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INTANGIBLE INVESTMENT IN JAPAN: MEASUREMENT AND CONTRIBUTION TO ECONOMIC GROWTH

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Following the approach of Corrado, Hulten, and Sichel (2005, 2006), we measure intangible investment and examine the contribution of intangible capital to economic growth in Japan. We find that the ratio of intangible investment to GDP in Japan has risen during the past 20 years and now stands at 11.1 percent, which is lower than the ratio estimated for the U.S. in the early 2000s. The ratio of intangible to tangible investment in Japan is also lower than equivalent values estimated for the U.S. In addition, we find that, in stark contrast to the U.S., 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. Our conclusions regarding intangible investment in Japan remain largely unchanged even if, using data with respect to firm-specific resources, we take on-the-job training into account.

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 U.S. productivity growth led governments of other developed countries such as the U.K., Germany, France, the Netherlands,

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and Japan to promote ICT investment in order to catch up with U.S. productivity levels. In Japan, ICT investment has shown steady growth, increasing at an annual average rate of 8.6 percent from 1995 to 2005 and reaching 23.5 trillion yen in 2005 (in 2000 constant prices), which is equivalent to 18 percent of total investment. Yet, the increase in ICT investment in Japan so far has failed to close the productivity gap with the U.S.[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 U.S. is due to the low productivity growth in ICT-using services.

Examining the slow productivity growth in EU countries, van Ark (2004) suggested that the difference with the U.S. 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 U.S. economy during the 1990s, and Corrado, Hulten, and Sichel (2005, 2006), who measured intangible investment in the U.S. and showed the significant contribution of intangible capital to U.S. 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 that we want to check whether trends in intangible investment can explain the productivity gap between the U.S. 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 U.S. 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 U.S. 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

[1]Discussions of recent developments in productivity growth in the U.S. and the role of ICT investment can be found in Corrado *et al.* (2007), Stiroh and Botsch (2007), and Oliner *et al.* (2007).

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	U.S.	France	Germany	Italy	U.K.	Japan	U.S.	France	Germany	Italy	U.K.
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.

contribute to economic growth at the same rate as it does in the U.S., labor productivity growth in Japan would be 0.3 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 final 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 non-scientific 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.

2.1. *Computerized Information*

We take data on investment in computerized information from the 2008 version of the Japan Industrial Productivity Database (JIP Database).[2] 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 of 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, 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

[2]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).

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 costs for hiring temporary workers for making in-house software 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; it corresponds to ISIC codes 2211, 2212, and 2213) and JIP 2008 industry no. 93 (video picture, sound information, character information production, and distribution industry; it corresponds to ISIC code 9211).[3] Nominal output in the JIP Database is based on the *Input–Output Tables* constructed by the Ministry of Internal Affairs and Communications. Relatively reliable, the *Input–Output Tables* are published every five years. Fukao *et al.* (2007) constructed annual nominal output series using the *Linked IO Tables* published by the Ministry of Internal Affairs and Communications, the *Extended IO Tables* published by the Ministry of Economy, Trade and Industry, and the *SNA IO Tables* published by the Cabinet Office.

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; (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

[3]A correspondence table for industry classifications in the JIP Database and the ISIC code is provided in the appendix in Fukao *et al.* (2008).

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) by focusing on new product development costs in financial services, because we do not have any reliable data for estimating new product development costs in other service industries. Using data on intermediate purchases in JIP 2008 industries no. 69 (finance industry; it corresponds to ISIC codes 6511, 6519, 6592, 6599, 6711, 6712, and 6719) and no. 70 (insurance industry; it corresponds to ISIC codes 6601, 6603, and 6720), we count 20 percent for intermediate costs in financial services as investment in new product development. 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*. We are unable to find suitable data for (3).

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; it corresponds to ISIC code 7430).

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.

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 them 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.

