in firm-specific resources employed CHS (2005), but Japanese firms often utilize on-the-job training to accumulate firm-specific human capital and they therefore may represent an important element of intangible investment. Since there are no official surveys providing information on on-the-job training, we use information on on-the-job training from a survey conducted by the Cabinet Office in 2007 for the *Annual Report on the Japanese Economy and Public Finance* 2007. The survey was sent to 979 listed firms of which 818 responded. According to this survey, Japanese workers spend about 9.9 percent of their time on on-the-job training. Therefore, we count 9.9 percent of employees' wages as on-the-job training costs.[6]

(2) In Section 2, we assume that all off-the-job training activities contribute to the accumulation of firm-specific human capital. However, according to a survey on household behavior conducted by Keio University, 63 percent of workers answered that skills gained through off-the-job training supported by employers would be useful even if they were to change jobs. Above, we count training costs which are useful for a specific firm as investment in firm-specific human capital, but the result of the Keio survey implies that we should not treat all such off-the-job training as investment in firm-specific human capital. Unfortunately, we do not know how much of the training given to the 63 percent that thought it would be useful also in a different job was firm-specific. For our sensitivity analysis, we therefore assume that the training that the 63

[6] This result is very much in line with informal interviews with Japanese managers we conducted, which suggest that about 10 percent of workers' working time is used for on-the-job training.

percent received was not firm-specific and only count 37 percent of formal training costs as investment in the accumulation of firm-specific human capital.

(3) Following CHS (2005), in the analysis above, we assumed that executives spend 20 percent of their working time on organizational change. However, according to Robinson and Shimizu (2006), who surveyed the time use of Japanese CEOs, Japanese CEOs spent only 9 percent of their working time on strategy development, developing new business, and re-organization. Therefore, as an alternative, we measure investment in organizational structure using 9 percent rather than 20 percent of the remuneration of executives.

Figure 2 shows the sensitivity analysis considering the above modifications. The Base Case is the estimation described in Section 2, the alternative Case 1 is the case where we change the depreciation rate of firm-specific resources, and Case 2 is the case where we consider informal training and Japanese data with respect to investment in firm-specific human capital and organizational change. We find no substantial differences between Case 1 and the Base Case. The change in the depreciation rate of firm-specific resources does not affect the growth accounting results.[7]

(Insert Figure 2)

In Case 2, we find that the intangible investment/GDP ratio (14.2 percent in the early 2000s) is higher than that in the Base Case because on-the-job training costs are taken into account. In the growth accounting in Case 2, both labor productivity growth and the capital deepening effect are lower than in the Base Case from the late 1990s onward. As lower productivity growth is offset by the low capital deepening effect, the MFP growth rate in Case 2 since the second half of the 1990s is similar to that in the Base Case. Our sensitivity analysis thus shows that if on-the-job training costs and the working time of Japanese CEOs on organizational change surveyed by Robinson and Shimizu (2006) with respect to firm-specific resources are taken into account, the ratio of intangible investment to GDP in Japan is actually higher than that in the US or the UK. In the growth accounting in Case 2, labor productivity growth and the total capital deepening effect are lower than in the Base Case since the second half of the 1990s. As a result, the recovery in MFP

[7] We examine the effect of change in depreciation rate in other components. The results are similar to Case 1.

growth from the late 1990s to the early 2000s in Case 2 is similar to that suggested in the Base Case estimation.

5. Policy implications and future research agenda

The purpose of this paper was to measure intangible assets in Japan. Using our estimates, we constructed the capital stock of intangible assets and examined the contribution of intangible capital to Japanese economic growth. The results of our study can be summarized as follows.

First, investment in intangible assets in Japan grew rapidly until 2000. Consequently, the ratio of intangible investment to GDP also rose during this period. However, the ratio of intangible investment to GDP in Japan is still lower than the value for the US for the early 2000s estimated by Dr. Corrado. In addition, the ratio of intangible to tangible investment in Japan is lower than that in the US. One possible reason for this are differences in the financial system, in particular the fact that much corporate financing in Japan relies on loans from banks which require tangible assets as collateral.

Second, we also estimated intangible investment by sector. We found that it is the service sector which is responsible for the low intangible investment/GDP ratio overall.

Third, the growth rate of intangible capital in Japan declined from the late 1980s to the early 2000s. This slowdown stands in stark contrast with the high growth rate of intangible capital in the US in the late 1990s.

Fourth, due to the slowdown in the accumulation of intangible assets, the contribution of intangible capital to economic growth in Japan turned negative in the early 2000s. The contribution of intangible capital to total labor productivity growth in Japan has been much smaller that than in the US. If the contribution of intangible capital to labor productivity growth were as large in Japan as in the United States, then Japanese labor productivity growth in the early 2000s would have been 0.2 percentage points higher than it actually was.

Fifth, the sensitivity analysis has shown that the intangible investment/GDP ratio in Japan exceeds the level in the US and the UK if we take on-the-job training and Japanese data with respect to investment in firm-specific resources into account. However, we find no change in the slowdown of the contribution of

intangible capital deepening to economic growth and the recovery in MFP growth from the second half of the 1990s, which we observed in the Base Case.

Our results have a direct bearing on the debate on how to overcome the low productivity growth in the service sector that has slowed down aggregate productivity growth in Japan. Service sector activities tend to be more intangible asset-intensive than manufacturing activities and until now, it has been the *tangible* asset-intensive manufacturing sector which has driven Japan's economic growth. However, Japan is facing strong competition in the manufacturing sector from emerging Asian economies such as China, India, and South Korea, and Japan cannot rely on the manufacturing sector alone to generate economic growth in the future. It therefore has to promote growth in the service sector in order to attain GDP growth rates of 2 or 3 percent. In order to achieve such change in economic structure, reforms to the accounting system and the financial system are necessary. As mentioned in Section 2, firms in the service sector which hold few tangible assets are stunted in their growth opportunities because they face difficulties in obtaining external finance. Introducing a new accounting system which also values intangible assets would open the way for banking and insurance firms to recognize intangible assets as collateral for finance. Therefore, it would be helpful to devise a methodology that aids the valuation of the intangible assets of such firms. In addition, efforts should be made to transform the current system in which banks dominate corporate financing to a new financial system in which even small firms can gain access to funds through capital markets.

Our study is in progress and much remains to be done. For example, firm-specific human capital and organizational structure are likely to be underestimated due to the lack of reliable data. To measure these more accurately, we will need to gather data concerning firm-specific human capital and organizational change by examining firm-level activities.[8]

We hope that once we have completed these tasks, we will have a clearer understanding of the role of intangible assets in promoting Japan's economic growth through faster productivity growth in the service sector.

[8] One study along these lines is that by Bloom and Van Reenen (2007), who tried to assemble and analyze data on the organizational structure of firms through interviews with firm managers.

References

Ark, B. van (2004), "The Measurement of Productivity: What Do the Numbers Mean?" in G. Gelauff, L. Klomp. S. Raes, and T. Roelandt (eds.), *Fostering Productivity*, Elsevier, Amsterdam.

Bloom, N. and J. van Reenen (2007), "Measuring and Explaining Management Practices Across Firms and Countries," *Quarterly Journal of Economics* 122: 1351-1408.

Corrado, C., C. Hulten, and D. Sichel (2005), "Measuring Capital and Technology: An Extended Framework," in C. Corrado, J. Haltiwanger, and D. Sichel (eds.), *Measuring Capital in the New Economy*, The University of Chicago Press, Chicago,.

Corrado, C., C. Hulten, and D. Sichel (2006), "Intangible Capital and Economic Growth," *NBER Working Paper* No. 11948.

Corrado, C. P. Lengermann, E. Bartelsman, and J. Beaulieu (2007), "Sectoral Productivity in the United States: Recent Developments and the Role of IT," *German Economic Review* 8: 188-210.

Fukao, K., S. Hamagata, T. Inui, K. Ito, H.U. Kwon, T. Makino, T. Miyagawa, Y. Nakanishi, and J. Tokui (2007), "Estimation Procedure and TFP Analysis of the JIP Database 2006 (revised)," *RIETI Discussion Paper* No. 07-E-003.

Jorgenson, D. W., F. M. Gollop, and B. M. Fraumeni (1987), *Productivity and U. S. Economic Growth*, Harvard University Press, Cambridge, MA..

Marrano, M. G. and J. Haskel, (2006) "How Much Does the UK Invest in Intangible Assets?" *Department of Economics Queen Mary University of London Working Paper* No. 578.

Marrano, M. G., J. Haskel and G. Wallis (2007), "What Happened to the Knowledge Economy? ICT, Intangible Investment and Britain's Productivity Record Revisited," paper presented at the NBER Summer Institute 2007.

McGrattan, E., and E. Prescott (2005), "Expensed and Sweat Equity," Federal Reserve Bank of Minneapolis, *Working Paper* No. 636.

Nomura, K. (2005), "Turn the Tables! Reframing the Measurement of Capital in Japanese National Accounts," paper presented at the Conference on the Next Steps for the Japanese SNA.

Ooki Eiichi (2003) “Performance-based Wage Systems and Vocational Education/Training Investment, (Gyoseki-shugi to Kyoiku Kunren Toshi),” *Implications of Performance-based Wage Systems for Individuals and Organizations*, in K. Konno (ed.), Chuo Keizai Sha, Tokyo (in Japanese).

