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Abstract

Using the Japan Industrial Productivity (JIP) database and other primary statistics, we estimate intangible investments in Japan at the industry level. Comparing our estimates with Korean ones measured by Professor Chun, intangible investment/gross value added (GVA) ratios in Japan are higher than those in Korea in many industries. However, in some service industries, Korean intangible investments are larger than their Japanese counterparts. Although intangible capital stock in 2008 was 136 trillion yen, the growth rate in intangibles became negative in some industries in Japan in the 2000s due to harsh restructuring. When we examine the impacts of intangible investments on total factor productivity (TFP) growth, we find a significant and positive effect on it in the market economy after the IT revolution. However, in the service sector, we do not find any clear evidence of the effect of intangibles. The estimation results show that the government should improve its management skills to utilize intangible assets effectively through deregulation in the service sector.

Keywords: Intangible investment, Total factor productivity (TFP), Computerized information, Innovative property, Economic competencies
JEL classification numbers: E01, E22, O31, O32

1. Introduction

The IT revolution in the 1990s and the productivity growth induced by its revolution in the US led to many studies on intangible investment. Hall (2000), (2001), Bresnahan, Brynjolfsson, and Hitt. (2002), and Basu, Fernald, Oulton, and Srinivasan, (2003) emphasized intangible assets, which are complementary to IT assets and played a crucial role in productivity improvement. However, they estimated the role of intangible assets indirectly due to the difficulty in measuring intangibles.[1]

Corrado, Hulten and Sichel (2009) overcame this difficulty and measured intangible investment at the aggregate level in the US for the first time. Based on their estimation, they found that the ratio of intangible investment to GDP exceeded the ratio of tangible investment to GDP in the early 2000s, and that one third of the productivity growth in the late 1990s and the early 2000s is attributable to the growth in intangible asset. After their success in measuring intangible assets, many economists followed their method and estimated intangible investment in their own countries.[2]

However, the aggregate data does not provide enough information to conduct productivity analysis. As Jorgenson, Ho, and Stiroh (2005), Inklaar, O'Mahony and Timmer (2005), Fukao, et al. (2012) suggested, there is a significant productivity gap between IT industries and non-IT industries. In addition, even in IT-heavy service industries, there is a productivity gap between the US and Japan. To understand the above gaps, we require intangible investment data at the industry level. Moreover, the aggregate series also constrains our analysis. The measured time series intangible investment data are at most 30 years. This size of data is not sufficient for several econometric analyses.

As a result, we measure intangible investment at the industry-level in Japan to clarify the puzzle between the productivity gap and intangible investment. A few studies focus on intangible investment at the sectoral level. For example, Fukao, et al. (2009) measure intangible investment in the manufacturing and service sectors. Following their work, Barnes (2010) summarized the measurement in intangible investment at the

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[1] Miyagawa and Kim (2008) also considered the role of intangible assets on productivity improvement through the indirect measurement in intangible assets by using firm-level data.

[2] Marrano, Haskel, and Wallis (2009) for the UK, Fukao et, al. (2009) for Japan, Delbecque and Bounfour (2011) for France and Germany, Hao, Manole, and van Ark(2008) and Piekkola (2011) for major EU countries, Burnes and McClure (2009) for Australia, and Pyo, Chun and Rhee (2011) for Korea..

sectoral level. However, the industry classification in the previous studies is close to the aggregate level. In our paper, we measure intangible investment at the two-digit industry level following the Japan Industrial Productivity (JIP) database.[3]

In the next section, we explain how to measure intangible investment by industry. In the third section, we show some features of intangible investment at the industry level in Japan with some comparisons with estimates in Korea. In the fourth section, using the industry level data, we examine the effect of intangible assets on productivity improvement empirically. In the final section, we summarize our results.

2. Measurement in Intangible Investment by Industry (Japanese Case)

Following Corrado, Hulten, and Sichel (2005, 2009), we measure intangible investment by industry in Japan. Intangible assets consist of computerized information, innovative property, and economic competencies. Regarding industry classifications, we follow the Japan Industrial Productivity (JIP) database. The JIP database consists of 108 industries that correspond to the two-digit industry classification. In the JIP database, the market economy consists of 92 industries, the manufacturing sector consists of 52 industries, and the service sector consists of 33 industries. Combining the JIP database with other statistics, we estimate intangible investment by industry in Japan. We explain the measurement in the following sub-sections. The detailed explanation of the measurement is summarized in the Appendix table.

2-1. Measurement of Computerized Information

Computerized information consists of custom and packaged software, and own account software. Custom and packaged software is estimated in the SNA. In the JIP database, we obtain the SNA data and distribute the total custom and software investment into each industry by using the *Fixed Capital Formation Matrix* (FCFM). Our estimation follows that in the JIP database.

We estimate the cost of workers who are involved in the development of software for their own firms to measure own account software. We estimate the ratio of the system engineers (SE) and programmers to total workers by industry using *the Population Census*. Multiplying this ratio by the number of total workers in the JIP database, we obtain an estimate of the number of SEs and programmers by industry. We

[3] The JIP database consists of 108 industries. The website of the database is **http://www.rieti.go.jp/en/database/JIP2011/index.html**. Fukao et al. (2007) explain how this database was constructed.

obtain wage data for SEs and programmers from *Basic Survey on Wage Structure*. Multiplying this wage by the number of SEs and programmers, we estimate own account software investment. The Cabinet Office (CAO) in Japan recently published own account software investment at the aggregate level in the new estimation of SNA. Our estimation method is similar to that by the CAO. However, due to the difference in coverage, our estimate in 2008 is smaller than that by CAO.

2-2. Measurement of Innovative Property

Innovative property consists of science and engineering R&D, mineral exploitation, copyright and license costs, and other product development, design, and research expenses. First, we estimate science and engineering R&D costs by using the *Survey of Research and Development* published by the Statistical Bureau of the Ministry of Internal Affairs and Communications. However the survey does not cover R&D data in most service sectors before 2000. Using service sectors' expenditures for R&D outsourcing in the JIP database, we calculate backwards to find the service sectors' R&D costs.

Because expenditures of mineral exploitation are allocated to only the mining industry, we follow the estimation by Fukao, et al. (2009) which measured the aggregate intangible investment in Japan. The *Mining Industry Handbook* and the *Establishment and Enterprise Survey* provide data on expenses for mineral exploitation (the total expenses for geological investigation). Combining the above two surveys with FCFM we estimate expenditures of mineral exploitation.

Copyright and license costs are 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. By using the I-O table in the JIP database, we allocate these inputs into 108 industries. The allocation device is as follows. For example, when we estimate copyright and license costs in industry i at year t, we obtain the input data from JIP industry no. 92 and no. 93 to industry i by using JIP I-O table at year t. As JIP database has I-O tables from 1973 to 2008, we are able to obtain the data of cost and license costs by industry in the above period.

We estimate the outsourcing costs of design, display, machine design and architectural design by using the sales data of these industries from *the Survey of Selected Service Industries* and the input from the other services for businesses industry (JIP industry no.88). We calculate the ratio of the sales of design and display industries to the nominal output of the other services for businesses industry (JIP industry no.88)

of the JIP database. Like the estimation in copyright and license costs, we allocate the estimated costs to 108 industries by using the I-O table in the JIP database.

As for in-house expenditures, we only estimate in-house designing. We estimate the ratio of the designers to total workers by industry using *the Population Census*. Multiplying this ratio by the number of total workers in the JIP database, we obtain the number of designers by industry. The Census data is available for every five years. For other years, we estimate the ratio by linear interpolation. We obtain wage data from *the Basic Survey on Wage Structure*, and multiplied it by the number of estimated workers. Like the estimation in the own account software investment, we do not take account of other expenditures except labor cost.

As for the estimation in product development in financial services, the estimation method by Corrado, Hulten, and Sichel (2005) was very controversial because they assumed that 20 percent of intermediate inputs produced by the financial services can be regarded as expenditures in intangible assets. Recently, Corrado suggested that the cost of new product development in the financial services is equal almost 8% of the compensation of high skilled workers in the financial industry to harmonize their estimate to estimates in EU countries by COINVEST and INNODRIVE projects. Thus, following Corrado's suggestions, we assume that 8 percent of the compensation of workers graduated from college in the financial industry (JIP industry no. 69) and the insurance industry (JIP industry no. 70) can be regarded as expenditures in intangible assets. These expenditures are treated as those in the financial sector and insurance industry respectively.