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), Giorgio Marrano and Haskel (2006), and Giorgio Marrano *et al.* (2007) use sales data for consulting firms. However, we are not able to find suitable data for the consulting industry in Japan. 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 to 2005 was 53 trillion yen. The share of intangible investment in GDP in the same period was 11.1 percent, which is similar to the estimate for the U.S. by CHS (2006) and larger than that for the U.K. by Giorgio Marrano and Haskel (2006). However, the figure for the U.S. obtained by CHS (2006) is for the period from 1998 to 2000, and more recent, but as yet unpublished estimates by Dr. Corrado suggest that the intangible investment/GDP ratio in the U.S. in the early 2000s had reached 13.8 percent, meaning that the equivalent ratio for Japan is lower than that for the U.S. While the investment/GDP ratios for computerized information and innovative property are larger than those estimated for the U.S. and the U.K., the GDP ratio of economic competencies is much smaller than those estimated for the U.S. and U.K. due to the low GDP ratio of investment in firm-specific human capital and organizational structure. 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.

Moreover, comparing the relative levels of intangible and tangible investment in Japan and the U.S., other significant differences emerge. For example, CHS (2006) found that in the U.S., 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 U.S., 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 U.S. We find that in Japan, the GDP ratio of intangible investment is still much smaller than that of tangible investment, while in the U.S., intangible investment has exceeded tangible investment since 2000.

TABLE 2
INTANGIBLE INVESTMENT BY CATEGORY: COMPARISON AMONG JAPAN, THE U.S., AND THE U.K.

	Japan 2000–05		U.S. CHS (2006) 1998–2000		U.K. MH (2006) 2004	
	(billion yen)	GDP Share	(billion U.S. dollars)	GDP Share	(billion pounds)	GDP Share
Computerized information	10,803	2.2	154	1.7	19.8	1.7
Custom software	6,584	1.4	151[1]	1.6[1]	7.5[2]	0.6[2]
Packaged software	848	0.2				
In-house software	2,332	0.5			12.4[3]	1.1[3]
Databases	1,039	0.2	3	0.0		
Innovative property	28,629	6.0	425	4.6	37.6	3.2
Science and engineering R&D	13,690	2.8	184	2.0	12.4	1.1
Mineral exploitation	16	0.0	18	0.2	0.4	0.0
Copyright and license costs	5,161	1.1	75	0.8	2.4	0.2
Other product development, design, and research expenses	9,761	2.0	149	1.6	22.4	1.9
Economic competencies	13,764	2.9	505	5.4	58.8	5.0
Brand equity	5,534	1.2	140	1.5	11.1	1.0
Firm-specific human capital	2,241	0.5	365[4]	3.9[4]	28.5	2.4
Organizational structure	5,988	1.2			19.2	1.6
Total	53,197	11.1	1,085	11.7 (13.8)[5]	116.2	10.0
Intangible investment/tangible investment	0.6		1.2 (1.1)[5]		1.1	

Notes:
[1]Figures include not only custom software but also packaged software and in-house software.
[2]Figures include not only custom software but also packaged software.
[3]Figures include not only in-house software but also databases.
[4]Figures include not only firm-specific human capital but also organizational structure.
[5]Figures in parentheses indicate estimates for the period from 2000 to 2003.
Source: Japan: authors' calculations; U.S.: Corrado, Hulten and Sichel (2006); U.K.: Giorgio Marrano and Haskel (2006).