Oliner, S., D. Sichel, and Stiroh (2007), “Explaining a Productive Decade,” *Brookings Papers on Economic Activity* 2007-1: 81-152.

Robinson, P. and N. Shimizu (2006), “Japanese Corporate Restructuring: CEO Priorities as a Window on Environmental and Organizational Change,” *The Academy of Management Perspectives* 20(3): 44-75.

Stiroh, K. and M. Botsch (2007), “Information Technology and Productivity Growth in the 2000s,” *German Economic Review* 8: 255-280.

Table 1: MFP growth and share in total hours worked by sector, major developed economies (%)

	1995-2005											
	MFP growth						Average share in total hours worked					
	Japan	US	France	Germany	Italy	UK	Japan	US	France	Germany	Italy	UK
Market economy total	0.5	1.7	0.8	0.4	-0.7	0.9	100.0	100.0	100.0	100.0	100.0	100.0
.Electrical machinery, post and communication	5.4	8.7	5.9	4.7	2.7	3.7	5.0	4.3	4.5	5.1	3.7	4.9
.Manufacturing, excluding electrical	-0.7	2.2	1.8	1.3	-1.2	0.8	19.4	15.7	18.3	23.4	22.4	18.0
.Other goods producing industries	0.0	-0.3	0.7	1.4	-0.1	0.1	20.0	14.3	19.2	15.6	16.6	13.9
.Distribution services	0.9	2.1	0.4	1.5	-0.9	1.1	26.2	27.1	24.2	25.8	26.2	26.7
.Finance and business services	-0.1	0.4	-0.8	-3.3	-0.4	1.1	12.8	21.2	21.1	17.3	13.7	23.0
.Personal and social services	-0.1	0.0	0.9	-0.7	-2.0	-0.7	16.6	17.4	12.8	12.7	17.4	13.5

Source: EU KLEMS Database March 2008.

Table 2 : Intangible investment by category: comparison among Japan, the US, and the UK

	Japan	**US**	**UK**
		CHS (2006)	MH (2006)
	2000-2005	1998-2000	2004
	(billion yen)	(billion US dollars)	(billion pounds)
Computerized information	**10,803**	**154**	**19.8**
Custom software	6,584		7.5
Packaged software	848	151	
In-house software	2,332		12.4
Databases	1,039	3	
Innovative property	**28,629**	**425**	**37.6**
Science and engineering R&D	13,690	184	12.4
Mineral exploitation	16	18	0.4
Copyright and license costs	5,161	75	2.4
Other product development, design, and research expenses	9,761	149	22.4
Economic competencies	**16,186**	**505**	**58.8**
Brand equity	5,534	140	11.1
Firm-specific human capital	2,241	365	28.5
Organizational structure	8,410		19.2
Total	55,618	1085	116.2
Intangible investment /Value added（%）	11.5	11.7 (13.8)	10.0
Intangible investment/Tangible investment	0.6	1.2 (1.1)	1.1

1) Sources: Japan:authors' calculations, US:Corrado, Hulten and Sichel (2006), UK:Marrano and Haskel (2006).
2) Figures in parentheses indicate estimates for the period from 2000 to 2003.

Table 3 : Intangible investment by category : share in total intangible investment (%)

	Japan							US	UK
	1980-89			1990-1999			2000-05		
		1980-84	1985-89		1990-94	1995-99		1998-2000	2004
Computerized information	10.0	7.7	12.2	16.3	15.1	17.4	19.5	14.2	17.0
Custom software	5.0	3.8	6.2	8.4	7.4	9.4	11.8		6.5
Packaged software	0.5	0.4	0.6	0.8	0.8	0.8	1.5	13.9	
In house software	3.5	2.7	4.3	5.7	5.7	5.7	4.3		10.7
Databases	1.0	0.8	1.1	1.4	1.3	1.5	1.8	0.3	
Innovative property	54.1	53.9	54.3	51.7	52.4	51.0	51.3	39.2	32.4
Science and engineering R&D	24.2	24.2	24.2	24.1	23.9	24.3	24.4	17.0	10.7
Mineral exploitation	0.1	0.2	0.1	0.1	0.1	0.1	0.0	1.7	0.3
Copyright and license costs	10.2	10.3	10.2	10.0	10.1	9.8	9.3	6.9	2.1
Other product development, design, and research expenses	19.6	19.3	19.9	17.6	18.4	16.8	17.6	13.7	19.3
Economic competencies	35.9	38.3	33.5	32.0	32.4	31.6	29.2	46.5	50.6
Brand equity	9.4	10.2	8.5	9.3	8.8	9.8	9.9	12.9	9.6
Firm-specific human capital	7.9	7.9	8.0	6.2	6.9	5.5	4.1	33.6	24.5
Organizational structure	18.6	20.2	17.0	16.5	16.7	16.3	15.1		16.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1) Sources: Japan:authors' calculations, US:Corrado, Hulten and Sichel (2006), UK:Marrano and Haskel (2006).

Table 4: The ratio of intangible investment to value added: by category and year (%)

	Japan							US	UK
	1980-89			1990-1999			2000-05		
		1980-84	1985-89		1990-94	1995-99		1998-2000	2004
Computerized information	0.8	0.6	1.1	1.6	1.4	1.8	2.2	1.7	1.7
Custom software	0.4	0.3	0.5	0.8	0.7	1.0	1.4		0.6
Packaged software	0.0	0.0	0.1	0.1	0.1	0.1	0.2	1.6	
In-house software	0.3	0.2	0.4	0.6	0.5	0.6	0.5		1.1
Databases	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.0	
Innovative property	4.3	3.9	4.7	5.1	5.0	5.2	5.9	4.6	3.2
Science and engineering R&D	1.9	1.7	2.1	2.4	2.3	2.5	2.8	2.0	1.1
Mineral exploitation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Copyright and license costs	0.8	0.7	0.9	1.0	1.0	1.0	1.1	0.8	0.2
Other product development, design, and research expenses	1.6	1.4	1.7	1.7	1.8	1.7	2.0	1.6	1.9
Economic competencies	2.8	2.8	2.9	3.2	3.1	3.2	3.4	5.4	5.0
Brand equity	0.7	0.7	0.7	0.9	0.8	1.0	1.1	1.5	1.0
Firm-specific human capital	0.6	0.6	0.7	0.6	0.7	0.6	0.5	3.9	2.4
Organizational structure	0.3	0.3	0.3	0.4	0.4	0.4	0.5		1.6
Total	7.9	7.2	8.6	9.9	9.5	10.3	11.5	11.7	10.0

1) Sources: Japan:authors' calculations, US:Corrado, Hulten and Sichel (2006), UK:Marrano and Haskel (2006).

Table 5 : Intangible investment by category in the manufacturing sector and the service sector

	Manufacturing sector		Services sector	
	2000-2005 (billion yen)	Ratio to value added (%)	2000-2005 (billion yen)	Ratio to value added (%)
Computerized information	**2,447**	**(2.09)**	**6,125**	**(2.37)**
Custom software	1,526	(1.30)	4,197	(1.61)
Packaged software	184	(0.16)	388	(0.15)
In-house software	510	(0.45)	1,065	(0.42)
Databases	226	(0.19)	475	(0.18)
Innovative property	**13,316**	**(11.22)**	**9,161**	**(3.55)**
Science and engineering R&D	9,312	(7.83)	1,052	(0.40)
Mineral exploitation	0	(0.00)	16	(0.01)
Copyright and license costs	472	(0.41)	4,152	(1.61)
Other product development, design, and research expenses	3,531	(2.98)	3,940	(1.54)
Economic competencies	**4,657**	**(3.95)**	**9,292**	**(3.59)**
Brand equity	1,876	(1.59)	3,477	(1.33)
Firm-specific human capital	584	(0.49)	1,334	(0.54)
Organizational structure	2,198	(0.91)	4,480	(0.36)
Total	20,420	(17.27)	24,577	(9.51)
Intangible investment/Tangible investment	0.9		0.5	

Source: Authors' calculation.

Table 6: Deflators for intangible investment

	Data source and comments
Computerized information	
Custom software	Investment deflator in the JIP 2008 Database
Packaged software	Investment deflator in the JIP 2008 Database
In-house software	Investment deflator in the JIP 2008 Database
Databases	Investment deflator in the JIP 2008 Database
Innovative property	
Science and engineering R&D	Output deflators for JIP 2008 Database industry nos. 99 and 106
Mineral exploitation	Investment deflator in the JIP 2008 Database
Copyright and license costs	Output deflators for JIP 2008 Database industry nos. 92 and 93
Other product development, design, and research expenses	Output deflators for JIP 2008 Database industry nos. 69, 70, and 88
Economic competencies	
Brand equity	Output deflator for JIP 2008 Database industry no. 85
Firm-specific human capital	Output deflator in JIP 2008 Database industry no. 80
Organizational structure	Output deflator in JIP 2008 Database industry no. 88

Table 7: Depreciation rates for intangible assets

Category	Depreciation rate (%)
Computerized information	33
Innovative property	20
Brand equity	60
Firm-specific human capital	40

Source: Corrado, Hulten and Sichel (2006).