2-3. *Measurement of Economic Competencies*

Economic competencies consist of three components; brand equity, firm specific human capital, and organizational structure. Regarding the measurement of brand equity, we obtain the input data of the advertising industry (JIP industry no. 85) and allocate it into 108 industries by using the I-O table in the JIP database. The allocation device is similar to the case in copyright and license costs or the outsourcing costs of design, display, machine design and architectural design.

In estimating firm specific human capital, we focus on off-the-job-training costs. We estimate the ratio of off-the-job training costs to the total labor costs from the *General Survey on Working Conditions* by industry published by the Ministry of Health, Labor and Welfare. Multiplying this ratio by the total labor costs in the JIP database, we estimate off-the-job training costs by firms by industry. 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 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) conducted by the Japan Institute for Labour Policy and Training, Ooki calculated the average ratio of the opportunity cost of off-the-job training to direct firm expenses for training in 1998 for the entire business sector. The value was 1.51. We use this same value to estimate the opportunity cost.

To estimate expenditures into organizational structure, Corrado, Hulten, and Sichel (2005) assumed that 20% of the remuneration of executives is counted as intangible assets for organizational structure. However, we replaced 20% by 9%, because only 9% of the total working time of executives is spent on organizational reform and the restructuring of organization, according to Robinson and Shimizu (2001). We calculated the ratio of the remuneration of executives to value added using *the Financial Statements Statistics of Corporations by Industry* published by the Ministry of Finance. Then, we find the expenditure for the organizational structure by industry by multiplying this ratio to value added in the JIP database.

2-4. Measurement of Capital Stock in Intangible Assets

Based on the measurement of expenditures in intangible assets, we estimate capital stock in intangible assets. Corrado, Hulten, and Sichel (2005) pointed out that some of expenditures in intangible assets should not be accounted for as capital formation, because their service lives are too short. Therefore, based on the argument in Corrado, Hulten, and Sichel (2005), we revise our estimates in expenditures in intangible assets as follows to find a capital formation series;

(1) New product development costs in the entertainment industry are assumed to be short lived.
(2) 60% of advertisement costs are counted as capital formation.
(3) 80% of remuneration of executives that is spent for organizational reform is counted as capital formation.

The capital formation series is measured in nominal terms. Using the deflator by assets shown in Table1, we construct a real capital formation series in intangible assets. Then, we accumulate the capital formation series by use of the perpetual inventory method and find real capital stock in intangible assets. The depreciation rate by asset that is used for the perpetual inventory method is shown in Table 2.

(Place Tables 1 and 2 around here)

3. Accumulation of Intangible Assets

3-1. Expenditures in Intangible Assets

Our estimates of expenditures in intangible assets at the aggregate and the sector levels are summarized in Table 3. The total annual spending on intangible assets in Japan for the period 2001-2008 is about 44 trillion yen on average. Annual capital spending on intangibles is about 39 trillion yen in the same period. In the market economy, the annual expenditures for the same period are about 40 trillion yen and the annual capital spending is about 36 trillion yen.

(Place Tables 3 around here)

When we focus on the spending on intangible assets at the sector level, spending in the manufacturing sector for the period 2001-08 is about 18 trillion yen, which is almost the same as that for the period 1991-2000. On the other hand, spending on intangible assets in the service sector is about 22 trillion yen for the period 2001-08, which increased at 24% from the previous period.

In Table 4, we compare the ratios of intangible investment to GVA of Japan and Korea. In the 1980s, the total intangible investment/GVA ratio in Japan was 6.1% on average, which is higher than that in Korea (3.4%). This gap between Japan and Korea has reduced in the 2000s. While the Japanese intangible/GVA ratio is 9.4%, that in Korea is 7.4% in 2008.[4] While the intangible investment/GVA ratios in the Japanese manufacturing sector is larger than that in Korea, the ratio in the service sector in Korea is larger than that in Japan in the period from 1981 to 2008.

(Place Tables 4 around here)

Table 5 shows the intangible investment/GVA ratio by industry in Japan and Korea.[5] While the ratios in most industries in Japan are higher than those in Korea, Korean intangible investment/GVA ratios are higher than those in Japan in the food,

[4] In Korea, software investment may not include own account software which is estimated in Japan. If own account software investment in Korea is correctly estimated, the gap between Japan and Korea will be lower.

[5] When we compare intangible investment by industry between Japan and Korea, we harmonize the Japanese industry classification with Korea industry classification.

beverage and tobacco, machinery equipment, electric, gas and water supply, and culture and entertainment services industries.

(Place Tables 5 around here)

In Figure 1, we compare intangible investment by industry and by component between Japan and Korea in 2008. In the manufacturing sector, the composition of the components in Japan is similar to that in Korea in the sense that the share of investment in innovative property is the largest. However, in the service sector, investment in computerized information in Korea is greater than in Japan in some industries such as information and communication and business service industries. In the non-market sector such as education and health and social work industries, investment in computerized information in Korea is larger than that in Japan. In addition, in the information and communication, and culture and entertainment services industries, investment in economic competencies in Korea is greater than that in Japan.

(Place Figure 1 around here)

3-2 Capital Stock in Intangible Assets

The amount of capital stock and its growth rate in Japan are summarized in Table 6. The total capital stock in 2008 is about 136 trillion yen. The amount of capital stock in the manufacturing sector is almost the same as that in the service sector. The annual growth rate of intangible capital in the market economy from 1985 to 2008 is 4.2%. Although the growth rate in the late 1980s exceeded 10%, it declined after 1990. In particular, the growth rate in the 2000s is 1.3% in the market economy due to the negative growth in capital in economic competencies. Although assets in computerized information increased in the late 1990s due to the IT revolution, it also declined in the 2000s.

(Place Table 6 around here)

Figure 2 shows the growth in intangible assets by industry. As seen in Table 6, we find negative growth in intangible assets in the 2000s in some industries such as textile and leather, construction and wholesale and leather. Figure 3 shows the growth rate in intangible assets by industry and by component in the 2000s. In most industries, assets in economic competencies declined. Few industries such as petroleum, coal and

chemicals, transport equipment and information and communication industries grew these assets. In the cultural and entertainment, education and health and social work industries, assets in computerized information have declined greatly since 2000. The decline in assets in economic competencies is caused by the harsh restructuring due to the long-term economic slump. On the other hand, assets in computerized information in the non-market sector declined because the network system among establishments has not improved due to regulation and a lack of management skill.

(Place Figures 2 and 3 around here)

4. The Impacts of Intangible Assets on Productivity Growth using Japanese Data

Based on our estimates, we examine the impacts of intangible assets on productivity growth. We assume the following production function at industry i.

$$(1) \qquad Q_{t,i} = A_{t,i} F(K_{t,i}, L_{t,i}, M_{t,i}),$$

where V is value added, A is TFP, K is tangible capital, L is labour for each industry, and M is intermediate input for each industry. We assume that intangible assets (Z) are exogenous and affect TFP.

$$(2) \qquad A_{t,i} = Z_{t,i}^{\gamma} \exp(\lambda_i t)$$

When we take the logarithm of Equation (2) and differentiate it with respect to time, we get

$$(3) \qquad \frac{\Delta A_{t,i}}{A_{t,i}} = \lambda_i + \gamma \frac{\Delta Z_{t,i}}{Z_{t,i}} = \lambda_i + \rho_Z \frac{\Delta Z_{t,i}}{Q_{t,i}}$$

where we define the time difference of x as $\frac{\partial x}{\partial t} = \Delta x$, and ρ_Z is $\frac{\partial Q}{\partial Z}$. If ρ_Z is positive, intangible investment improves TFP growth.

To examine the effect of intangible investment on TFP growth, we estimate Equation (3). We obtain TFP growth and value added data from the JIP database. We estimated the intangible investment of 108 industries from 1980 to 2008. As the industry classification of intangible investment is same as JIP database, we are able to conduct a panel estimation for Equation (3). As we take a one-year lag of an explanatory variable in (3) to avoid a simultaneous bias, the estimation period is from 1981 to 2008. Estimation methods are fixed effects estimation, fixed effects estimation with instrumental variables, and GMM. A summary of the resulting statistics in variables is shown in Table 7. Instruments are lag variables of explanatory variables.