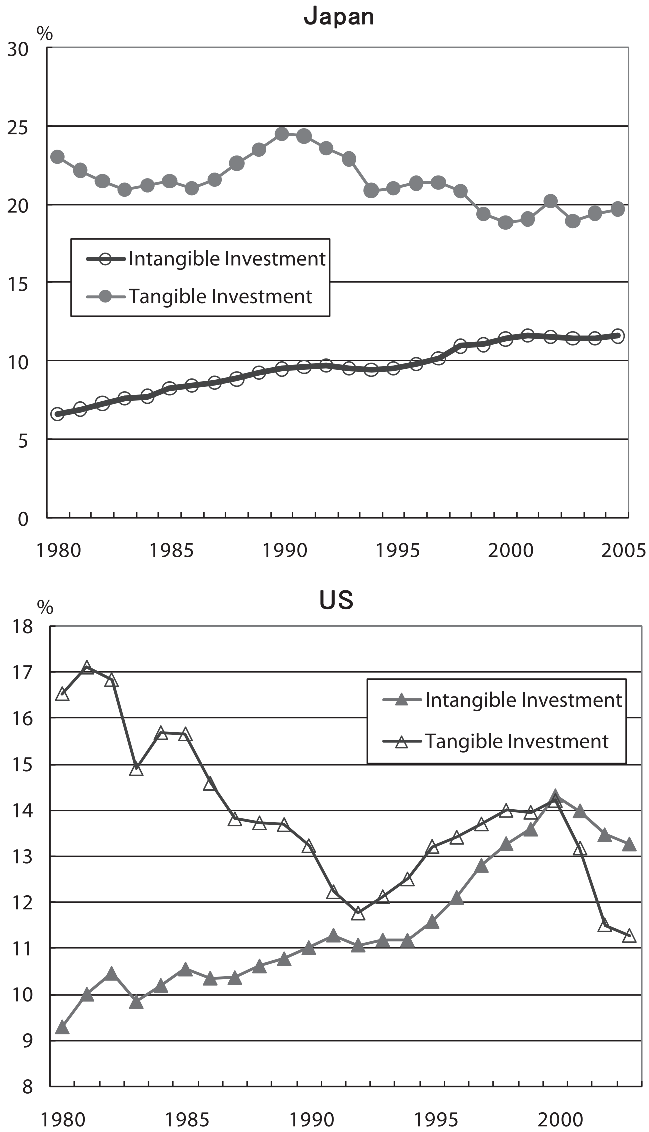

Figure 1. Business Investment (Percentage of Business Output)

Source: Authors' calculation.

We suspect that the difference in investment behavior between Japan and the U.S. 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.[4]

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 54 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.

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.[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 U.S. 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 U.S. 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. Fukao *et al.* (2007) took price index in information services in the *Corporate Service Price Index* published by the Bank of Japan as the deflator in software investment in the JIP Database. The price index in information services in the *Corporate Service Price*

[4]According to the *Survey on Financial Statements of Business Enterprise*s which covers about 25,000 firms in Japan, the ratios of financial loans to total asset in 2007 fiscal year were 21.2 percent in the manufacturing sector and 35.3 percent in the service sector respectively. Because the equivalent ratios in 1985 fiscal year were 31.9 percent in the manufacturing sector and 45.3 percent in the service sector, firms in the service sector still depend on loans from financial institutions. In particular, small and medium enterprises in the service sector heavily depend on financial loans, as its ratio of financial loans to total asset was 44.7 percent in 2007 fiscal year.

[5]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.

TABLE 3

Intangible Investment by Category: Share in Total Intangible Investment (%)

	Japan							U.S.	U.K.
	1980–89	1980–84	1985–89	1990–99	1990–94	1995–99	2000–05	1998–2000	2004
Computerized information	10.4	8.1	12.7	16.9	15.7	18.1	20.4	14.2	17.0
Custom software	5.2	4.0	6.5	8.7	7.7	9.8	12.4		6.5[2]
Packaged software	0.5	0.4	0.6	0.8	0.8	0.8	1.6	13.9[1]	
In-house software	3.6	2.8	4.5	5.9	5.9	6.0	4.5		10.7[3]
Databases	1.0	0.9	1.1	1.5	1.3	1.6	1.9	0.3	
Innovative property	56.5	56.5	56.6	53.8	54.6	53.1	53.7	39.2	32.4
Science and engineering R&D	25.3	25.3	25.2	25.1	24.8	25.4	25.5	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	10.7	10.7	10.6	10.4	10.5	10.2	9.8	6.9	2.1
Other product development, design, and research expenses	20.5	20.2	20.7	18.3	19.1	17.5	18.4	13.7	19.3
Economic competencies	33.0	35.4	30.7	29.2	29.7	28.8	26.0	46.5	50.6
Brand equity	9.8	10.7	8.9	9.7	9.2	10.2	10.3	12.9	9.6
Firm-specific human capital	8.3	8.3	8.3	6.5	7.2	5.7	4.3	33.6[4]	24.5
Organizational structure	14.9	16.4	13.5	13.1	13.4	12.8	11.3		16.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes:
[1]Figures include not only custom software but also packaged software and in-house software.
[2]Figures include not only custom software but also packaged software.
[3]Figures include not only in-house software but also databases.
[4]Figures include not only firm-specific human capital but also organizational structure.
Source: Japan: authors' calculations; U.S.: Corrado, Hulten and Sichel (2006); U.K.: Giorgio Marrano and Haskel (2006).