Table 8 : Real value and growth rate of intangible capital stock

	Real value (billion yen)	Growth rate (%)			
	2005	1985-90	1990-95	1995-2000	2000-05
Computerized information	33,877	12.83	6.66	7.99	2.37
Custom software	20,798	14.32	6.30	10.01	4.71
Packaged software	2,709	12.46	1.60	10.76	12.83
In-house software	6,896	13.33	7.04	5.49	-6.73
Databases	3,474	4.06	10.25	4.51	7.96
Innovative property	138,638	11.53	4.90	2.95	2.38
Science and engineering R&D	66,593	9.63	4.05	3.71	2.44
Mineral exploitation	104	-5.73	-1.61	5.30	-7.43
Copyright and license costs	25,245	12.43	5.26	1.94	0.91
Other product development, design, and research expenses	46,696	14.36	5.93	2.47	3.18
Economic competencies	37,232	5.27	2.23	1.08	-0.43
Brand equity	9,646	4.85	2.04	4.10	1.06
Firm-specific human capital	5,556	9.02	-1.61	-0.88	-4.43
Organizational structure	22,030	3.68	4.34	1.21	1.20
Total	209,747	9.96	4.54	3.34	1.97

Source: Authors' calculation.

Table 9-1: Growth accounting with and without intangible capital (Whole Economy)

(a) Conventional growth accounting

(%)

	1985-90	1990-95	1995-2000	2000-2005
Growth rate of GDP	4.66	1.10	0.98	1.53
Growth rate of labor input	0.93	-0.11	-0.52	-0.61
Growth rate of labor productivity	3.73	1.20	1.50	2.14
Contribution of capital deepening	2.14	1.47	1.13	1.12
Contribution of MFP growth	1.59	-0.27	0.37	1.02

(b) Growth accounting with intangibles

(%)

	1985-90	1990-95	1995-2000	2000-05
Growth rate of GDP	4.89	1.06	1.26	1.51
Growth rate of labor input	0.93	-0.11	-0.52	-0.61
Growth rate of labor productivity	3.96	1.17	1.78	2.12
Contribution of capital deepening	2.66	1.75	1.34	1.17
Contribution of tangible capital	1.76	1.25	0.86	0.82
Contribution of intangible capital	0.90	0.51	0.48	0.35
Contribution of MFP growth	1.30	-0.59	0.44	0.94

Source: Authors' calculation.

Table 9-2: Growth accounting with and without intangible capital (Manufacturing sector)

(a) Conventional growth accounting

(%)

	1985-90	1990-95	1995-2000	2000-05
Growth rate of GDP	4.30	0.15	1.05	2.16
Growth rate of labor input	0.22	-2.42	-1.85	-1.82
Growth rate of labor productivity	4.08	2.57	2.90	3.98
Contribution of capital deepening	3.11	2.66	1.37	2.78
Contribution of MFP growth	0.97	-0.09	1.53	1.20

(b) Growth accounting with intangibles

(%)

	1985-90	1990-95	1995-2000	2000-05
Growth rate of GDP	4.66	0.27	1.48	2.43
Growth rate of labor input	0.22	-2.42	-1.85	-1.82
Growth rate of labor productivity	4.43	2.69	3.33	4.26
Contribution of capital deepening	3.91	3.34	2.05	2.82
Contribution of tangible capital	2.18	1.84	0.97	1.85
Contribution of intangible capital	1.72	1.50	1.08	0.96
Contribution of MFP growth	0.53	-0.65	1.29	1.44

Source: Authors' calculation.

Table 9-3 : Growth accounting with and without intangible capital (Service sector)

(a) Conventional growth accounting

(%)

	1985-90	1990-95	1995-2000	2000-05
Growth rate of GDP	4.71	2.51	1.30	1.52
Growth rate of labor input	1.56	0.62	0.06	-0.50
Growth rate of labor productivity	3.15	1.89	1.24	2.02
Contribution of capital deepening	2.52	1.53	1.23	1.35
Contribution of MFP growth	0.63	0.36	0.01	0.67

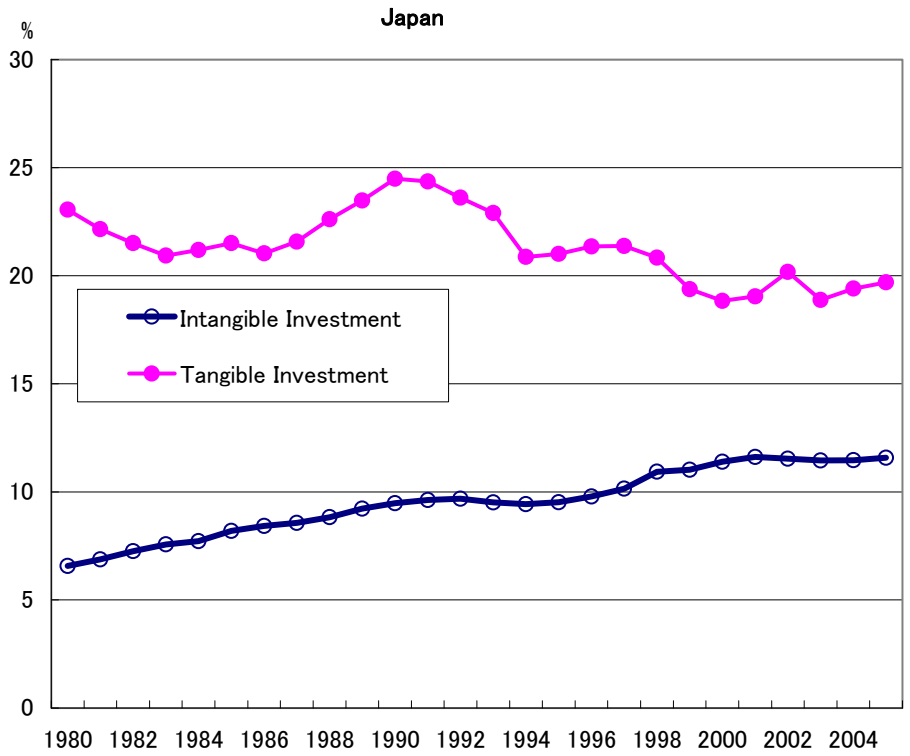
(b) Growth accounting with intangibles

(%)

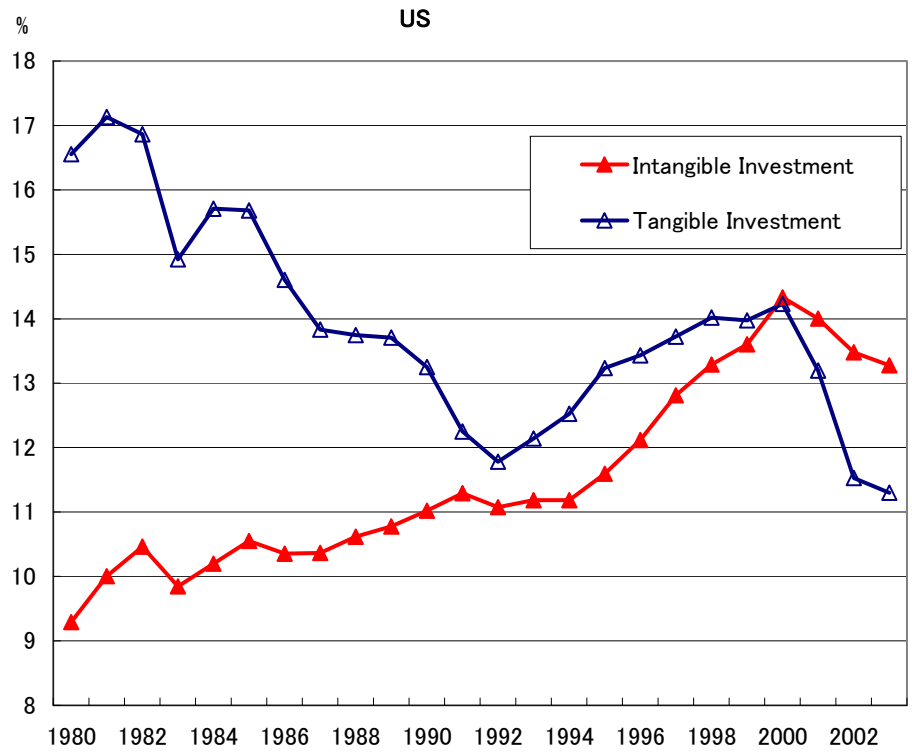
	1985-90	1990-95	1995-2000	2000-05
Growth rate of GDP	4.98	2.34	1.56	1.84
Growth rate of labor input	1.56	0.62	0.06	-0.48
Growth rate of labor productivity	3.41	1.72	1.50	2.32
Contribution of capital deepening	2.87	1.69	1.33	1.23
Contribution of tangible capital	2.09	1.26	0.95	0.91
Contribution of intangible capital	0.78	0.43	0.38	0.32
Contribution of MFP growth	0.54	0.03	0.17	1.09

Source: Authors' calculation.

Figure 1: Business investment (Percentage of Business Output)



Source: Authors' calculation.



Source: Corrado, Hulten and Sichel (2006).