(Place Table 7 around here)

Table 8 summarizes the estimation results in the market economy. In all estimations, the coefficients of total intangible investment are not positive. When we divide total intangible investment into three components and estimate TFP growth of each component, the estimation results are similar to those using total intangible investment..

(Place Table 8 around here)

Then, we divide the whole period into two sub-periods at 1995 and estimate (3) by period, because the IT revolution started from the mid 1990s. In the first period, the estimation results are similar to Table 8 (Table 9-1). However, after the IT revolution, we find the positive and significant effect of total investment on productivity growth (Table 9-2).

(Place Table 9 around here)

Next, we divide the market economy into two sectors, manufacturing sector and service sector and estimate (3) in the period for 1996-2008. In the manufacturing sector, the coefficients in the total intangible investment show a positive and significant effect on productivity growth (Table 10-1). As for the estimation results using each component as an explanatory variable, only investment in innovative property has a

positive and significant effect on productivity growth. The results show that intangible investment has played an crucial role in productivity growth after the IT revolution However, in the service sectors, we are not able to find the positive and significant effect of total investment on productivity growth (Table 10-2).

(Place Table 10 around here)

As we expected, we find the role of intangible investment on productivity improvement after the IT revolution. However, this effect is not found in the service sector. These results are consistent with productivity gap between the manufacturing sector and the service sector in the 2000s. In the service sector, intangible assets are not utilized effectively for the productivity improvement.

5. Concluding Remarks

Based on the framework of Corrado, Hulten and Sichel (2005, 2009), we estimated intangible investment by industry. Using the JIP database, we were able to construct intangible investment in 108 industries for the period from 1980 to 2008. The total annual expenditures in intangible assets in Japan are about 44 trillion yen on average for the period 2001-08. Annual capital spending on intangibles is about 39 trillion yen in the same period. Its ratio to GVA in 2008 is 9.4%.

Comparing intangible investment in Japan with that in Korea, the ratio of intangible investment to GVA in Japan is higher than that in Korea in most industries. However, in the service sector, investment in computerized information in Korea is greater than that in Japan in some industries such as information and communication, business service, education and health and social work industries.

Using intangible investment data, we construct capital stock by industry using the perpetual inventory method. The total capital stock in 2008 is about 136 trillion yen and the annual growth rate of intangible capital in the market economy from 1985 to 2008 is 4.2%. However the annual growth rate in the 2000s is very slow. The slow growth of intangible assets in the 2000s is due to the decline in capital accumulation in economic competencies in many industries. The decline in assets in economic competencies is caused by the harsh restructuring due to the long-term economic slump. In the non-market sector, the capital accumulation in computerized information is negative in some industries.

Using our estimated data on intangibles and the JIP database, we examined the effect of intangible investment on TFP growth. Estimation results show that intangible investment contributes to TFP growth positively after 1996. It means that intangible investment has played a crucial role on productivity growth after the IT revolution. However, in the service sector, we were not able to find a positive effect of intangible investment on productivity growth. The results are consistent with the productivity gap between the manufacturing sector and the service sector in the 2000s.

Our estimation results suggest that the low productivity growth in the 2000s is caused by slow growth in intangible asset and ineffective utilization in intangible assets in the service sector. Not only more aggressive accumulation in intangible assets but also more effective use in intangible assets will stimulate economic growth in Japan. If the Japanese government wants to attain higher economic growth, it should assist intangible investment in the private sector through subsidies or financing with a low interest rate. In the case of the service sector, encouraging firms to invest in intangible assets should be more cautious than in the case of manufacturing sector, because in this sector, using intangibles does not seem to directly improve productivity. In particular, investment in firm-specific human capital which is a crucial factor in the service sector declined drastically after the collapse of bubble. In the early 1990s, the ratio of investment in firm specific human capital to investment in economic competencies was almost 50%. However, in 2008, this ratio declined to 32%.

To ensure intangible assets lead to productivity improvement, the government should subsidize the accumulation in human capital. As Miyagawa et,al. (2011) showed, the increase in the non-regular workers does not contribute to the productivity improvement and the job training improves productivity. In addition, managers should improve to utilize intangible assets effectively. The government should lift regulations that restrict managerial skill. In the non-market sector including health and social work industries, these regulations hinder productivity improvement through accumulation of intangible assets, although these industries are expected to grow in the aging society.

We will reexamine our estimation. In our estimation, as intangible assets are assumed to be exogenous variables, we examine the external effects of intangibles. However, the recent revisions of SNA have recommended that intangible assets should be treated as production factors. To follow the recent trend of the SNA, we should include intangible assets within a production function by estimating intangible capital service. If we are able to estimate capital service in intangibles, analytical possibilities will be broader than the current study. We will be able to show growth accounting by

industry and to examine the complementarities between IT equipments and intangibles.

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Table 1: Deflators for Intangible Investment

	Data source and comments
Computerized information	
Custom and packaged software	Investment deflator in the JIP 2011 Database based on SNA
In-house software	Investment deflator in the JIP 2011 Database based on SNA
Innovative property	
Science and engineering R&D	Output deflators for JIP 2011 Database industry nos. 99 and 106
Mineral exploitation	Investment deflator in the JIP 2011 Database
Copyright and license costs	Output deflators for JIP 2011 Database industry nos. 92 and 93
Other product development,	Output deflators for JIP 2011 Database industry nos. 69, 70, and 88
Economic competencies	
Brand equity	Output deflator for JIP 2011 Database industry no. 85
Firm-specific human capital	Output deflator in JIP 2011 Database industry no. 80
Organizational structure	Output deflator in JIP 2011 Database industry no. 88

Table 2: 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 (2005)

Table 3: Estimated Spending on Intangible Assets in Japan

(billions of JPY)

		Total	Market Economy	Manufacturing	Service
1991-2000	**Computerized information**	**5,572**	**4,986**	**1,530**	**3,445**
		(5,572)	**(4,986)**	**(1,530)**	**(3,445)**
	Innovative property	**17,978**	**17,651**	**12,166**	**5,435**
		(17,761)	**(17,452)**	**(12,166)**	**(5,207)**
	Economic competencies	**14,176**	**12,166**	**3,831**	**8,592**
		(10,296)	**(9,031)**	**(2,615)**	**(6,233)**
	Total	**37,725**	**35,278**	**17,527**	**17,461**
		(33,628)	**(31,440)**	**(16,311)**	**(14,885)**
2001-2008	**Computerized information**	**9,319**	**8,227**	**2,654**	**5,546**
		(9,379)	**(8,227)**	**(2,654)**	**(5,546)**
	Innovative property	**19,931**	**19,182**	**11,996**	**7,158**
		(19,518)	**(18,552)**	**(11,996)**	**(6,829)**
	Economic competencies	**14,627**	**11,996**	**3,791**	**9,037**
		(10,118)	**(8,858)**	**(2,497)**	**(6,191)**
	Total	**43,777**	**40,434**	**18,441**	**21,725**
		(38,955)	**(35,938)**	**(17,147)**	**(18,566)**