TABLE 4

The Ratio of Intangible Investment to Value Added: by Category and Year (%)

	Japan						
	1980–89	1980–84	1985–89	1990–99	1990–94	1995–99	2000–05
Computerized information	0.8	0.6	1.1	1.6	1.4	1.8	2.2
Custom software	0.4	0.3	0.5	0.8	0.7	1.0	1.4
Packaged software	0.0	0.0	0.1	0.1	0.1	0.1	0.2
In-house software	0.3	0.2	0.4	0.6	0.5	0.6	0.5
Databases	0.1	0.1	0.1	0.1	0.1	0.2	0.2
Innovative property	4.3	3.9	4.7	5.1	5.0	5.3	6.0
Science and engineering R&D	1.9	1.7	2.1	2.4	2.3	2.5	2.8
Mineral exploitation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Copyright and license costs	0.8	0.7	0.9	1.0	1.0	1.0	1.1
Other product development, design, and research expenses	1.6	1.4	1.7	1.7	1.8	1.7	2.0
Economic competencies	2.8	2.8	2.9	3.2	3.1	3.2	3.4
Brand equity	0.7	0.7	0.7	0.9	0.8	1.0	1.1
Firm-specific human capital	0.6	0.6	0.7	0.6	0.7	0.6	0.5
Organizational structure	1.1	1.1	1.1	1.2	1.2	1.3	1.2
Total	7.6	6.9	8.3	9.6	9.2	9.9	11.1

Source: Authors' calculations.

TABLE 5

Intangible Investment by Category in the Manufacturing Sector and the Service Sector

	Manufacturing Sector		Service Sector	
	2000–05 (billion yen)	Ratio to Value Added (%)	2000–05 (billion yen)	Ratio to Value Added (%)
Computerized information	2,447	(2.1)	6,125	(2.4)
Custom software	1,526	(1.3)	4,197	(1.6)
Packaged software	184	(0.2)	388	(0.1)
In-house software	510	(0.4)	1,065	(0.4)
Databases	226	(0.2)	475	(0.2)
Innovative property	13,316	(11.5)	9,161	(3.6)
Science and engineering R&D	9,312	(8.0)	1,052	(0.4)
Mineral exploitation	0	(0.0)	16	(0.0)
Copyright and license costs	472	(0.4)	4,152	(1.6)
Other product development, design, and research expenses	3,531	(3.0)	3,940	(1.5)
Economic competencies	3,579	(3.0)	8,364	(3.2)
Brand equity	1,876	(1.6)	3,477	(1.3)
Firm-specific human capital	584	(0.5)	1,334	(0.5)
Organizational structure	1,120	(0.9)	3,553	(1.4)
Total	19,342	(16.6)	24,577	(9.2)
Intangible investment/tangible investment	0.8		0.5	

Source: Authors' calculations.

Index covers only custom software. However, we use it for deflating all kinds of nominal software investment, because we assume that packaged software and in-house software are substitutable goods for custom software. As we are not able to find a suitable deflator for the investment in database, we use the same price

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).

index as the deflator in software investment to deflate nominal investment in database. For the deflators in other investment goods, we use output deflators in the 2008 version of the JIP Database. Fukao *et al.* (2007) constructed output deflators in the JIP Database by using the deflator in SNA which is constructed from the *Corporate Goods Price Index* and the *Corporate Service Price Index* published by the Bank of Japan.

We then use the perpetual inventory method to construct the capital stock of intangible assets. The depreciation rates for intangible assets are taken from CHS (2006) and are shown in Table 7. Since data on intangible investment at 2000 prices are available from 1973, we can use 1980 as the starting point for the construction of the capital stock of intangible assets.

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 203 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. The deceleration of growth in intangible assets is affected by the long-term stagnation in Japan since 1990. Through restructuring, Japanese firms suppressed the advertising costs and the training costs for the accumulation in human capital during the long-term stagnation. This pattern—rapid growth during the 1980s but a slowdown during the 1990s and

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	30,812	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	15,610	3.39	4.56	0.39	0.33
Total	203,327	9.96	4.54	3.34	1.97

Source: Authors' calculations.