Figure 2 : Sensitivity Analysis

Figure 2-1: Share of intangible investment in Japan's GDP
(%, nominal)

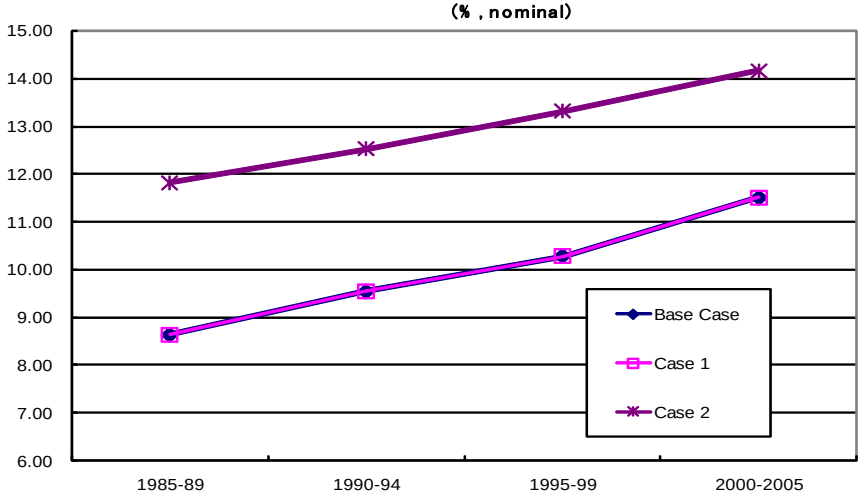


Figure 2-2: Capital deepening (Intangibles)

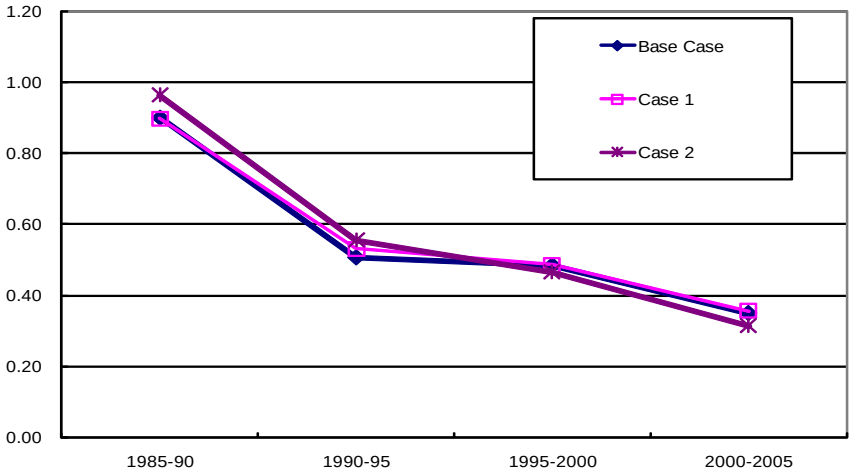


Figure 2-3: MFP growth

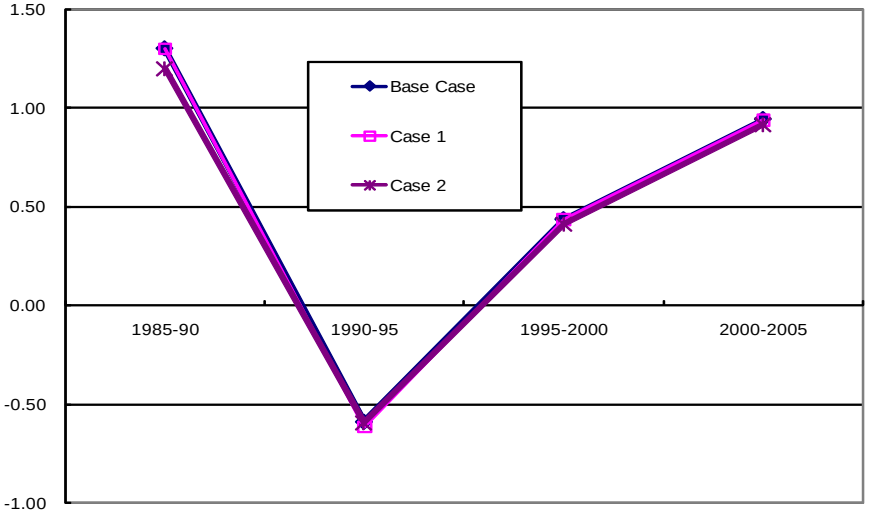
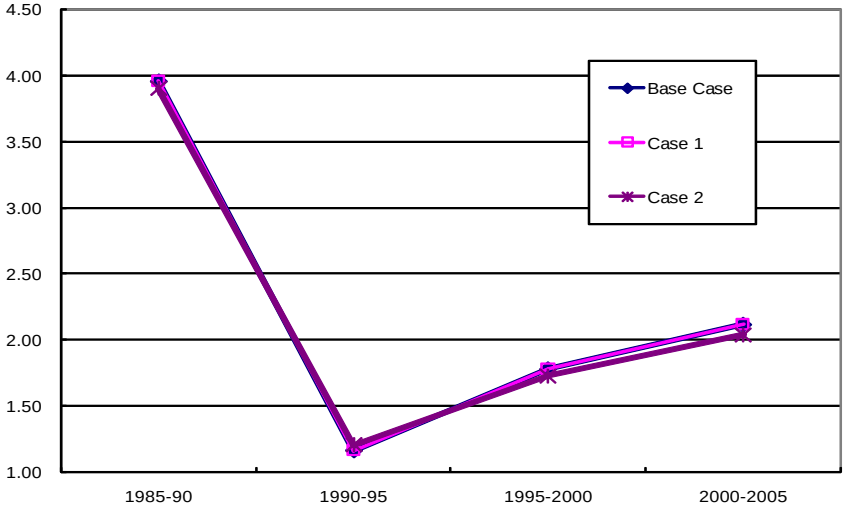


Figure 2-4: Labor productivity



Source: Authors' calculation.

Appendix 1. Details of the Estimation Method of Intangible Investment

Component	Estimation method	Method of estimating industry-level investment	Data Sources
Computerized information			
Custom software	We used data of custom software investment (JIP asset classification no. 38). The method employed to estimate the JIP data is as follows: for recent years, we used fixed capital formation matrices, which are available in five-year intervals. For intervening years between these benchmark years, and extrapolating backwards, we used the section on the information service industry in the *Survey of Selected Service Industries* to estimate investment. For years after 1983, annual sales of custom software in "Software development and programming" in this survey are regarded as custom software investment. Data for 1982 and before are estimated using the share of custom software in "Software development and programming" in 1983 because the shares for these earlier years are not available.	Manufacturing: We aggregate custom software investment (JIP asset classification no. 38) in the manufacturing sector (JIP industries nos. 8-59) in the JIP 2008 Database. Services: We aggregate custom software investment (JIP asset classification no. 38) in the service sector (JIP industries nos. 65-97) in the JIP 2008 Database.	JIP 2008 Database
Packaged software	The methodology of estimating packaged software investment is based on the compilation of the IT capital stock series in chapter 4 of Cabinet Office, *Economic Analysis* No.170, "Productivity by industry and economic growth 1970-98." The total amount of intermediate input produced by the software service sector in the Linked Input Output Table 1985-90-95 is used to estimate packaged software investment. Because the software service sector produces not only packaged software but also provides data processing, database services, etc., we excluded the sales of data	Manufacturing: We estimate packaged software investment in the manufacturing sector by multiplying the total amount of packaged software investment by the ratio of packaged software sales to the manufacturing sector to the total of packaged software sales. The data on packaged software sales by sector are taken from the *ICT Workplace Survey*	*ICT Workplace Survey* and JIP 2008 Database

	processing, database services from the total sales in the software service sector by using the *Survey of Selected Service Industries*. Annual sales of software products ("Software development and programming") after 1973 in this survey are regarded as packaged software.	conducted by the Ministry of Economy, Trade and Industry and the JIP 2008 Database. Services: We estimate packaged software investment in the service sector by multiplying the total amount of packaged software investment by the ratio of packaged software sales to the service sector to the total of packaged software sales. The data on sales of packaged software by sector are taken from the *ICT Workplace Survey* conducted by the Ministry of Economy, Trade and Industry and the JIP 2008 Database.	
In-house software	We measure in-house software investment using the *ICT Workplace Survey* and the *Population Census*. The *ICT Workplace Survey*, which is also conducted annually by Ministry of Economy, Trade and Industry, provides information on enterprises and organizations that heavily use ICT equipment, with regard to their labor costs, other expenditure, and number of employees categorized by job type such as programmers, systems engineers, and network managers. As the *ICT Workplace Survey* does not cover all workers who are involved in making in-house software in Japan, we employ the following estimation procedures. From this survey, we take two types of costs: the first is wages for workers in divisions which are specialized in in-house software development and the second is other expenditures in these divisions. Using these values, we calculate the cost of in-house	As in the estimation of investment in packaged software, we estimate in-house software investment by sector using the ratio of software sales obtained from the *ICT Workplace Survey*. Manufacturing: We estimate in-house software investment in the manufacturing sector by multiplying total in-house software investment by the ratio of the sales of software to the manufacturing sector to total software sales. The data on software sales by sector are taken from the *ICT Workplace Survey* conducted by Ministry of Economy, Trade and Industry and the JIP 2008	*ICT Workplace Survey*, *Population Census*, *Establishment and Enterprise Census*, and JIP 2008 Database