*** Capital spending on intangibles is shown in parenthesis.**

Table 4: Intangible Investment/GVA Ratio in Japan and Korea

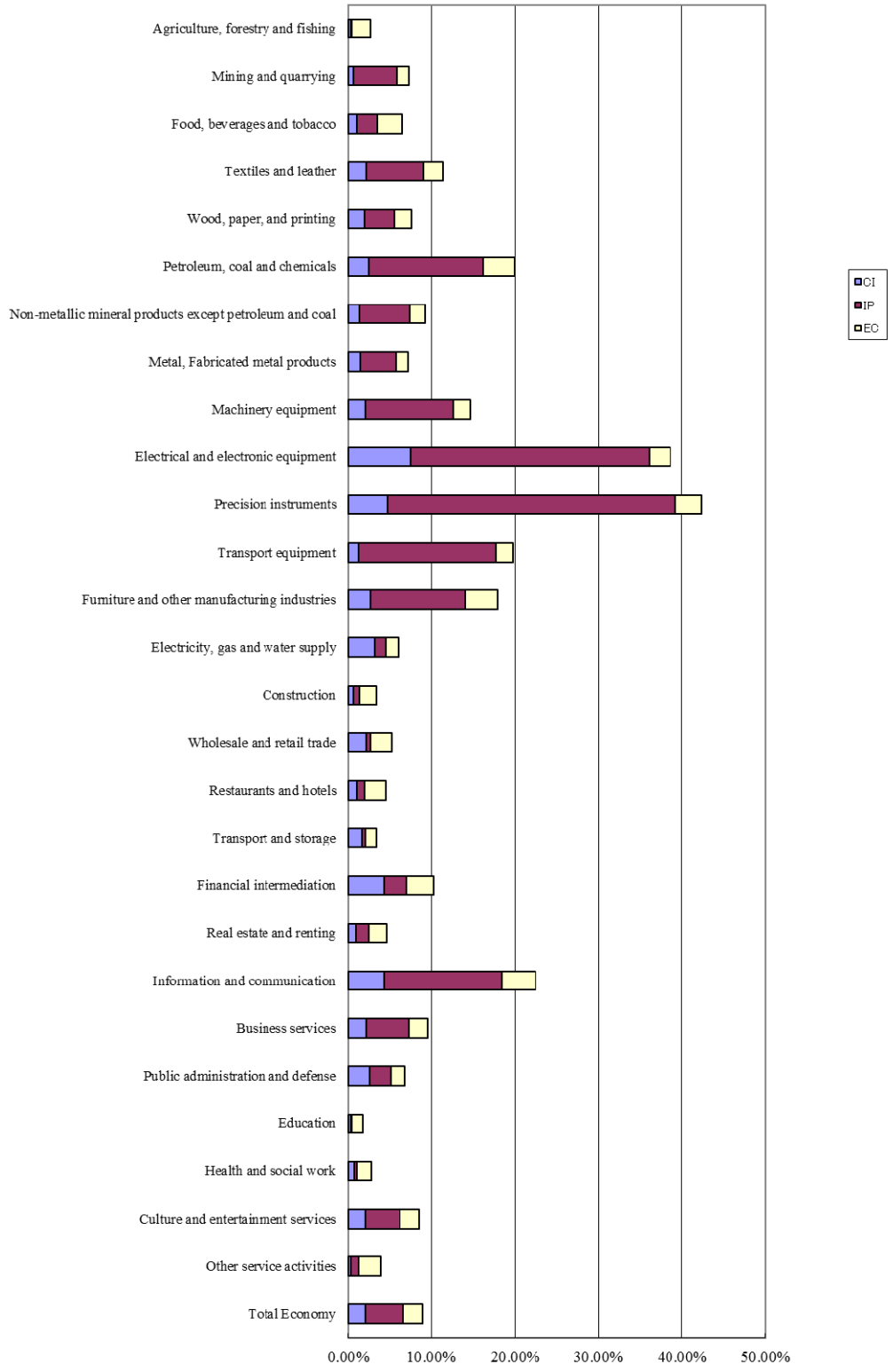
	Japan				Korea			
	1981-1990	1991-2000	2001-2008	1981-2008	1981-1990	1991-2000	2001-2008	1981-2008
Total economy								
CI	0.75%	1.35%	2.16%	1.34%	0.39%	1.10%	1.66%	1.01%
IP	3.23%	4.09%	4.46%	3.87%	1.44%	2.29%	2.95%	2.17%
EC	2.12%	2.35%	2.30%	2.25%	1.59%	2.24%	2.03%	1.95%
Total	6.10%	7.79%	8.92%	7.46%	3.43%	5.62%	6.64%	5.13%
Manufacturing								
CI	0.64%	1.55%	2.76%	1.53%	0.24%	0.46%	1.08%	0.56%
IP	8.31%	11.41%	12.05%	10.43%	3.21%	5.46%	7.51%	5.24%
EC	2.04%	2.43%	2.51%	2.31%	2.62%	3.11%	2.92%	2.88%
Total	10.99%	15.40%	17.32%	14.26%	6.07%	9.02%	11.51%	8.68%
Service								
CI	0.77%	1.32%	1.95%	1.28%	0.55%	1.46%	1.98%	1.28%
IP	1.25%	1.78%	2.25%	1.71%	0.87%	1.18%	1.23%	1.08%
EC	2.20%	2.39%	2.30%	2.30%	1.43%	2.09%	1.76%	1.76%
Total	4.23%	5.49%	6.51%	5.29%	2.85%	4.73%	4.97%	4.13%