2000s—is almost the exact opposite of that observed in the U.S., where the accumulation of intangible assets accelerated around the middle of the 1990s.

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:

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

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. L_t stands for labor input. From equation (1), we obtain:

$$\Delta y = \Delta a + \alpha \Delta k^T + \beta \Delta k^I + \Delta l \tag{2}$$

where $\Delta x = \dfrac{\partial \ln X_t}{\partial t}$, and $x = \ln X_t$ ($x = a, y, l, K^T, K^I$). 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.[6]

[6]As for labor and capital inputs, we take quality into account.

TABLE 9

Growth Accounting With and Without Intangible Capital (Whole Economy)

(a) Conventional Growth Accounting

(%)

	1985–90	1990–95	1995–2000	2000–05
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	1.05	1.24	1.50
Growth rate of labor input	0.93	–0.11	–0.52	–0.61
Growth rate of labor productivity	3.96	1.16	1.76	2.11
Contribution of capital deepening	2.66	1.75	1.34	1.17
Contribution of tangible capital	1.77	1.25	0.86	0.83
Contribution of intangible capital	0.89	0.49	0.47	0.33
Contribution of MFP growth	1.30	–0.59	0.43	0.95

Source: Authors' calculation.

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 percentage 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 for the second half of the 1990s.

When we compare growth accounting for Japan and the U.S., 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 U.S. If the contribution of intangible capital to labor productivity growth were as large in Japan as in the U.S., then Japanese labor productivity growth in the early 2000s would have been 0.3 percentage points higher than it actually was.

4. Sensitivity Analysis

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.[7]

(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 also be useful in a different job was firm-specific. For our sensitivity analysis, we therefore assume that the training that the 63 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 reorganization. Therefore, as an alternative, we measure investment in organizational structure using 9 percent rather than 20 percent of the remuneration of executives.

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

TABLE 10
SENSITIVITY ANALYSIS

The Share of Intangible Investment in Japan's GDP (%, nominal)				
	1985–89	1990–94	1995–99	2000–05
Base Case	8.33	9.21	9.91	11.06
Case 1	8.33	9.21	9.91	11.06
Case 2	11.52	12.21	12.96	13.75
Labor Productivity Growth (%, real)				
	1985–89	1990–94	1995–99	2000–05
Base Case	3.96	1.16	1.76	2.11
Case 1	3.96	1.16	1.76	2.11
Case 2	3.90	1.20	1.72	2.03
Capital Deepening (intangibles, %, real)				
	1985–89	1990–94	1995–99	2000–05
Base Case	0.89	0.49	0.47	0.33
Case 1	0.89	0.52	0.47	0.33
Case 2	0.95	0.54	0.44	0.29
MFP Growth (%, real)				
	1985–89	1990–94	1995–99	2000–05
Base case	1.30	–0.59	0.43	0.95
Case 1	1.30	–0.62	0.43	0.95
Case 2	1.20	–0.59	0.41	0.92

Source: Authors' calculations.

Table 10 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.[8]

In Case 2, we find that the intangible investment/GDP ratio (13.8 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 U.S. or the U.K. 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,

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

the recovery in MFP 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 investment 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 U.S. 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 U.S. One possible reason for this is differences in the financial system, in particular the fact that much corporate financing in the Japanese service sector relies on loans from financial institutions 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.[9]

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 U.S. in the late 1990s.

Fourth, due to the slowdown in the accumulation of intangible assets, the contribution of intangible capital to total labor productivity growth in Japan has been much smaller that than in the U.S. If the contribution of intangible capital to labor productivity growth were as large in Japan as in the U.S., then Japanese labor productivity growth in the early 2000s would have been 0.3 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 U.S. and the U.K. 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

[9]Fukao and Miyagawa (2008) and Kwon *et al.* (2008) pointed out that the recent productivity growth in the Japanese service sector has been achieved by restructuring. They argued that the service sector should accumulate more intangible assets to engage in business in the global market like the manufacturing sector and to achieve sustainable productivity growth.

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 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.[10]

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.

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[10]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.

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