	software investment per engineer and programmer. We then multiply the result by the total number of engineers and programmers in the market economy, which is available from the *Population Census*, and derive in-house software investment in the market economy. We measure the labor costs involved in making in-house software by multiplying the total labor costs by the share of system engineers and programmers in total workers. We have to exclude firms in the software industry and the information service industry whose workers are involved in making custom software. Therefore, in-house software investment is estimated by multiplying the estimated investment by the ratio of workers involved in making in-house software development.	Database. Services: We estimate in-house software investment in the service sector by multiplying total in-house software investment by the ratio of the sales of software to the service sector to total software sales. The data on software sales by sector are taken from the *ICT Workplace Survey* conducted by Ministry of Economy, Trade and Industry and the JIP 2008 Database.	
Databases	From the *Survey of Selected Service Industries* by the Ministry of Economy, Trade and Industry, we take data on the annual sales of data processing and other database utility service. Sales of database services are assumed to be investment in intangible assets. However, the *Survey of Selected Service Industries* does not cover all firms which produce database services. Therefore, we estimate the total investment in databases by multiplying the figure taken from the *Survey of Selected Service Industries* by the ratio of the number of firms in the *Survey of Selected Service Industries* to the numbers of firms in the information service industry in the *Establishment and Enterprise Survey*. For years in which the *Establishment and Enterprise Survey* was not conducted, we estimated investment in databases by linear interpolation.	As in the estimations of packaged and in-house software investment, we estimate investment in databases by sector using the sales ratio in the *ICT Workplace Survey* and the JIP 2008 Database. Manufacturing: We estimate investment in databases in the manufacturing sector by multiplying the total amount of investment in databases by the ratio of sales of database services to the manufacturing sector to the total sales of database services. The data on sales of database services by sector are taken from the *ICT Workplace Survey* conducted by the	*ICT Workplace Survey*, *Establishment and Enterprise Survey*, and JIP 2008 Database

		Ministry of Economy, Trade and Industry and the JIP 2008 Database. Services: We estimate investment in databases in the service sector by multiplying the total investment in database services by the ratio of the sales of database services to the service sector to the total sales of database services. The data on sales of database services by sector are taken from the *ICT Workplace Survey* conducted by the Ministry of Economy, Trade and Industry and the JIP 2008 Database.	
Innovative property			
Science and engineering R&D	The *Survey of Research and Development* published by the Ministry of Internal Affairs and Communications provides data on employment costs, material costs, depreciation expenses for property, plant and equipment, rent payments for property, plant and equipment, and other expenditures. Among the above data on R&D expenses, we exclude data for property, plant and equipment when calculating intangible investment because we have already included these assets as tangible assets. We also exclude leasing costs in calculating intangible investment. Thus, we assume intangible investment to consist of the sum of employment costs, material costs, and other expenditures. Because the survey is conducted on a fiscal-year basis, the values are then converted to a calendar-year basis.	The *Survey of Research and Development* conducted by the Ministry of Internal Affairs and Communications provides data by industry, so we simply take the data on research and development expenditures in the manufacturing and service sectors provided in this survey.	*Survey of Research and Development*

Mineral exploitation		The *Mining Industry Handbook* and the *Establishment and Enterprise Survey* provide data on expenses for mineral exploitation (the total expenses for geological investigation) and we used these two sources for data on the costs of searching for minerals and expenditures on mineral exploitation.	Because we assume that firms which conduct investment in mineral exploitation belong to the service sector, the total estimated investment in mineral exploitation is assigned to the intangible investment in the service sector.	*Handbook of the Mining Industry, Annual Report on Oil and Natural Gas Exploitation*
Copyright and license costs		Intangible investment in copyright and license costs is assumed to consist of the input from the publishing industry (JIP industry no. 92) and the video picture, sound information, character information production and distribution industry (JIP industry no. 93) to JIP industries nos. 1-71 and 73-107.	Manufacturing: The input from the publishing industry (JIP industry no. 92) ,the video picture, sound information, character information production and distribution industry (JIP industry no. 93) to the manufacturing sector (JIP industries nos. 8-59). Services: The input from the publishing industry (JIP industry no. 92) and the video picture, sound information, character information production and distribution industry (JIP industry no. 93) to the service sector (JIP industries nos. 65-97).	JIP 2008 Database
Other product development, design, and research expenses				
	Design	Intangible investment in design is estimated using the sales data of the design industry in the *Survey of Selected Service Industries*. The survey was conducted in 1973, 1974, 1979, 1982, 1985, 1990, 1992, 1995, 1998, 2000, and 2003. We calculate the ratio of the	Manufacturing: We take the data on the design industry's sales to the manufacturing and mining industries provided in the *Survey of Selected Service Industries* conducted by the	*Survey of Selected Service Industries, Establishmen*

		sales of the design industry in the *Survey of Selected Service Industries* to the nominal output of the other services for businesses industry (JIP industry no.88) of the JIP 2008 Database for each year that the survey was conducted. The ratio for years in which the survey was not conducted is obtained by linear interpolation. The ratio in 2003 is used for years after 2003. Sales in each year were estimated by multiplying this ratio by the nominal output of the other services for businesses industry of the JIP 2008 Database. The estimated value of sales is adjusted by using the number of firms taken from the *Establishment and Enterprise Survey* because the *Survey of Selected Service Industries* is a sample survey. The number of firms in the design industry is estimated using the *Survey of Selected Service Industries* and the *Establishment and Enterprise Survey*. Intangible investment in design is assumed to consist of the sales of the design industry estimated from the *Survey of Selected Service Industries* multiplied by the ratio of the number of firms in the design industry in the *Establishment and Enterprise Survey* to the number of firms in the design industry in the *Survey of Selected Service Industries*.	Ministry of Economy, Trade and Industry. We separate the sales to manufacturing industry from the data on sales to the manufacturing and mining industries by using the data on sales in the other services to businesses industry (JIP industry no. 88) in the JIP 2008 Database. Services: We take the data on the design industry's sales to the service sector provided in the *Survey of Selected Service Industries* conducted by the Ministry of Economy, Trade and Industry.	*t and Enterprise Survey*, and JIP 2008 Database
	Display	We estimate intangible investment in display using the sales data of the display industry in the *Survey of Selected Service Industries*. The survey data on the display industry in the *Survey of Selected Service Industries* was published in 1981, 1986, 1991, 1994, 1997, 2000, and 2003. The ratio of sales in the display industry in the *Survey of Selected Service Industries* to the nominal output of the other services for businesses	As in the estimation of investment in design, we estimate investment in display by sector using the *Survey of Selected Service Industries* conducted by the Ministry of Economy, Trade and Industry and the JIP 2008 Database. As for investment in display in the	

		industry of the JIP 2008 Database (JIP industry no. 88) is calculated for each year that the survey was conducted. The ratio for intervening years is obtained by linear interpolation. Sales in each year were estimated by multiplying this ratio by the nominal output of the other services for businesses industry of the JIP 2008 Database. The estimated value of sales is adjusted using the number of firms taken from the *Establishment and Enterprise Survey* because the *Survey of Selected Service Industries* is a sample survey. The number of firms in the display industry is estimated using the *Survey of Selected Service Industries* and the *Establishment and Enterprise Survey*. Intangible investment in display is assumed to consist of the sales of the display industry estimated from the *Survey of Selected Service Industries* multiplied by the ratio of the number of firms in the display industry in the *Establishment and Enterprise Survey* to the number of firms in the display industry in the *Survey of Selected Service Industries*.	manufacturing sector, we take the data on sales of the display industry to the manufacturing and mining industries from the *Survey of Selected Service Industries*. We separate the sales to manufacturing from the data on sales to the manufacturing and mining industries by using the data on sales in the other services for businesses industry (JIP industry no. 88) in the JIP 2008 Database. As for investment in display in the service sector, we take the data on sales of the display industry to the service sector from the *Survey of Selected Service Industries* conducted the by Ministry of Economy, Trade and Industry.	
	Machine design	Intangible investment in machine design is estimated using the sales data of the machine design industry in the *Survey of Selected Service Industries*. The survey data on the machine design industry in the *Survey of Selected Service Industries* was published in 1983, 1990, 1993, 1996, 1999, 2000, and 2003. The ratio of sales in the machine design industry in the *Survey of Selected Service Industries* to the nominal output of the other services for businesses industry of the JIP 2008 Database (JIP industry no. 88) is calculated for each year that the survey was conducted.	As in the estimations of investment in design and display, we estimate investment in machine design by sector using the *Survey of Selected Service Industries* conducted by the Ministry of Economy, Trade and Industry, and the JIP 2008 Database. As for investment in machine design in the manufacturing sector, we take the data on sales of the machine design industry to the manufacturing	

