RIETI Discussion Paper Series 07-E-034

Intangible Investment in Japan: Measurement and Contribution to Economic Growth

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May 2007

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***** We are grateful to Professors van Ark and Timmer of the University of Groningen and Mr. Tojo of the OECD for valuable comments on earlier results. Thanks are also due to Mr. Takahara of the Research Institute of Economy, Trade, and Industry (RIETI), Mr. Sumita of the Ministry of Economy, Trade and Industry, and participants of the RIETI seminar. The views expressed in this paper are those of authors and should not be attributed to RIETI.

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 2006 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 7.5%. However, the ratios of intangible investment to GDP and of intangible to tangible investment in Japan are smaller than the values estimated for the US by Corrado et al. (2006). In addition, we find that the growth rate for intangible capital in Japan declined from the 1980s to the 1990s, which is in stark contrast to the high growth rate for intangible capital in the US in the late 1990s. Therefore, the contribution of intangible capital to total labor productivity growth in Japan is substantially smaller than in the US.

Keywords: intangible investment, labor productivity, growth accounting.

JEL Classification Code: E22, O32, O47.

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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 4.2% from 1990 to 2002 and reaching 27 trillion yen in 2002, which is equivalent to 25% of total investment. As a result of this heavy investment in ICT, ICT capital stock stood at 128 trillion yen (approximately 1 trillion euro) in 2002, accounting for about 10% of total capital stock. Yet, the rapid increase in ICT investment in Japan so far has failed to close the productivity gap with the US.

Examining the reasons for the productivity gap, we find that a major factor is the low productivity growth in services that use ICT, such as banking and insurance, retail, etc., as shown in Table 1. The table also indicates that in the case of the 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 US 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 that we want to check whether trends in intangible investment can explain the productivity gap between the

US and Japan in the 1990s. The second is that to date no studies have been carried out on intangible capital in Japan. Even more than its predecessors, the new government under Prime Minister Abe has made the achievement of higher 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 US. The role of intangible capital is potentially 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 tentative 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 US. 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 contributed to economic growth at the same rate as in the US, labor productivity growth in Japan would be 0.2 percentage points higher. The last section summarizes our results and their policy implications and discusses future tasks.

2. Measurement of intangible investment

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 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 2006 version of the Japan Industry Productivity (JIP) Database. 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 2002. In the JIP 2006 Database, investment in custom software and packaged software is estimated using sales data for the information service industry from METI's *Survey on Selected Service Industries* and data from the Input-Output Tables. In-house software investment is estimated using the *Survey on ICT Workplaces*, the *Population Census*, and the *Establishment and Enterprise Census.* 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

As for the investment in science and engineering R&D, we take the expenses on materials and labor costs on R&D activities from the *Survey on R&D Expenses* conducted by the Ministry of Education, Culture, Sports, Science and Technology. We estimate the investment in mineral exploration by using data from the *Handbook of the Mining Industry* and the *Annual Report on Natural Gas*. The estimation of copyright and license costs relies on data from the JIP 2006 Database. To estimate these costs, we use the nominal output data of JIP industry no. 92 (publishing and newspaper industry) and JIP industry no. 93 (video picture, sound information, character information production and distribution industry).

As for the estimation 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% of intermediate purchases in these industries); (2) new architectural and engineering designs, which account for roughly 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 the Census Bureau's *Services Annual Survey*). Because reliable data for the estimation of (2) and (3) are unavailable, we only estimate (1) using data for JIP industries no. 69 (finance industry) and no. 70 (insurance industry).

2.3 Economic Competencies

As for the investment in brand equity, we follow the approach by CHS (2006), taking 60% of the nominal output purchased by other industries in the advertising industry (JIP industry no. 85).

Following CHS (2005), we assume that investment in firm-specific human capital consists of two types of expense: (1) direct firm expenses, and (2) the wage and salary costs of employee time spent in formal and informal training. To estimate both items we take the data of educational and vocational costs per worker from the *General Survey on Wages and Working Hours System* conducted by the Ministry of Health, Labour and Welfare and estimate the former item.

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.

Due to the lack of reliable data, we are unable to estimate the first component. Following CHS (2005), we approximate the second component by taking 20% of salaries and bonuses for executives, data for which we take from the *Survey on Financial Statements of Business Enterprise*s published by the Ministry of Finance.