***CI: computerized information, IP: innovative property, EC: economic competencies**

Table 5: Intangible Investment/GVA Ratio by Industry in Japan and Korea

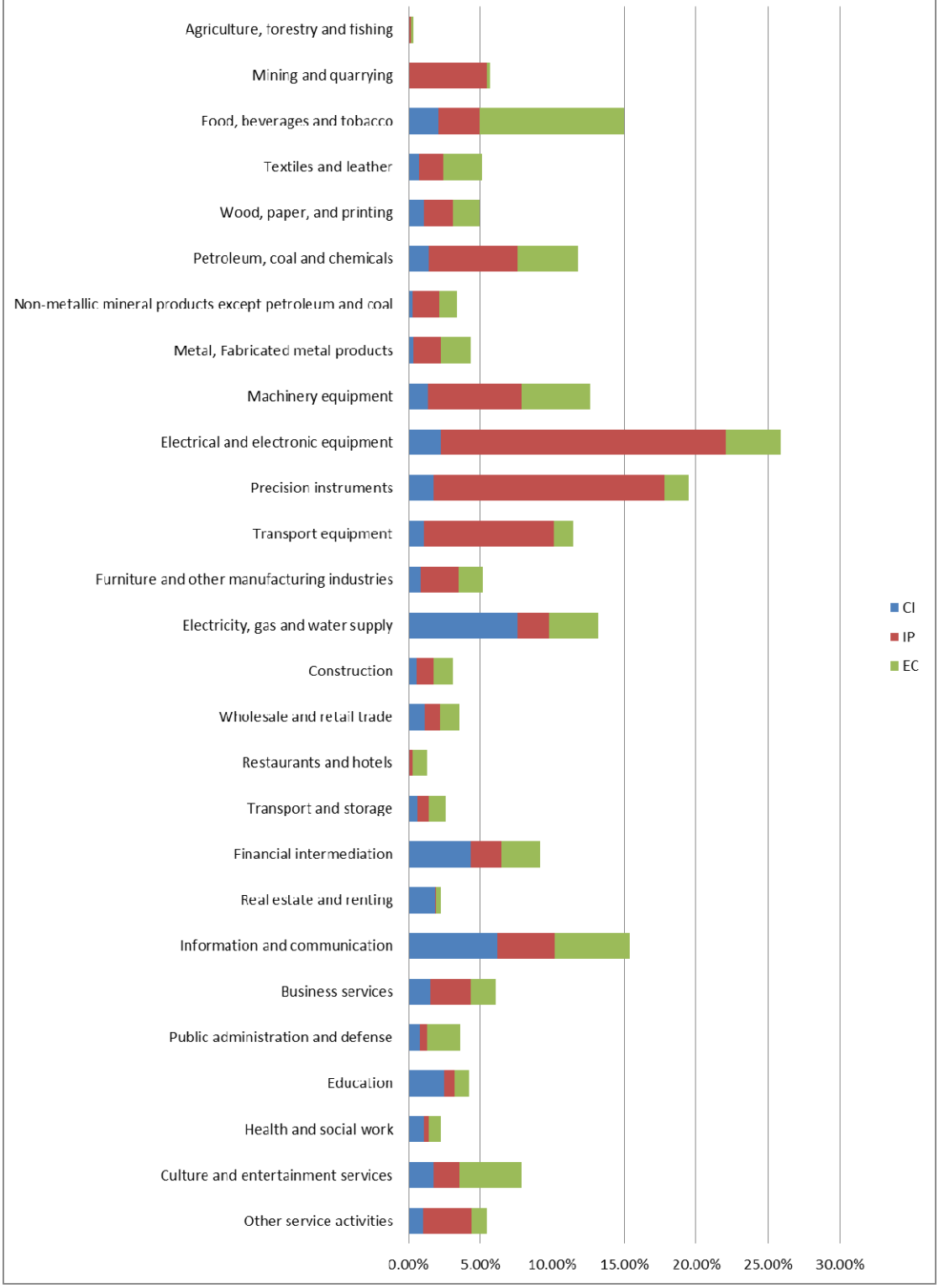
Industry name	1980		1990		2000		2008	
	Japan	**Korea**	**Japan**	**Korea**	**Japan**	**Korea**	**Japan**	**Korea**
Agriculture, forestry and fishing	**1.70%**	**0.10%**	**1.71%**	**0.20%**	**2.60%**	**0.24%**	**3.68%**	**0.36%**
Mining and quarrying	**2.30%**	**1.28%**	**4.78%**	**2.86%**	**7.59%**	**4.41%**	**10.99%**	**5.66%**
Food, beverages and tobacco	**3.14%**	**4.54%**	**6.20%**	**9.95%**	**6.45%**	**9.56%**	**6.32%**	**15.00%**
Textiles and leather	**3.98%**	**1.73%**	**6.30%**	**4.12%**	**9.60%**	**3.93%**	**16.81%**	**5.11%**
Wood, paper, and printing	**3.32%**	**4.73%**	**5.22%**	**3.36%**	**7.17%**	**3.70%**	**9.09%**	**4.94%**
Petroleum, coal and chemicals	**11.89%**	**2.97%**	**17.50%**	**10.71%**	**21.48%**	**8.88%**	**21.24%**	**11.83%**
Non-metallic mineral products except petroleum and coal	**5.17%**	**1.13%**	**8.27%**	**3.33%**	**10.00%**	**2.25%**	**8.73%**	**3.42%**
Metal, Fabricated metal products	**4.35%**	**1.61%**	**6.48%**	**2.73%**	**7.79%**	**2.68%**	**7.01%**	**4.30%**
Machinery equipment	**6.55%**	**3.97%**	**9.74%**	**8.71%**	**14.77%**	**11.80%**	**14.25%**	**12.60%**
Electrical and electronic equipment	**17.38%**	**4.23%**	**23.28%**	**17.19%**	**30.06%**	**13.28%**	**46.68%**	**25.87%**
Precision instruments	**11.06%**	**1.39%**	**22.31%**	**7.28%**	**39.31%**	**9.24%**	**38.48%**	**19.47%**
Transport equipment	**10.14%**	**4.48%**	**16.84%**	**8.89%**	**20.11%**	**12.16%**	**20.21%**	**11.51%**
Furniture and other manufacturing industries	**7.88%**	**2.49%**	**12.23%**	**5.13%**	**29.45%**	**6.13%**	**17.33%**	**5.16%**
Electricity, gas and water supply	**1.75%**	**1.64%**	**3.97%**	**1.88%**	**5.45%**	**5.00%**	**8.40%**	**13.22%**
Construction	**2.06%**	**1.31%**	**3.06%**	**3.97%**	**3.81%**	**3.02%**	**2.83%**	**3.12%**
Wholesale and retail trade	**3.05%**	**1.40%**	**5.25%**	**1.92%**	**5.62%**	**4.07%**	**4.44%**	**3.54%**
Restaurants and hotels	**1.87%**	**4.87%**	**5.36%**	**3.62%**	**4.57%**	**1.51%**	**4.33%**	**1.29%**
Transport and storage	**1.93%**	**1.31%**	**2.15%**	**1.52%**	**2.67%**	**3.20%**	**4.23%**	**2.57%**
Financial intermediation	**4.10%**	**4.12%**	**5.29%**	**6.01%**	**9.21%**	**8.12%**	**14.02%**	**9.15%**
Real estate and renting	**2.04%**	**2.16%**	**3.01%**	**3.88%**	**4.85%**	**4.99%**	**4.47%**	**2.27%**
Information and communication	**5.43%**	**4.02%**	**19.03%**	**5.00%**	**21.56%**	**11.06%**	**23.38%**	**15.36%**
Business services	**3.96%**	**6.41%**	**7.11%**	**8.53%**	**9.24%**	**7.16%**	**10.26%**	**6.11%**
Public administration and defense	**3.12%**	**3.34%**	**4.36%**	**3.65%**	**5.81%**	**4.72%**	**7.26%**	**3.61%**
Education	**1.49%**	**2.76%**	**1.76%**	**3.50%**	**1.85%**	**4.41%**	**1.47%**	**4.19%**
Health and social work	**1.77%**	**1.84%**	**3.40%**	**1.89%**	**3.41%**	**2.22%**	**1.79%**	**2.28%**
Culture and entertainment services	**5.96%**	**2.29%**	**5.22%**	**2.99%**	**8.54%**	**4.56%**	**6.65%**	**7.86%**
Other service activities	**2.04%**	**2.37%**	**3.19%**	**2.06%**	**4.21%**	**4.18%**	**3.49%**	**5.44%**

Figure 1-1 Intangible Investment by Industry and Component in Japan (2008)



***CI: computerized information, IP: innovative property, EC: economic competencies**

Figure 1-2 Intangible Investment by Industry and Component in Korea (2008)



***CI: computerized information, IP: innovative property, EC: economic competencies**

Table 6: Capital Stock in Intangible Assets in Japan

	2008 billions of JPY	1985-1990 annual growth rate (%)	1990-1995 annual growth rate (%)	1995-2000 annual growth rate (%)	2000-2008 annual growth rate (%)	1985-2008 annual growth rate (%)
Market economy						
CI	**26,839**	**15.07%**	**5.90%**	**8.72%**	**4.84%**	**8.07%**
IP	**91,351**	**11.28%**	**4.40%**	**2.68%**	**1.05%**	**4.29%**
EC	**17,493**	**5.68%**	**1.49%**	**1.36%**	**-1.68%**	**1.23%**
Total	**135,600**	**10.34%**	**4.00%**	**3.23%**	**1.29%**	**4.22%**
Manufacturing						
CI	**9,116**	**12.80%**	**7.22%**	**8.95%**	**6.13%**	**8.40%**
IP	**63,232**	**10.89%**	**3.98%**	**1.99%**	**0.25%**	**3.68%**
EC	**4,757**	**4.36%**	**-0.06%**	**0.76%**	**-1.57%**	**0.53%**
Total	**77,106**	**10.23%**	**3.78%**	**2.34%**	**0.68%**	**3.73%**
Service						
CI	**17,662**	**16.07%**	**5.34%**	**8.58%**	**4.24%**	**7.90%**
IP	**27,957**	**12.86%**	**5.90%**	**4.87%**	**3.17%**	**6.18%**
EC	**12,265**	**6.61%**	**2.17%**	**1.66%**	**-1.81%**	**1.59%**
Total	**57,801**	**10.79%**	**4.43%**	**4.72%**	**2.19%**	**5.05%**