		The ratio for intervening years is obtained by linear interpolation. Sales in each year were estimated by multiplying this ratio by the nominal output of the other service for businesses industry of the JIP 2008 Database. The estimated value of sales is adjusted by using the number of firms taken from the *Establishment and Enterprise Survey* because the *Survey of Selected Service Industries* is a sample survey. The number of firms in the display industry is estimated using the *Survey of Selected Service Industries* and the *Establishment and Enterprise Survey*. Intangible investment in machine design is assumed to consist of the sales of the machine design industry estimated from the *Survey of Selected Service Industries* multiplied by the ratio of the number of firms in the machine design industry in the *Establishment and Enterprise Survey* to the number of firms in the machine design industry in the *Survey of Selected Service Industries*.	and mining industries from the *Survey of Selected Service Industries*. We separate the sales to manufacturing industry from the data on sales to the manufacturing and mining industries by using the data on sales in the other services to businesses industry (JIP industry no.88) in the JIP 2008 Database. As for investment in the service sector, we take the data on sales of the machine design industry to the service sector from the *Survey of Selected Service Industries* conducted by the Ministry of Economy, Trade and Industry.	
	Architectural design	Architectural design is included in the other services for businesses industry of the JIP 2008 Database (JIP industry no. 88). To estimate intangible investment in architectural design, we multiply the total output in the other business services for businesses industry of the JIP 2008 by the ratio of nominal output of the architectural design industry to the total output of the other services for businesses industry for every year. We calculate this ratio by using the Input-Output Table.	<u>Manufacturing</u>: We estimate investment in architectural design in the manufacturing sector by multiplying the total investment in architectural design by the ratio of sales to the manufacturing sector to the total sales in the business service industry. We calculate this ratio using the data on the other services to businesses industry (JIP industry no. 88) in the JIP 2008 Database. <u>Services</u>: We estimate investment in architectural design in the service sector by multiplying the total	Input and Output Table and JIP 2008 Database

			investment in architectural design by the ratio of sales to the service sector to the total sales of the business service industry. We calculate the ratio using the data on the other services for businesses industry (JIP industry no. 88) in the JIP 2008 Database.	
	Product development in financial services	Following CHS (2005), we assumed that 20 percent of intermediate inputs produced by the financial sector (JIP industry no. 69) and the insurance sector (JIP industry no. 70) can be regarded as intangible investment.	We assume that all product development in financial services is conducted in the service sector.	JIP 2008 Database
Economic competencies **Brand equity**		Following CHS (2005), we assumed that 60 percent of nominal intermediate inputs produced by the advertising sector (JIP industry no. 85) can be regarded as intangible investment.	Manufacturing: We assume that 60 percent of the input from the advertising industry (JIP industry no. 85) to the manufacturing sector (JIP industries nos. 8-59) is investment in brand equity. Services: Similarly, we assume that 60 percent of the input from the advertising industry (JIP industry no. 85) to the service sector (JIP industries nos. 65-97) is investment in brand equity.	JIP 2008 Database
Firm-specific human capital **Off-the-job training (OFF-JT)**				
	Education and training	We use data on vocational education costs per worker from the *General Survey on Working Conditions* (*Shugyo Joken Sogo Chosa*) conducted by the Ministry	Corresponding the industry classification in the *General Survey on Working Conditions* to the	*General Survey on Working*

	expenses	of Health, Labour and Welfare. The purpose of this survey is to statistically review the wage system, fringe benefits, and retirement system of Japanese firms. It covers about 5,000 Japanese firms and asks these about training costs, including the wage and salary costs of employees who teach workers in an off-the-job mode or employees who support the off-the-job training processes.	industry classification in the JIP 2008 Database, we take the data on the off-the-job training costs in the manufacturing sector and the service sector respectively.	*Conditions*
	Opportunity cost of OFF-JT	For the opportunity cost of off-the-job training in terms of working hours lost, we use the results obtained by Ooki (2003). Using micro-data of The Japan Institute for Labour Policy and Training's *Survey on Personnel Restructuring and Vocational Education/Training Investment in the Age of Performance-based Wage Systems* (*Gyoseki-shugi Jidai no Jinji Seiri to Kyoiku/Kunren Toshi ni Kansuru Chosa*), Ooki calculated the average opportunity cost ratio of off-the-job training to direct firm expenses for training in 1998 for the whole business sector. The value was 1.51. We use this value to estimate the opportunity cost.	We assume that the average opportunity cost ratio of off-the-job training to direct firm expenses for training is identical across industries.	Ooki (2003)
On-the-job training (OJT), estimation for the sensitivity analysis		We use information on on-the-job training from a survey, "Survey of New Growth Strategies in companies," conducted by the Cabinet Office in 2007 for the *Annual Report on the Japanese Economy and Public Finance* 2007. The survey was sent to 979 listed firms of which 818 responded. According to this survey, Japanese regular workers spend about 9.9 percent of their time on on-the-job training (weighted average across all types of regular workers and all industries). Therefore, we count 9.9 percent of wages of regular workers as on-the-job training costs.	We assume that the average percentage of regular workers' time on on-the-job training is identical across industries.	

Organizational structure				
	Executive salaries	Following CHS (2005), we assumed that 20 percent of executive salaries in the *Financial Statements Statistics of Corporations by Industry* published by the Ministry of Finance can be assumed to be intangible investment.	The *Financial Statements Statistics of Corporations by Industry* provide data on the remuneration of executives by industry. Using these data, we measure executive remuneration in the manufacturing sector and the service sector respectively.	*Financial Statements Statistics of Corporations by Industry*
	Legal affairs, financial affairs, and accounting services	Legal affairs, financial affairs and accounting services are included in the other services for businesses industry of the JIP 2008 Database (JIP industry no. 88). To estimate intangible investment in the above services, we multiply the total output of the other services for businesses industry of the JIP 2008 by the ratio of nominal output of the legal affairs, financial affairs and accounting services industry to the total output of the other business service industry for every year. We calculate this ratio using the Input-Output Table.	Manufacturing: We estimate investment in legal affairs, financial affairs, and accounting services in the manufacturing sector by multiplying the total investment in legal affairs, financial affairs, and accounting services by the ratio of sales to the manufacturing sector to the total sales of the business service industry. We calculate the ratio using the data for the other services for businesses industry (JIP industry no. 88) in the JIP 2008 Database. Services: We estimate investment in legal affairs, financial affairs, and accounting services in the service sector by multiplying the total investment in legal affairs, financial affairs, and accounting services by the ratio of sales to the service sector to the total sales of the business service industry. We calculate the	Input -Output Table and JIP 2008 Database

			ratio using the data for the other services for businesses industry (JIP industry no. 88) in the JIP 2008 Database.	

Appendix 2. Correspondence Tables of the Japan Industrial Productivity Database 2006 Sector Classification and International Standard Industrial Classification of All Economic Activities Third Revision, (ISIC, Rev.3)

The Japan Industrial Productivity Database 2006 (JIP 2006) Sector Classification		International Standard Industrial Classification of All Economic Activities Third Revision, (ISIC, Rev.3)	
Code	Sector	4-digit codes	Classes
1	Rice, wheat production	0111	cutting, shaping and finishing of stone
2	Miscellaneous crop farming	0111	Growing of cereals and other crops n.e.c.
		0112	Growing of vegetables, horticultural specialties and nursery products
		0113	Growing of fruit, nuts, beverage and spice crops
3	Livestock and sericulture farming	0121	Farming of cattle, sheep, goats, horses, asses, mules and hinnies; dairy farming
		0122	Other animal farming; production of animal products n.e.c.
4	Agricultural services	8520	Veterinary activities
		0140	Agricultural and animal husbandry service activities, except veterinary activities
5	Forestry	0112	Growing of vegetables, horticultural specialties and nursery products
		0150	Hunting, trapping and game propagation including related service activities
		0200	Forestry, logging and related service activities
6	Fisheries	500	Fishing, operation of fish hatcheries and fish farms; service activities incidental to fishing
7	Mining	1010	Mining and agglomeration of hard coal
		1020	Mining and agglomeration of lignite
		1030	Extraction and agglomeration of peat
		1110	Extraction of crude petroleum and natural gas
		1120	Service activities incidental to oil and gas extraction excluding surveying
		1200	Mining of uranium and thorium ores
		1310	Mining of iron ores
		1320	Mining of non
		1410	Quarrying of stone, sand and clay
		1421	Mining of chemical and fertilizer minerals
		1422	Extraction of salt
		1429	Other mining and quarrying n.e.c.
		2696	Cutting, shaping and finishing of stone
8	Livestock products	1511	Production, processing and preserving of meat and meat products
		1514	Manufacture of vegetable and animal oils and fats
		1520	Manufacture of dairy products
		1549	Manufacture of other food products n.e.c.
9	Seafood products	1511	Production, processing and preserving of meat and meat products
		1512	Processing and preserving of fish and fish products
		1514	Manufacture of vegetable and animal oils and fats
10	Flour and grain mill products	1531	Manufacture of grain mill products
11	Miscellaneous foods and related products	1513	Processing and preserving of fruit and vegetables
		1514	Manufacture of vegetable and animal oils and fats
		1531	Manufacture of grain mill products
		1532	Manufacture of starches and starch products
		1541	Manufacture of bakery products
		1542	Manufacture of sugar
		1543	Manufacture of cocoa, chocolate and sugar confectionery
		1544	Manufacture of macaroni, noodles, couscous and similar farinaceous products
		1549	Manufacture of other food products n.e.c.
12	Prepared animal foods and organic fertilizers	1512	Processing and preserving of fish and fish products
		1533	Manufacture of prepared animal feeds
13	Beverages	1513	Processing and preserving of fruit and vegetables
		1549	Manufacture of other food products n.e.c.
		1551	Distilling, rectifying and blending of spirits; ethyl alcohol production from fermented materials
		1552	Manufacture of wines
		1553	Manufacture of malt liquors and malt
		1554	Manufacture of soft drinks; production of mineral waters
14	Tobacco	1600	Manufacture of tobacco products
		0111	Growing of cereals and other crops n.e.c.
15	Textile products	1711	Preparation and spinning of textile fibres; weaving of textiles
		1712	Finishing of textiles
		1721	Manufacture of made
		1722	Manufacture of carpets and rugs
		1723	Manufacture of cordage, rope, twine and netting