2.4 Measurement results for intangible investment in Japan

Our measurement results are shown in Table 2. Our estimates of intangible investment suggest that the share of intangible investment in GDP in Japan was 7.5% on average from 1995-2002, which is smaller than the estimates for the US by CHS (2006) and the UK by Marrano and Haskel (2006). 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 0.3.

Given that the share of intangible investment in GDP in Japan is not far behind 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. We suspect that the difference in investment behavior between Japan and the United States is at least partially caused by 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.

The trend in estimated total investment in intangible assets, as well as the three components, is depicted in Figure 1. As can be seen, investment in intangible assets increased until 1998, but then registered a slowdown around the turn of the millennium and actually declined in 2002, when it stood at around 40 trillion yen. The largest component of intangible investment in Japan is innovative property, with a share of nearly 45% in the early 2000s, although this represents a decrease from the past (Table 3). Conversely, the share of computerized information has increased during the past 20 years, and it is this item that is responsible for the increase in the ratio of total intangible investment to GDP. In contrast, the GDP ratios of the other intangible investment components remained stable (Table 4). While the investment/GDP ratio for computerized information is larger than those estimated for the US and the UK, the small GDP ratios of innovative property and economic competencies are in clear contrast with the US and the UK cases.

(Insert Figure 1, Tables 3 and 4)

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 5. 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 6. 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 5 and 6)

The value and growth rate of Japan's intangible capital stock are reported in Table 7. In 2002, the real intangible capital stock stood at 149 trillion yen, following growth at a rate of 7.1% in the 1980s and 3.1% in the 1990s and 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 7)

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:

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

where Y_t represents GDP, A_t stands for total factor productivity (TFP), K_t^T is tangible capital, and K_t^I stands for intangible capital. From Equation (1), we obtain:

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

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 TFP in equation (1), are taken from the JIP 2006 Database. While CHS also consider labor quality, we here simply use the man-hour index to represent labor input. We calculate production factor shares on a revenue basis. The labor share is calculated by dividing labor compensation by nominal GDP. 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.[1]

The results of our growth accounting exercise based on equation (2) are shown in Table 8, which compares the results of our growth accounting with intangible capital with the results of a conventional growth accounting exercise without intangible capital. The results suggest that the contribution of intangible capital to Japan's annual economic growth is about 0.4 percentage points and there is little change in this contribution between the 1980s and the 1990s. The reason why the contribution of intangible capital accumulation to labor productivity did not change from the 1980s to the 1990s is that the slowdown in the growth rate of intangible capital in the 1990s was offset by the increase in the share of intangible capital in total capital. We find that the capital deepening effect was larger in the growth accounting with intangible capital than in the conventional growth accounting. Conversely, TFP growth is slightly smaller in the growth accounting with intangible capital than in the conventional growth accounting without intangible assets. Thus, the TFP growth rate in the growth accounting with intangible investment became negative in 2000-02, but was positive in the growth accounting without intangible investment.

(Insert Table 8)

The share of the contribution of intangible capital to labor productivity growth in the 1990s was 23%, which is less than the share estimated by CHS for the United States. CHS found that the increase in intangible capital in the late 1990s was responsible for about 30% 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

[1] In the case of capital input, we took quality into account.

States, then Japanese labor productivity growth in the 1990s would have been 0.2 percentage points higher than it actually was.

4. Policy implications and future research agenda

The purpose of this paper was to measure intangible assets in Japan. Using our estimate, 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 has grown rapidly. Consequently, the ratio of intangible investment to GDP has also risen during the past 20 years. However, the ratio of intangible investment to GDP in Japan is less than the value estimated for the US by CHS. In addition, the ratio of intangible to tangible investment in Japan is lower than that in the US. Possible reasons for this include differences in the financial system, in particular the fact that much corporate financing in Japan relies on loans from banks that require tangible assets as collateral.

Second, the growth rate in intangible capital in Japan declined from the 1980s to the 1990s. This slowdown stands in stark contrast to the high growth rate in intangible capital in the US in the late 1990s.