***CI: computerized information, IP: innovative property, EC: economic competencies**

Figure 2 Growth rate in Intangible Assets by Industry

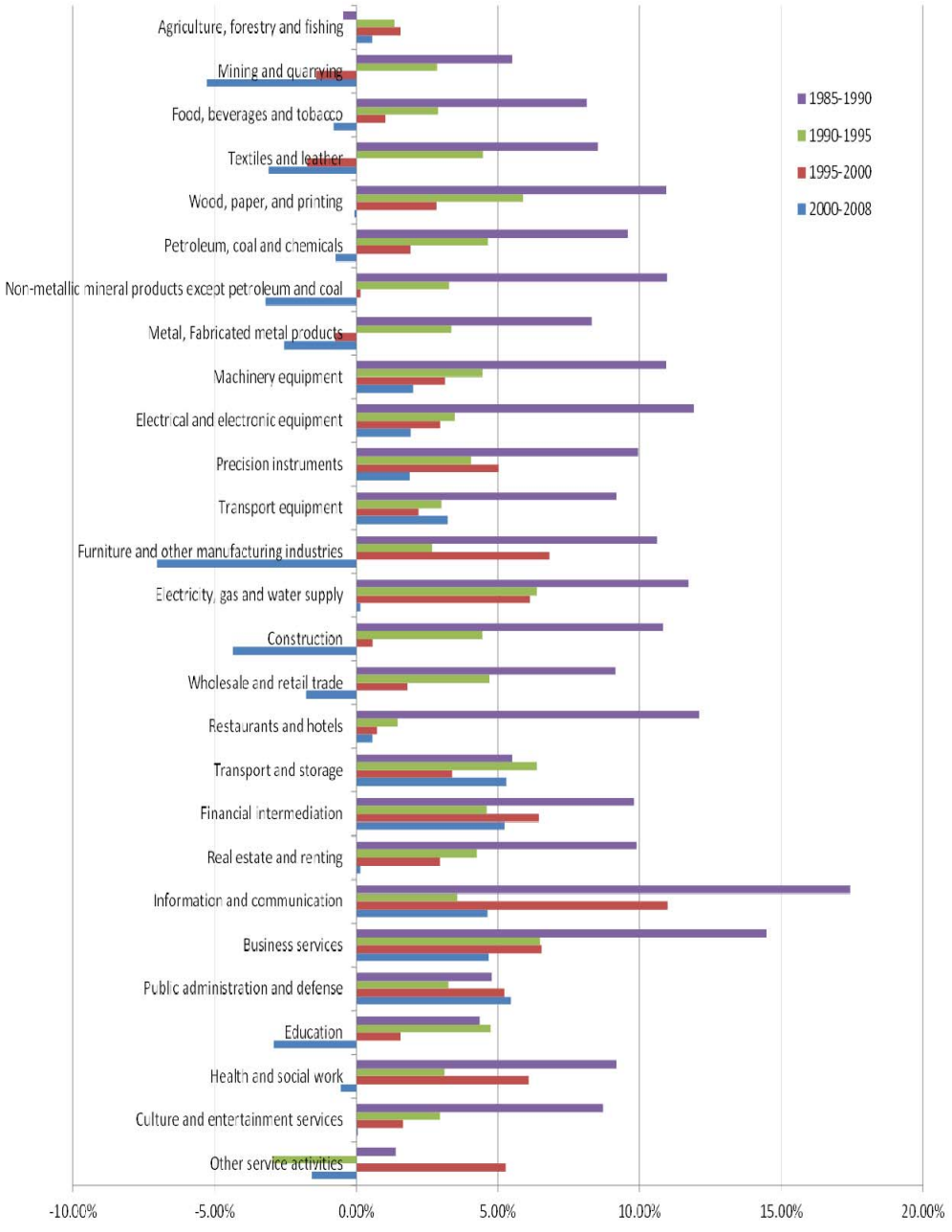
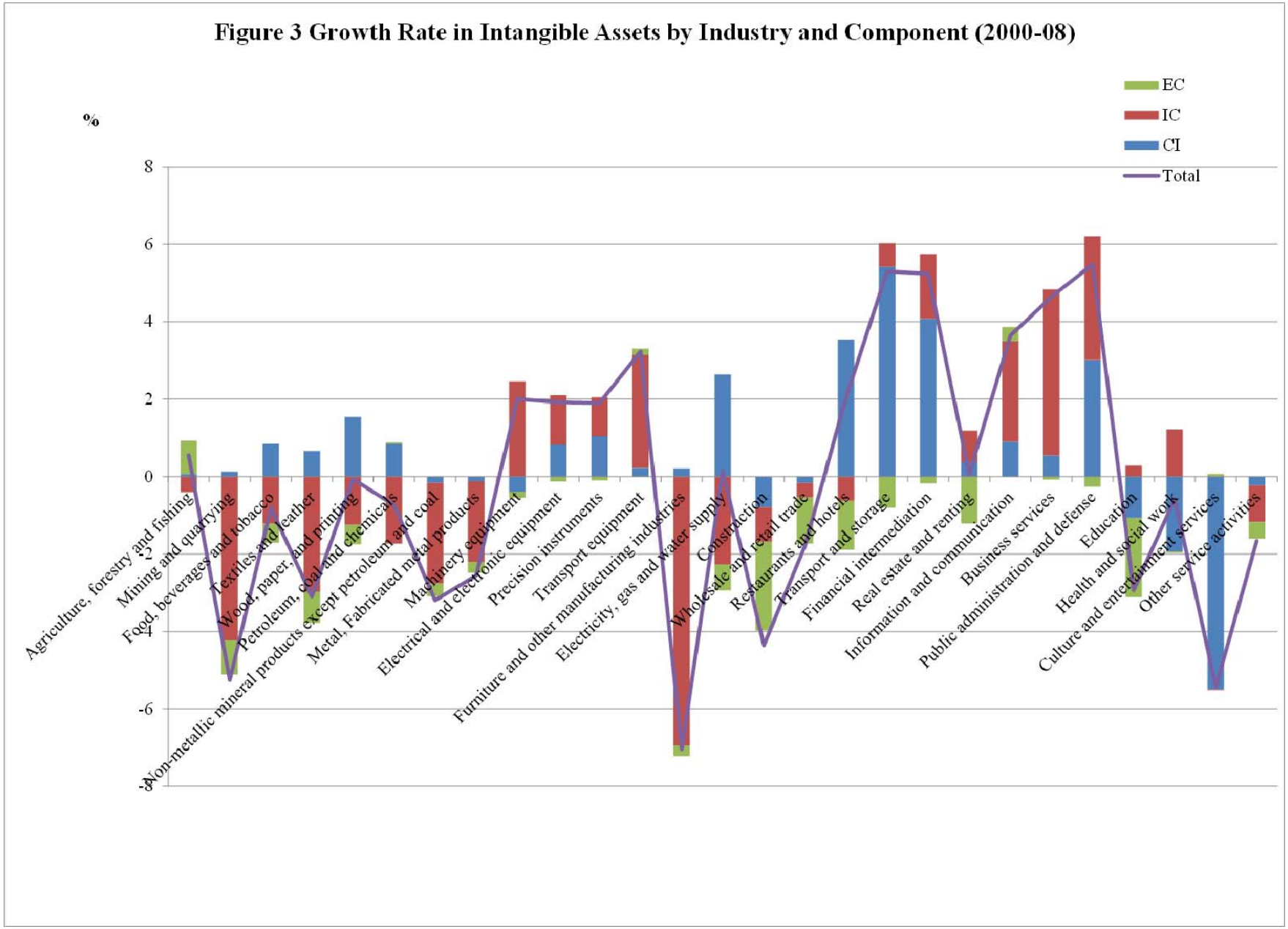


Figure 3 Growth Rate in Intangible Assets by Industry and Component (2000-08)



***CI: computerized information, IP: innovative property, EC: economic competencies**

Table 7: A summary of statistics in variables

	Number of Observation	Mean	Standard Derivation	Minimum	Maximam	Median
TFP	2,668	0.004	0.052	-0.634	0.570	0.002221
I(T)	2,668	319,988	388,095	374	2,664,098	177,412
I（E)	2,668	90,931	153,144	218	1,028,715	38,132
I(I)	2,668	175,579	253,326	0	1,767,127	84,710
I（C)	2,668	53,478	114,720	0	1,246,050	15,679
Q	2,668	7,533,394	9,165,578	114,639	64,400,000	4,539,904
I(T)/Q	2,668	0.058	0.087	0.002	1.181	0.029
I(E)/Q	2,668	0.010	0.008	0.001	0.111	0.008
I(I)/Q	2,668	0.042	0.082	0.000	1.121	0.013
I(C)/Q	2,668	0.006	0.008	0.000	0.106	0.004

Table 8 Estimation Results in the Market Economy

Dependent variable: TFP growth

	FE	FE	FE	FE	FE-IV	FE-IV	FE-IV	FE-IV	GMM	GMM	GMM	GMM
I(T)/Q	0.199347				0.225301				1.375314			
	[2.28]**				[2.21]**				[9.21]***			
I(E)/Q		3.822158				4.080855				16.510463		
		[3.86]***				[3.37]***				[9.01]***		
I(I)/Q			0.186172				0.225211				1.271521	
			[2.00]**				[2.06]**				[8.05]***	
I(C)/Q				0.362169				-0.491527				5.20966
				[0.47]				[0.37]				[5.35]***
TFP(-1)									-0.234351	-0.245282	-0.232648	-0.223921
									[16.70]***	[17.44]***	[16.54]***	[15.87]***
constant	-0.053018	-0.078753	-0.048431	-0.04487	-0.054319	-0.081031	-0.049719	-0.03561	-0.101924	-0.180118	-0.069804	-0.075323
	[2.86]***	[3.88]***	[2.66]***	[2.30]**	[2.89]***	[3.79]***	[2.72]***	[1.58]	[5.94]***	[7.83]***	[4.38]***	[4.18]***
R-suqared	0.03	0.03	0.03	0.03								
No. of observations	2529	2529	2529	2529	2443	2443	2443	2443	2520	2520	2520	2520
No. of industries	92	92	92	92	92	92	92	92	92	92	92	92
Estimation period	1981-2008	1981-2008	1981-2008	1981-2008	1981-2008	1981-2008	1981-2008	1981-2008	1981-2008	1981-2008	1981-2008	1981-2008

*** t-values are shown in parenthesis. ***, **, * show that a coefficient is significant at 1%, 5%, and 10% level respectively.**