	1729	Manufacture of other textiles n.e.c.
	1730	Manufacture of knitted and crocheted fabrics and articles
	1810	Manufacture of wearing apparel, except fur apparel
	1820	Dressing and dyeing of fur; manufacture of articles of fur
16 Lumber and wood products	1920	Manufacture of footwear
	2010	Sawmilling and planing of wood
	2021	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board and other panels and boards
	2022	Manufacture of builders' carpentry and joinery
	2023	Manufacture of wooden containers
	2029	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials
17 Furniture and fixtures	2022	Manufacture of builders' carpentry and joinery
	3610	Manufacture of furniture
18 Pulp, paper, and coated and glazed paper	2101	Manufacture of pulp, paper and paperboard
	2102	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
	2109	Manufacture of other articles of paper and paperboard
19 Paper products	2101	Manufacture of pulp, paper and paperboard
	2102	Manufacture of corrugated paper and paperboard and of containers of paper and paperboard
	2109	Manufacture of other articles of paper and paperboard
20 Printing, plate making for printing and bookbinding	2221	Printing
	2222	Service activities related to printing
21 Leather and leather products	1820	Dressing and dyeing of fur; manufacture of articles of fur
	1911	Tanning and dressing of leather
	1912	Manufacture of luggage, handbags and the like, saddlery and harness
	1920	Manufacture of footwear
22 Rubber products	1920	Manufacture of footwear
	2511	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres
	2519	Manufacture of other rubber products
23 Chemical fertilizers	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
	2412	Manufacture of fertilizers and nitrogen compounds
24 Basic inorganic chemicals	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
	2412	Manufacture of fertilizers and nitrogen compounds
	2421	Manufacture of pesticides and other agro
	2429	Manufacture of other chemical products n.e.c.
25 Basic organic chemicals	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
26 Organic chemicals	1551	Distilling, rectifying and blending of spirits; ethyl alcohol production from fermented materials
	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
	2413	Manufacture of plastics in primary forms and of synthetic rubber
	2424	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
27 Chemical fibers	2430	Manufacture of man
28 Miscellaneous chemical products	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
	2412	Manufacture of fertilizers and nitrogen compounds
	2421	Manufacture of pesticides and other agro
	2422	Manufacture of paints, varnishes and similar coatings, printing ink and mastics
	2424	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations
	2429	Manufacture of other chemical products n.e.c.
29 Pharmaceutical products	2421	Manufacture of pesticides and other agro
	2423	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
	2429	Manufacture of other chemical products n.e.c.
30 Petroleum products	2320	Manufacture of refined petroleum products
31 Coal products	1010	Mining and agglomeration of hard coal
	1020	Mining and agglomeration of lignite
	2310	Manufacture of coke oven products
32 Glass and its products	2610	Manufacture of glass and glass products
33 Cement and its products	2692	Manufacture of refractory ceramic products
	2694	Manufacture of cement, lime and plaster

		2695	Manufacture of articles of concrete, cement and plaster
34	Pottery	2691	Manufacture of non
35	Miscellaneous ceramic, stone and clay products	2692	Manufacture of refractory ceramic products
		2693	Manufacture of structural non
		2692	Manufacture of refractory ceramic products
		2693	Manufacture of structural non
		2694	Manufacture of cement, lime and plaster
		2695	Manufacture of articles of concrete, cement and plaster
		2696	Cutting, shaping and finishing of stone
		2699	Manufacture of other non
36	Pig iron and crude steel	2710	Manufacture of basic iron and steel
		2731	Casting of iron and steel
		2891	Forging, pressing, stamping and roll
37	Miscellaneous iron and steel		
38	Smelting and refining of non-ferrous metals	2720	Manufacture of basic precious and non
39	Non-ferrous metal products	2330	Processing of nuclear fuel
		2720	Manufacture of basic precious and non
		2732	Casting of non
		2891	Forging, pressing, stamping and roll
		2899	Manufacture of other fabricated metal products n.e.c.
		3130	Manufacture of insulated wire and cable
40	Fabricated constructional and architectural metal products	2811	Manufacture of structural metal products
41	Miscellaneous fabricated metal products	2812	Manufacture of tanks, reservoirs and containers of metal
		2891	Forging, pressing, stamping and roll
		2892	Treatment and coating of metals; general mechanical engineering on a fee or contract basis
		2893	Manufacture of cutlery, hand tools and general hardware
		2899	Manufacture of other fabricated metal products n.e.c.
		2919	Manufacture of other general purpose machinery
		2930	Manufacture of domestic appliances n.e.c.
42	General industry machinery	2813	Manufacture of steam generators, except central heating hot water boilers
		2893	Manufacture of cutlery, hand tools and general hardware
		2911	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
		2912	Manufacture of pumps, compressors, taps and valves
		2913	Manufacture of bearings, gears, gearing and driving elements
		2914	Manufacture of ovens, furnaces and furnace burners
		2915	Manufacture of lifting and handling equipment
		2919	Manufacture of other general purpose machinery
43	Special industry machinery	2919	Manufacture of other general purpose machinery
		2921	Manufacture of agricultural and forestry machinery
		2922	Manufacture of machine
		2923	Manufacture of machinery for metallurgy
		2924	Manufacture of machinery for mining, quarrying and construction
		2925	Manufacture of machinery for food, beverage and tobacco processing
		2926	Manufacture of machinery for textile, apparel and leather production
		2929	Manufacture of other special purpose machinery
44	Miscellaneous machinery	2912	Manufacture of pumps, compressors, taps and valves
		2913	Manufacture of bearings, gears, gearing and driving elements
		2919	Manufacture of other general purpose machinery
		2926	Manufacture of machinery for textile, apparel and leather production
		2929	Manufacture of other special purpose machinery
		2930	Manufacture of domestic appliances n.e.c.
45	Office and service industry machines	2929	Manufacture of other special purpose machinery
		3000	Manufacture of office, accounting and computing machinery
46	Electrical generating, transmission, distribution and industrial apparatus	2914	Manufacture of ovens, furnaces and furnace burners
		2922	Manufacture of machine
		3110	Manufacture of electric motors, generators and transformers
		3120	Manufacture of electricity distribution and control apparatus

		3190	Manufacture of other electrical equipment n.e.c.
47	Household electric appliances	2930	Manufacture of domestic appliances n.e.c.
		3230	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods
48	Electronic data processing machines, digital and analog computer equipment and accessories	3000	Manufacture of office, accounting and computing machinery
49	Communication equipment	3190	Manufacture of other electrical equipment n.e.c.
		3220	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy
50	Electronic equipment and electric measuring instruments	3311	Manufacture of medical and surgical equipment and orthopaedic appliances
		3312	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment
		3313	Manufacture of industrial process control equipment
51	Semiconductor devices and integrated circuits	3210	Manufacture of electronic valves and tubes and other electronic components
52	Electronic parts	3210	Manufacture of electronic valves and tubes and other electronic components
		3230	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods
53	Miscellaneous electrical machinery equipment	3120	Manufacture of electricity distribution and control apparatus
		3140	Manufacture of accumulators, primary cells and primary batteries
		3150	Manufacture of electric lamps and lighting equipment
		3190	Manufacture of other electrical equipment n.e.c.
54	Motor vehicles	3410	Manufacture of motor vehicles
		3591	Manufacture of motorcycles
55	Motor vehicle parts and accessories	3410	Manufacture of motor vehicles
		3420	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi
		3430	Manufacture of parts and accessories for motor vehicles and their engines
		3591	Manufacture of motorcycles
56	Other transportation equipment	2911	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
		2915	Manufacture of lifting and handling equipment
		3511	Building and repairing of ships
		3512	Building and repairing of pleasure and sporting boats
		3520	Manufacture of railway and tramway locomotives and rolling stock
		3530	Manufacture of aircraft and spacecraft
		3592	Manufacture of bicycles and invalid carriages
		3599	Manufacture of other transport equipment n.e.c.
57	Precision machinery & equipment	3311	Manufacture of medical and surgical equipment and orthopaedic appliances
		3312	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment
		3320	Manufacture of optical instruments and photographic equipment
		3330	Manufacture of watches and clocks
58	Plastic products	2520	Manufacture of plastics products
59	Miscellaneous manufacturing industries	2029	Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials
		2213	Publishing of recorded media
		2230	Reproduction of recorded media
		2927	Manufacture of weapons and ammunition
		3691	Manufacture of jewellery and related articles
		3692	Manufacture of musical instruments
		3693	Manufacture of sports goods
		3694	Manufacture of games and toys
		3699	Other manufacturing n.e.c.
60	Construction	0140	Agricultural and animal husbandry service activities, except veterinary activities
		4510	Site preparation
		4520	Building of complete constructions or parts thereof; civil engineering
		4530	Building installation