Third, despite the slowdown in the growth of intangible capital, the contribution of intangible capital to economic growth in Japan remained more or less unchanged during the 1980s and 1990s. The reason for this is that the slowdown in intangible capital accumulation was offset by an increase in the share of intangible capital in total capital. However, the contribution of intangible capital to total labor productivity growth in Japan has been much smaller than in the US.

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 that 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%. 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 that 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 still in progress and much remains to be done. For example, the measurement of firm-specific human capital and organizational structure is likely to be underestimated due to the lack of reliable data. To do so, we will need to gather data concerning firm-specific human capital and organizational change by examining firm-level activities.[2] In addition, we hope to construct intangible investment data by industry to examine the effects of intangible capital on productivity growth in the service sector.

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.

[2] One study along these lines is that by Bloom and Van Reenen (2006), who tried to assemble and analyze data on the organizational structure of firms through interviews with plant managers.

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Table 1: Labor productivity growth in the US, the EU and Japan

	Labor productivity growth						GDP share	
	1990-95			1995-2000			2000	
	Japan	EU	US	Japan	EU	US	Japan	EU
Total economy	0.6	1.9	1.1	1.5	1.4	2.5	100	100.0
ICT-producing manufacturing	10.1	11.1	15.1	14.3	13.8	23.7	5.4	4.3
ICT-producing services	9.8	4.4	3.1	2.7	6.5	1.8	3.8	1.6
ICT-using manufacturing	0.4	3.1	-0.3	3.2	2.1	1.2	4.3	5.9
ICT-using services	2.5	1.1	1.9	0.8	1.4	5.4	33.2	21.1
Non-ICT manufacturing	1.1	3.8	3.0	1.5	1.5	1.4	13.6	11.9
Non-ICT services	−1.6	0.6	-0.4	0.0	0.2	0.4	28.4	44.7
Non-ICT other	−2.7	2.7	0.7	0.5	1.9	0.6	11.2	10.5

Sources: JIP 2006; van Ark, Inklaar, and McGuckin (2002).

Table 2: Intangible investment by category: US-Japan comparison

	Intangible investment (including other product development, design and research expenses) 1995-2002 (billion yen)	Data sources and comments	CHS (2006) 1998-2000 (billion US dollars)	MH (2006) 2004 (billion pounds)
Computerized information	**9,714**		**154**	**19.8**
Custom software	5,663	Data sources: *Survey on Selected Service Industries* (information services), and Input-Output Tables		
Packaged software	449	Data sources: *Survey on Selected Service Industries* (information services), and Input-Output Tables		7.5
In-house software	2,708	Data sources: *Survey on ICT Workplaces, Population Census* , and *Establishment and Enterprise Census*	151	12.4
Database	894	Data sources: *Survey on Selected Service Industry* (information services), and *Establishment and Enterprise Census*	3	
Innovative property	**18,133**		**425**	**37.6**
Science and engineering R&D	9,634	We take nominal output data in research sectors (JIP 2006 industry nos. 99 and 106) purchased by other industries in the JIP Database.	184	12.4
Mineral exploration	40	Data sources: *Handbook of the Mining Industry; Annual Report on Natural Gas* .	18	0.4
Copyright and license costs	4,659	We take nominal output data in the publishing and newspaper industry (JIP 2006 industry no. 92) and the video picture, sound information, character information production and distribution industry (JIP 2006 industry No. 93) purchased by other industries in the JIP Database.	75	2.4
Other product development, design, and research expenses	3,801		149	22.4
Economic competencies	**12,899**		**505**	**58.8**
Brand equity	4,774	We take nominal output data in advertising industry (JIP 2006 industry No. 85) purchased by other industries in the JIP Database. Following CHS, we assume that 60% of advertisement expenses are capitalized.	140	11.1
Firm-specific human capital	1,600	We take the data of educational and vocational training cost per worker from the General Survey on Wages and Working Hours System published by the Ministry of Health, Labour and Welfare. We calculate the total costs of firm-specific human capital by multiplying the cost by workers.		28.5
Organizational structure	6,525	Data sources: *Survey on Financial Statements of Business Enterprises* published by the Ministry of Finance. We take the data on salaries and bonuses for executives from the survey and treat 20% of these payments as investment in organizational structure.	365	19.2
Total	40,746		1085	116.2
Intangible investment/GDP (%)	7.6		11.7	10.0
Intangible investment/tangible investment	0.3		1.2	1.1

Note (1): Data on "Other product development, design, and research expenses" in Japan are not available. Column B shows the estimated value of such expenses if their ratio to the total of intangible is assumed to be the same as that estimated by CHS (2006).
Note (2): The column labeled MH shows the estimation results of Marrano and Haskel (2006), "How Much Does the UK Invest in Intangible Assets?" Department of Economics, Queen Mary University of London, Working Paper No. 578.