Table 9-1 Estimation Results in the Market Economy (1981-1995)

Dependent variable: TFP growth

	FE	FE	FE	FE	FE-IV	FE-IV	FE-IV	FE-IV	GMM	GMM	GMM	GMM
I(T)/Q	-0.099253				-0.069868				-0.177948			
	[3.26]***				[1.84]				[2.98]***			
I(E)/Q		-0.929023				0.046176				-2.718007		
		[2.64]***				[0.10]				[4.63]***		
I(I)/Q			-0.103878				-0.080638				-0.158584	
			[3.17]***				[1.97]**				[2.49]**	
I(C)/Q				-0.323173				-0.355327				-0.893338
				[0.90]				[0.21]				[1.93]*
TFP(-1)									0.020952	0.030421	0.022429	0.025175
									[0.89]	[1.29]	[0.95]	[1.07]
constant	0.007563	0.011372	0.006259	0.003409	0.005868	0.001365	0.00527	0.003565	0.012019	0.029647	0.008507	0.006063
	[1.30]	[1.71]*	[1.09]	[0.58]	[1.00]	[0.19]	[0.92]	[0.37]	[1.84]*	[3.61]***	[1.38]	[1.01]
R-suqared	0.04	0.04	0.04	0.03								
No. of observations	1380	1380	1380	1380	1288	1288	1288	1288	1380	1380	1380	1380
No. of industries	92	92	92	92	92	92	92	92	92	92	92	92
Estimation period	1981-1995	1981-1995	1981-1995	1981-1995	1982-1995	1982-1995	1982-1995	1982-1995	1981-1995	1981-1995	1981-1995	1981-1995

*** t-values are shown in parenthesis. ***, **, * show that a coefficient is significant at 1%, 5%, and 10% level respectively.**

Table 9-2 Estimation Results in the Market Economy (1996-2008)

Dependent variable: TFP growth

	FE	FE	FE	FE	FE-IV	FE-IV	FE-IV	FE-IV	GMM	GMM	GMM	GMM
I(T)/Q	0.2054				0.083498				0.420937			
	[2.98]***				[0.94]				[5.81]***			
I(E)/Q		0.030763				-0.60411				4.329687		
		[0.03]				[0.59]				[3.70]***		
I(I)/Q			0.220548				0.113108				0.389179	
			[3.07]***				[1.23]				[5.12]***	
I(C)/Q				0.051277				-0.399059				1.616126
				[0.16]				[0.92]				[3.94]***
TFP(-1)									-0.109006	-0.095894	-0.106305	-0.101508
									[4.54]***	[3.96]***	[4.41]***	[4.19]***
constant	-0.017633	-0.005499	-0.014136	-0.005756	-0.010261	0.000454	-0.009788	-0.000967	-0.025331	-0.042818	-0.016566	-0.013687
	[2.84]***	[0.58]	[2.59]***	[0.99]	[1.45]	[0.04]	[1.65]	[0.15]	[4.74]***	[3.62]***	[3.68]***	[2.94]***
R-suqared	0.05	0.04	0.05	0.04								
No. of observations	1196	1196	1196	1196	1196	1196	1196	1196	1196	1196	1196	1196
No. of industries	92	92	92	92	92	92	92	92	92	92	92	92
Estimation period	1996-2008	1996-2008	1996-2008	1996-2008	1997-2008	1997-2008	1997-2008	1997-2008	1996-2008	1996-2008	1996-2008	1996-2008

*** t-values are shown in parenthesis. ***, **, * show that a coefficient is significant at 1%, 5%, and 10% level respectively.**

Table 10-1 Estimation Results in the Manufacturing Sectors (1996-2008)

	FE	FE	FE	FE	FE-IV	FE-IV	FE-IV	FE-IV	GMM	GMM	GMM	GMM
I(T)/Q	0.419141				0.277203				0.621194			
	[4.06]***				[1.96]*				[6.71]***			
I(E)/Q		-1.333164				-2.701576				3.034135		
		[0.91]				[1.67]*				[2.15]**		
I(I)/Q			0.417228				0.302202				0.615406	
			[3.96]***				[2.12]**				[6.34]***	
I(C)/Q				0.665795				-0.00731				1.740589
				[1.22]				[0.01]				[3.04]***
TFP(-1)									-0.132317	-0.127618	-0.132421	-0.136493
									[4.18]***	[3.94]***	[4.16]***	[4.27]***
constant	-0.027798	0.00676	-0.020151	-0.010461	-0.019609	0.01741	-0.015592	-0.00354	-0.030187	-0.017222	-0.020087	-0.005906
	[3.11]***	[0.51]	[2.56]**	[1.19]	[1.86]*	[1.22]	[1.79]*	[0.35]	[4.13]***	[1.38]	[3.14]***	[0.91]
R-suqared	0.09	0.06	0.08	0.06								
No. of observations	676	676	676	676	676	676	676	676	676	676	676	676
No. of industries	52	52	52	52	52	52	52	52	52	52	52	52
Estimation period	1996-2008	1996-2008	1996-2008	1996-2008	1997-2008	1997-2008	1997-2008	1997-2008	1996-2008	1996-2008	1996-2008	1996-2008

Table 10-2 Estimation Results in the Service Sectors (1996-2008)

	FE	FE	FE	FE	FE-IV	FE-IV	FE-IV	FE-IV	GMM	GMM	GMM	GMM
I(T)/Q	-0.016987				-0.156633				0.074556			
	[0.20]				[1.55]				[1.53]			
I(E)/Q		0.040327				0.009582				0.961353		
		[0.04]				[0.01]				[1.21]		
I(I)/Q			0.012143				-0.130517				0.077624	
			[0.14]				[1.19]				[1.55]	
I(C)/Q				-0.445106				-0.786988				-0.078469
				[1.34]				[1.78]*				[0.24]
TFP(-1)									-0.039442	-0.037012	-0.039187	-0.040251
									[1.00]	[0.93]	[1.00]	[1.02]
constant	-0.011038	-0.012779	-0.012907	-0.006507	-0.000633	-0.012416	-0.005818	-0.002055	-0.018464	-0.025348	-0.016938	-0.012979
	[1.29]	[0.96]	[1.74]*	[0.89]	[0.07]	[0.86]	[0.72]	[0.25]	[3.54]***	[2.43]**	[3.61]***	[2.42]**
R-suqared	0.05	0.05	0.05	0.06								
No. of observations	429	429	429	429	429	429	429	429	429	429	429	429
No. of industries	33	33	33	33	33	33	33	33	33	33	33	33
Estimation period	1996-2008	1996-2008	1996-2008	1996-2008	1997-2008	1997-2008	1997-2008	1997-2008	1996-2008	1996-2008	1996-2008	1996-2008

Appendix 1: Measurement of intangible investment by industry

Category	Industry classification	Estimation method and data sources
Computerlized information		
Custom and packaged software	**108**	**We use data of custom and package software investment of JIP Database 2011 (JIP asset alassification no. 38).**
Own account software	**108**	**We estimate the ratio of the system engineers and programmers to total workers by industry using *Population Census*. Multiplying this ratio by the number of total workers in JIP Database 2011, we obtain the number of SE and programmer by industry. The Census data is available for every five years. For other years, we estimate the ratio by linear interpolation. We multiply the number of estimated workers by the average wage of system engineers and programmers. We get wage data from *Basic Survey on Wage Structure*. We do not take account of other expenditures except labor cost. We used this result as the expenditure for in-house software except the case of the information service industry.**
Innovative Property		
Science and enginnering R&D	**108**	**We get data of R&D expenditures from *Survey of Research and Development*. However the survey does not cover R&D data in most of service sectors before 2000. Using service sectors' expenditures for R&D outsourcing, which is available at JIP 2011, we extraporate service sectors' R&D expenditures backwards. Because the survey is conducted on a fiscal-year basis, the values are then converted to a calendar-year basis.**
Mineral exploitation	**1**	**Because expenditures of mineral exploitation are allocated to only mining industry, we follow the estimation by Fukao, et, al (2009). The Mining Industry Handbook and the Establishment and Enterprise Survey provide data on expenses for mineral exploitation (the total expenses for geological investigation). Combined the above two surveys with FCFM, we estimate expenditures of mineral exploitation.**