	4540	Building completion
61 Civil engineering		
62 Electricity	4010	Production, collection and distribution of electricity
63 Gas, heat supply	4020	Manufacture of gas; distribution of gaseous fuels through mains
	4030	Steam and hot water supply
64 Waterworks	4100	Collection, purification and distribution of water
65 Water supply for industrial use	4100	Collection, purification and distribution of water
66 Waste disposal	9000	Sewage and refuse disposal, sanitation and similar activities
67 Wholesale	5010	Sale of motor vehicles
	5030	Sale of motor vehicle parts and accessories
	5040	Sale, maintenance and repair of motorcycles and related parts and accessories
	5110	Wholesale on a fee or contract basis
	5121	Wholesale of agricultural raw materials and live animals
	5122	Wholesale of food, beverages and tobacco
	5131	Wholesale of textiles, clothing and footwear
	5139	Wholesale of other household goods
	5141	Wholesale of solid, liquid and gaseous fuels and related products
	5142	Wholesale of metals and metal ores
	5143	Wholesale of construction materials, hardware, plumbing and heating equipment and supplies
	5149	Wholesale of other intermediate products, waste and scrap
	5150	Wholesale of machinery, equipment and supplies
	5190	Other wholesale
68 Retail	5010	Sale of motor vehicles
	5030	Sale of motor vehicle parts and accessories
	5040	Sale, maintenance and repair of motorcycles and related parts and accessories
	5050	Retail sale of automotive fuel
	5211	Retail sale in non
	5219	Other retail sale in non
	5220	Retail sale of food, beverages and tobacco in specialized stores
	5231	Retail sale of pharmaceutical and medical goods, cosmetic and toilet articles
	5232	Retail sale of textiles, clothing, footwear and leather goods
	5233	Retail sale of household appliances, articles and equipment
	5234	Retail sale of hardware, paint and glass
	5239	Other retail sale in specialized stores
	5240	Retail sale of second
69 Finance	6511	Central banking
	6519	Other monetary intermediation
	6592	Other credit granting
	6599	Other financial intermediation n.e.c.
	6711	Administration of financial markets
	6712	Security dealing activities
	6719	Activities auxiliary to financial intermediation n.e.c.
70 Insurance	6601	Life insurance
	6603	Non
	6720	Activities auxiliary to insurance and pension funding
71 Real estate	7010	Real estate activities with own or leased property
	7020	Real estate activities on a fee or contract basis
71,72 Real estate,		
73 Railway	6010	Transport via railways
	6021	Other scheduled passenger land transport
74 Road transportation	6021	Other scheduled passenger land transport
	6022	Other non
	6023	Freight transport by road
	6301	Cargo handling
	6303	Other supporting transport activities
	6309	Activities of other transport agencies
75 Water transportation	6110	Sea and coastal water transport
	6120	Inland water transport
	6301	Cargo handling
	6303	Other supporting transport activities
	6304	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.
76 Air transportation	6210	Scheduled air transport
	6220	Non-scheduled air transport
	6301	Cargo handling
	6303	Other supporting transport activities
	6304	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.
77 Other transportation and packing	6302	Storage and warehousing
	6304	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.
	6309	Activities of other transport agencies
78 Telegraph and telephone	6412	Courier activities other than national post activities
	6420	Telecommunications
79 Mail	6411	National post activities

80	Education (private and non-profit)	8010	Primary education
		8021	General secondary education
		8022	Technical and vocational secondary education
		8030	Higher education
		8090	Adult and other education
		8532	Social work without accommodation
		9231	Library and archives activities
		9232	Museums activities and preservation of historical sites and buildings
		9233	Botanical and zoological gardens and nature reserves activities
81	Research (private)	7310	Research and experimental development on natural sciences and engineering (NSE)
		7320	Research and experimental development on social sciences and humanities (SSH)
82	Medical (private)	8511	Hospital activities
		8512	Medical and dental practice activities
		8519	Other human health activities
83	Hygiene (private and non-profit)	7512	Regulation of the activities of agencies that provide health care, education, cultural services and other social services excluding social security
84	Other public services	9111	Activities of business and employers organizations
		9112	Activities of professional organizations
85	Advertising	7430	Advertising
86	Rental of office equipment and goods	4550	Renting of construction or demolition equipment with operator
		7111	Renting of land transport equipment
		7113	Renting of air transport equipment
		7121	Renting of agricultural machinery and equipment
		7122	Renting of construction and civil engineering machinery and equipment
		7123	Renting of office machinery and equipment (including computers)
		7129	Renting of other machinery and equipment n.e.c.
		7130	Renting of personal and household goods n.e.c.
87	Automobile maintenance services	5020	Maintenance and repair of motor vehicles
		5040	Sale, maintenance and repair of motorcycles and related parts and accessories
		7250	Maintenance and repair of office, accounting and computing machinery
88	Other services for businesses	7411	Legal activities
		7412	Accounting, book
		7414	Business and management consultancy activities
		7421	Architectural and engineering activities and related technical consultancy
		7422	Technical testing and analysis
		7491	Labour recruitment and provision of personnel
		7492	Investigation and security activities
		7493	Building
		7499	Other business activities n.e.c.
		9220	News agency activities
89	Entertainment	9212	Motion picture projection
		9214	Dramatic arts, music and other arts activities
		9219	Other entertainment activities n.e.c.
		9241	Sporting activities
		9249	Other recreational activities
90	Broadcasting	6420	Telecommunications
		9213	Radio and television activities
91	Information services and internet-based services	7210	Hardware consultancy
		7220	Software consultancy and supply
		7230	Data processing
		7240	Data base activities
		7413	Market research and public opinion polling
92	Publishing	2211	Publishing of books, brochures, musical books and other publications
		2212	Publishing of newspapers, journals and periodicals
		2219	Other publishing
93	Video picture, sound information, character information production and distribution	9211	Motion picture and video production and distribution
94	Eating and drinking places	5520	Restaurants, bars and canteens
95	Accommodation	5510	Hotels; camping sites and other provision of short
96	Laundry, beauty and bath services	9301	Washing, and (dry-) cleaning of textile and fur products
		9302	Hairdressing and other beauty treatment
		9309	Other service activities n.e.c.
97	Other services for individuals	0140	Agricultural and animal husbandry service activities, except veterinary activities
		5260	Repair of personal and household goods
		7494	Photographic activities
		8090	Adult and other education
		9241	Sporting activities
		9303	Funeral and related activities
		9309	Other service activities n.e.c.
		9500	Private households with employed persons
98	Education (public)	8010	Primary education

	8021	General secondary education
	8022	Technical and vocational secondary education
	8030	Higher education
	8090	Adult and other education
	8532	Social work without accommodation
	9231	Library and archives activities
	9232	Museums activities and preservation of historical sites and buildings
	9233	Botanical and zoological gardens and nature reserves activities
99 Research (public)	7310	Research and experimental development on natural sciences and engineering (NSE)
	7320	Research and experimental development on social sciences and humanities (SSH)
100 Medical (public)	8511	Hospital activities
	8512	Medical and dental practice activities
	8519	Other human health activities
101 Hygiene (public)	7512	Regulation of the activities of agencies that provide health care, education, cultural services and other social services excluding social security
102 Social insurance and social welfare (public)	7530	Compulsory social security activities
	8531	Social work with accommodation
	8532	Social work without accommodation
103 Public administration	4100	Collection, purification and distribution of water
	6301	Cargo handling
	6303	Other supporting transport activities
	6304	Activities of travel agencies and tour operators; tourist assistance activities n.e.c.
	7511	General (Over
	7512	Regulation of the activities of agencies that provide health care, education, cultural services and other social services excluding social security
	7513	Regulation of and contribution to more efficient operation of business
	7514	Ancillary service activities for the government as a whole
	7521	Foreign affairs
	7522	Defence activities
	7523	Public order and safety activities
	7530	Compulsory social security activities
	9000	Sewage and refuse disposal, sanitation and similar activities
104 Medical (non-profit)	8511	Hospital activities
	8512	Medical and dental practice activities
	8519	Other human health activities
105 Social insurance and social welfare (non-profit)	7530	Compulsory social security activities
	8531	Social work with accommodation
	8532	Social work without accommodation
106 Research (non-profit)	7310	Research and experimental development on natural sciences and engineering (NSE)
	7320	Research and experimental development on social sciences and humanities (SSH)
107 Other (non-profit)	8532	Social work without accommodation
	9112	Activities of professional organizations
	9120	Activities of trade unions
	9191	Activities of religious organizations
	9192	Activities of political organizations
	9199	Activities of other membership organizations n.e.c.
108		
	9900	Extra-territorial organizations and bodies