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

	1980-89	1990-2002						CHS	MH
		1980-84	1985-89		1990-94	1995-99	2000-02	1998-2000	2004
Computerized information	13.3	10.4	16.3	21.7	19.7	22.0	24.5	14.2	17.0
Custom software	6.7	5.1	8.4	11.9	9.7	12.0	15.5		
Packaged software	0.7	0.5	0.8	1.0	1.0	0.9	1.4		6.5
In house software	4.5	3.5	5.6	6.8	7.3	7.2	5.2	13.9	10.7
Database	1.4	1.4	1.5	2.0	1.8	2.0	2.4	0.3	
Innovative property	48.3	48.3	48.4	46.0	46.5	45.8	45.2	39.2	32.4
Science and engineering R&D	23.5	23.7	23.4	24.9	25.4	24.1	25.3	17.0	10.7
Mineral Exploitation	0.3	0.4	0.2	0.1	0.1	0.1	0.1	1.7	0.3
Copyright and license costs	13.4	13.3	13.4	12.1	12.7	12.1	11.0	6.9	2.1
Other product development, design, and research expenses	11.1	10.9	11.4	8.9	8.3	9.6	8.9	13.7	19.3
Economic competencies	38.3	41.3	35.3	32.3	33.7	32.1	30.3	46.5	50.6
Brand equity	12.2	13.1	11.2	11.5	11.0	11.7	11.8	12.9	9.6
Firm-specific human capital	6.4	6.7	6.0	4.3	5.0	4.1	3.5		24.5
Organizational structure	19.8	21.5	18.1	16.6	17.7	16.3	15.0	33.6	16.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 4: The share of intangible investment in Japan's GDP by category and year (%)

	1980-89	1990-2002					CHS	MH
		1980-84	1985-89		1990-94	1995-99	2000-02	1998-2000	2004
Computerized information	0.8	0.6	1.0	1.7	1.4	1.7	2.0	1.7	1.7
Custom software	0.4	0.3	0.5	0.9	0.7	0.9	1.3		
Packaged software	0.0	0.0	0.1	0.1	0.1	0.1	0.1		0.6
In-house software	0.3	0.2	0.4	0.5	0.5	0.6	0.4	1.6	1.1
Database	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.0	
Innovative property	2.9	2.6	3.1	3.5	3.3	3.5	3.7	4.6	3.2
Science and engineering R&D	1.4	1.3	1.5	1.9	1.8	1.8	2.1	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	0.9	0.9	0.9	0.9	0.8	0.2
Other product development, design, and research expenses	0.7	0.6	0.7	0.7	0.6	0.7	0.7	1.6	1.9
Economic competencies	2.2	2.2	2.3	2.4	2.4	2.5	2.5	5.4	5.0
Brand equity	0.7	0.7	0.7	0.9	0.8	0.9	1.0	1.5	1.0
Firm-specific human capital	0.4	0.4	0.4	0.3	0.4	0.3	0.3		2.4
Organizational structure	1.2	1.2	1.2	1.2	1.3	1.2	1.2	3.9	1.6
Total	5.9	5.4	6.4	7.6	7.1	7.7	8.3	11.7	10.0

Table 5: Deflators for intangible investment

	Data source and comments
Computerized information	
Custom software	Investment deflator in the JIP 2006 Database
Packaged software	Investment deflator in the JIP 2006 Database
In-house software	Investment deflator in the JIP 2006 Database
Databases	Investment deflator in the JIP 2006 Database
Innovative property	
Science and engineering R&D	Output deflators for JIP 2006 industries no. 99 and no. 106
Mineral exploitation	Investment deflator in the JIP 2006 Database
Copyright and license costs	Output deflators for JIP 2006 industries no. 92 and no. 93
Other product development, design, and research expenses	Deflator for intermediate input for JIP2006 industries no. 69 and 70
Economic competencies	
Brand equity	Output deflator for JIP 2006 industry no. 85
Firm-specific human capital	Wage index in the *Monthly Survey of Employees* published by the Ministry of Health, Labour and Welfare.
Organizational structure	Wage index in the *Monthly Survey of Employees* published by the Ministry of Health, Labour and Welfare.