Copyright and licence costs	**108**	**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.**
Other product development, design, and research expenses	**108 (2 for prodcut development in financial services**	**In the case of outsourcing of design, display, machine design and architectual design, we estimate intangible investment by using the sales data of these industries in the Survey of Selected Service Industries and the input from the other services for businesses industry (JIP industry no.88). We calculate the ratio of the sales of these industries 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 2011 Database for each year that the survey was conducted. The survey is conducted every three years. Then, the ratio for years in which the survey was not conducted is obtained by linear interpolation. 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. In the case of in-house expenditures, we only estimated in-house designing. We estimate the ratio of the designers to total workers by industry using the Population Census. Multiplying this ratio by the number of total workers in JIP Database 2011, we get the number of designers by industry. The Census data is available for every five years. For other years, we estimate the ratio by linear interpolation. We multiply the number of estimated workers by the average wage of designers. We get wage data from the Basic Survey on Wage Structure. We do not take account of other expenditures except labor cost. As for the estimation in product development in financial service, we assume that 8 percent of the compasation of high-skilled labors (workers graduated from college) in the financial industry (JIP industry no. 69) and the insurance industry (JIP industry no. 70) can be regarded as expenditures in intangible assets, following Corrado's suggestions. These expenditures are treated as those in financial sector and insurance industry respectively.**

Economic competencies		
Brand equity	**108**	**We get the input from the advertising industry (JIP industry no. 85) from JIP Database 2011.**
Firm specific human capital	**108**	**We estimate the ratio of off-the-job training costs to the total labor costs from the General Survey on Working Conditions by industry. Multiplying this ratio by the total labor costs in JIP database (2011 version), we get off-the-job trainig costs expensed by firms by industry. 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.**
Organizational structure	**108**	**We assume that 9% of the remuneration of executives is counted as intangible investment for organizational structure, because 9% of the total working time of executives is spent for the organizational reform and the restructuring of organization accroding to Robinson and Shimizu (2001). We calculate the ratio of the remuneration of executives to value added using the *Financial Statements Statistics of Corporations by Industry* published by the Ministry of Finance. Then, we get the expenditure for the organizational structure by industry by multiplying this ratio to value added in JIP database (2011 version)**

Appendix 2:Harmonization of industry classifications

JIP Classification		Korean Classification	
1	Rice, wheat production	1	Agriculture, forestry and fishing
2	Miscellaneous crop farming	1	Agriculture, forestry and fishing
3	Livestock and sericulture farming	1	Agriculture, forestry and fishing
4	Agricultural services	1	Agriculture, forestry and fishing
5	Forestry	1	Agriculture, forestry and fishing
6	Fisheries	1	Agriculture, forestry and fishing
7	Mining	2	Mining and quarrying
8	Livestock products	3	Food, beverages and tobacco
9	Seafood products	3	Food, beverages and tobacco
10	Flour and grain mill products	3	Food, beverages and tobacco
11	Miscellaneous foods and related products	3	Food, beverages and tobacco
12	Prepared animal foods and organic fertilizers	3	Food, beverages and tobacco
13	Beverages	3	Food, beverages and tobacco
14	Tobacco	3	Food, beverages and tobacco
15	Textile products	4	Textiles and leather
16	Lumber and wood products	5	Wood, paper, and printing
17	Furniture and fixtures	13	Furniture and other manufacturing industries
18	Pulp, paper, and coated and glazed paper	5	Wood, paper, and printing
19	Paper products	5	Wood, paper, and printing
20	Printing, plate making for printing and bookbinding	5	Wood, paper, and printing
21	Leather and leather products	4	Textiles and leather
22	Rubber products	6	Petroleum, coal and chemicals
23	Chemical fertilizers	6	Petroleum, coal and chemicals
24	Basic inorganic chemicals	6	Petroleum, coal and chemicals
25	Basic organic chemicals	6	Petroleum, coal and chemicals
26	Organic chemicals	6	Petroleum, coal and chemicals
27	Chemical fibers	6	Petroleum, coal and chemicals
28	Miscellaneous chemical products	6	Petroleum, coal and chemicals
29	Pharmaceutical products	6	Petroleum, coal and chemicals
30	Petroleum products	6	Petroleum, coal and chemicals
31	Coal products	6	Petroleum, coal and chemicals
32	Glass and its products	7	Non-metallic mineral products except petroleum and coal
33	Cement and its products	7	Non-metallic mineral products except petroleum and coal
34	Pottery	7	Non-metallic mineral products except petroleum and coal
35	Miscellaneous ceramic, stone and clay products	7	Non-metallic mineral products except petroleum and coal
36	Pig iron and crude steel	8	Metal, fabricated metal products
37	Miscellaneous iron and steel	8	Metal, fabricated metal products
38	Smelting and refining of non-ferrous metals	8	Metal, fabricated metal products
39	Non-ferrous metal products	8	Metal, fabricated metal products
40	Fabricated constructional and architectural metal products	8	Metal, fabricated metal products
41	Miscellaneous fabricated metal products	8	Metal, fabricated metal products
42	General industry machinery	9	Machinery equipment
43	Special industry machinery	9	Machinery equipment
44	Miscellaneous machinery	9	Machinery equipment
45	Office and service industry machines	9	Machinery equipment
46	Electrical generating, transmission, distribution and industrial apparatus	10	Electrical and electronic equipment
47	Household electric appliances	10	Electrical and electronic equipment
48	Electronic data processing machines, digital and analog computer equipment and accessories	10	Electrical and electronic equipment
49	Communication equipment	10	Electrical and electronic equipment
50	Electronic equipment and electric measuring instruments	10	Electrical and electronic equipment
51	Semiconductor devices and integrated circuits	10	Electrical and electronic equipment
52	Electronic parts	10	Electrical and electronic equipment
53	Miscellaneous electrical machinery equipment	10	Electrical and electronic equipment
54	Motor vehicles	12	Transport equipment

55	Motor vehicle parts and accessories	12	Transport equipment
56	Other transportation equipment	12	Transport equipment
57	Precision machinery & equipment	11	Precision instruments
58	Plastic products	6	Petroleum, coal and chemicals
59	Miscellaneous manufacturing industries	13	Furniture and other manufacturing industries
60	Construction	15	Construction
61	Civil engineering	15	Construction
62	Electricity	14	Electricity, gas and water supply
63	Gas, heat supply	14	Electricity, gas and water supply
64	Waterworks	14	Electricity, gas and water supply
65	Water supply for industrial use	14	Electricity, gas and water supply
66	Waste disposal	14	Electricity, gas and water supply
67	Wholesale	16	Wholesale and retail trade
68	Retail	16	Wholesale and retail trade
69	Finance	19	Financial intermediation
70	Insurance	19	Financial intermediation
71	Real estate	20	Real estate and renting
72	Housing		unmeasured
73	Railway	18	Transport and storage
74	Road transportation	18	Transport and storage
75	Water transportation	18	Transport and storage
76	Air transportation	18	Transport and storage
77	Other transportation and packing	18	Transport and storage
78	Telegraph and telephone	21	Information and communication
79	Mail	21	Information and communication
80	Education (private and non-profit)	24	Education
81	Research (private)	23	Public administration and defense
82	Medical (private)	25	Health and social work
83	Hygiene (private and non-profit)	25	Health and social work
84	Other public services	23	Public administration and defense
85	Advertising	22	Business services
86	Rental of office equipment and goods	20	Real estate and renting
87	Automobile maintenance services	22	Business services
88	Other services for businesses	22	Business services
89	Entertainment	26	Culture and entertainment services
90	Broadcasting	21	Information and communication
91	Information services and internet-based services	21	Information and communication
92	Publishing	21	Information and communication
93	Video picture, sound information, character information production and distribution	21	Information and communication
94	Eating and drinking places	17	Restaurants and hotels
95	Accommodation	17	Restaurants and hotels
96	Laundry, beauty and bath services	27	Other service activities
97	Other services for individuals	27	Other service activities
98	Education (public)	24	Education
99	Research (public)	23	Public administration and defense
100	Medical (public)	25	Health and social work
101	Hygiene (public)	25	Health and social work
102	Social insurance and social welfare (public)	25	Health and social work
103	Public administration	23	Public administration and defense
104	Medical (non-profit)	25	Health and social work
105	Social insurance and social welfare (non-profit)	25	Health and social work
106	Research (non-profit)	23	Public administration and defense
107	Other (non-profit)	25	Health and social work
108	Activities not elsewhere classified	23	Public administration and defense