Table 6: Depreciation rates for intangible assets

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

Source: Corrado et al. (2006).

Table 7: Real value and growth rate of intangible capital stock

	Real value	Growth rate (%)						
	2002	1980-90			1990-2002			
	(billion yen)		1980-85	1985-90		1990-95	1995-2000	2000-02
Computerized information	31,513	18.21	21.94	7.05	7.05	7.44	8.54	1.66
Custom software	19,547	19.79	23.38	7.84	8.83	7.08	11.24	4.81
Packaged software	1,689	20.90	27.34	7.14	6.92	2.45	7.32	11.56
In-house software	7,325	16.63	17.81	7.46	3.43	8.02	5.10	-7.37
Databases	2,953	15.36	27.27	2.26	7.90	9.92	6.33	4.53
Innovative property	89,028	7.25	3.85	3.27	2.62	3.45	2.33	0.85
Science and engineering R&D	47,973	7.33	4.30	2.90	2.92	3.79	2.36	1.43
Mineral exploitation	191	-1.11	2.25	-3.28	-2.14	-1.19	-1.42	-4.21
Copyright and license costs	22,748	5.71	2.22	3.42	1.45	2.31	1.37	-0.30
Other product development, design, and research expenses	18,115	10.46	5.82	4.38	3.54	4.36	3.64	0.87
Economic competencies	28,425	3.66	1.70	1.94	1.29	2.35	0.93	-0.30
Brand equity	8,059	4.91	1.74	3.12	2.40	2.31	3.33	0.24
Firm-specific human capital	3,902	3.30	1.35	1.92	-1.23	-1.65	-0.13	-1.95
Organizational structure	16,463	3.28	1.79	1.46	1.48	3.55	0.14	-0.16
Total	148,966	7.12	3.65	3.35	3.08	3.77	3.14	0.79
Intangible capital/tangible capital	0.10							

Table 8: Growth accounting with and without intangible capital

(a) Conventional growth accounting

	1980-90			1990-2002				(2)-(1)
	(1)	1980-85	1985-90	(2)	1990-95	1995-2000	2000-02	
Growth rate of GDP	3.87	3.11	4.64	1.05	1.22	1.41	-0.27	-2.82
Growth rate of labor input (man-hours)	0.53	0.49	0.57	-0.84	-0.63	-0.67	-1.77	-1.37
Growth rate of labor productivity	3.34	2.62	4.07	1.89	1.85	2.08	1.51	-1.46
Contribution of capital deepening	2.55	2.23	2.88	1.79	2.27	1.52	1.32	-0.76
TFP	0.80	0.39	1.18	0.10	-0.42	0.56	0.19	-0.70

(b) Growth accounting with intangibles

	1980-90			1990-2002				(2)-(1)
	(1)	1980-85	1985-90	(2)	1990-95	1995-2000	2000-02	
Growth rate of GDP	3.99	3.25	4.74	1.13	1.29	1.56	-0.32	-2.86
Growth rate of labor input (man-hours)	0.53	0.49	0.57	-0.84	-0.63	-0.67	-1.77	-1.37
Growth rate of labor productivity	3.46	2.76	4.17	1.97	1.92	2.23	1.45	-1.49
Contribution of capital deepening	2.87	2.53	3.20	2.03	2.50	1.78	1.54	-0.84
Contribution of tangible capital	2.43	2.21	2.66	1.57	1.94	1.33	1.07	-0.86
Contribution of intangible capital	0.43	0.33	0.54	0.45	0.55	0.45	0.47	0.02
Contribution of TFP growth	0.59	0.23	0.97	-0.06	-0.58	0.44	-0.09	-0.65

Figure 1: Intangible Investment in Japan