



Intellectual Capital for  
Communities  
In the Knowledge Economy

# Intangible Investment at the Industry Level

**Hyunbae Chun**  
Sogang University



# Motivation

- In the knowledge based economy, intangible assets become more crucial in the production process
- Corrado, Hulten, & Sichel (hereafter CHS; 2006, 2009) provide a broad definition of intangible asset

# CHS Definition of Intangibles

- Computerized Information (CI)
  - Mainly computer software
- Innovative Property (IP)
  - Scientific R&D, non-scientific R&D (R&D in financial industry, copyrights & license costs, and new architectural & engineering designs)
- Economic Competencies (EC)
  - Brand equity (advertising expenses)
  - Firm-specific resources (job training and consulting costs)

# International Collaboration of Intangible Data based on CHS

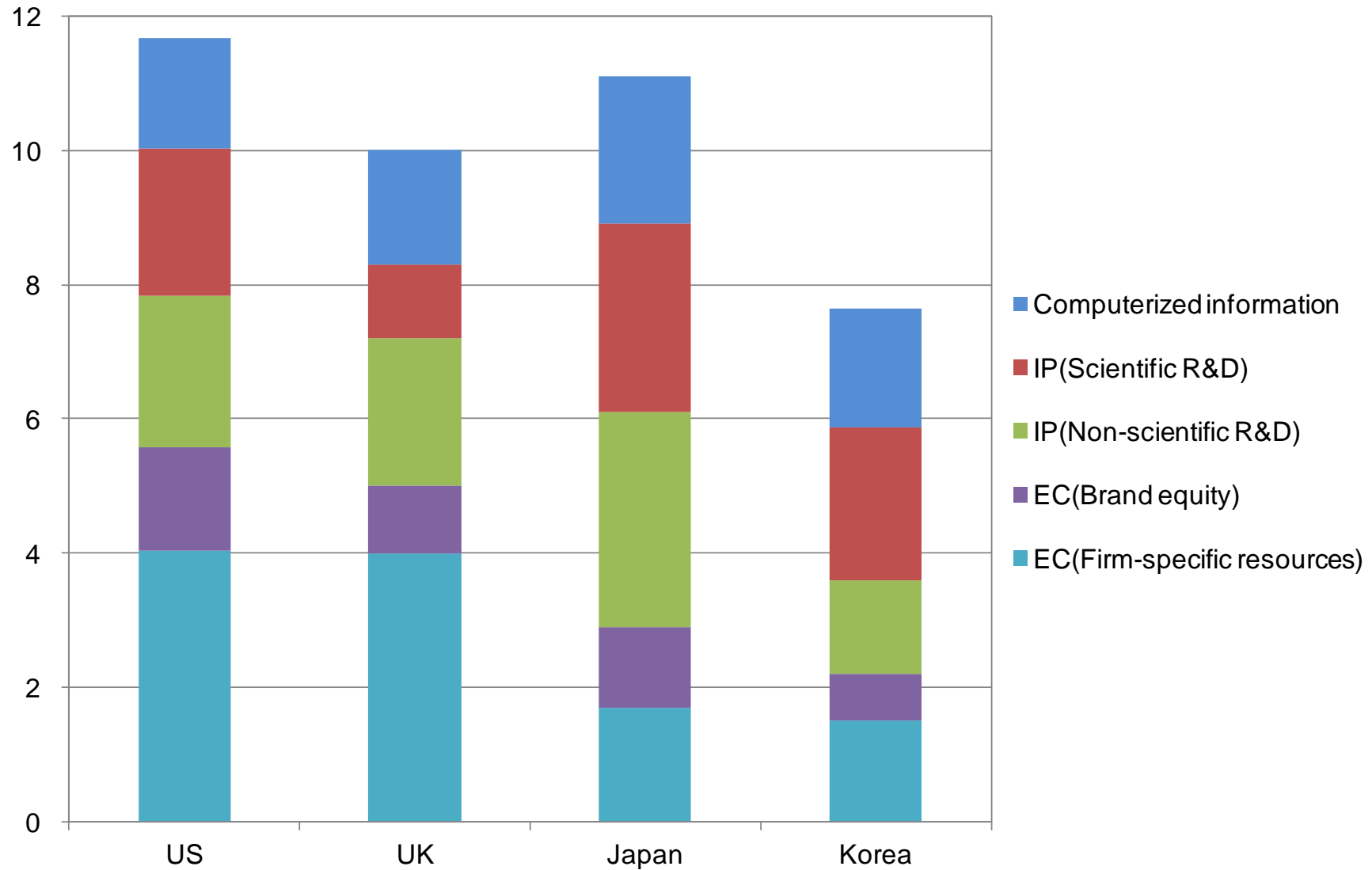
- Individual country
  - Fukao, Miyagawa & others (2009) for Japan
  - Chun and others (2011) for Korea
  - Marrano, Hakel & Wallis (2009) for UK
  - Barnes & McClure (2009) for Australia
  - Van Rooijeen-Horsten (2008) for Netherlands
- International Collaboration
  - Haskel & others' *Coinvest* project for European Countries
  - Miyagawa & others' collaboration with Chun & others for Japanese and Korean aggregate & 27-industry-level data

# Share of Intangible Investment in GDP: US, UK, Japan, and Korea

	U.S. 2000-'03	U.K. 2004	Japan 2000-'05	Korea 2000-'05
Computerized information	1.6	1.7	2.2	1.8
Innovative property	4.5	3.2	6.0	3.7
(a) Scientific R&D	2.2	1.1	2.8	2.3
(b) Non-scientific R&D	2.3	2.2	3.2	1.4
Economic competencies	5.6	5.0	2.9	2.1
(a) Brand equity	1.5	1.0	1.2	0.7
(b) Firm-specific resources	4.0	4.0	1.7	1.5
<b>Total</b>	<b>11.7</b>	<b>10.0</b>	<b>11.1</b>	<b>7.6</b>

Sources: Corrado, Hulten, & Sichel (2009) for US;  
 Marrano, Haskel & Wallis (2009) for UK;  
 Fukao, Miyagawa, Mukai, Shinoda, & Tonogi (2009) for Japan.

# Share of Intangible Investment in GDP: US, UK, Japan, and Korea



## Toward Industry-Level Data

- Need industry-level datasets because differences in the level and composition of intangibles might be explained by sectoral difference across countries
  - A higher intangible intensity in advance countries (than in developing countries) might reflect a larger share of intangible intensive industries such as durable manufacturing, financial, and IT services
  - A high scientific R&D intensity in the aggregate economy might reflect a larger share of durable goods and ICT industries

## Toward Industry-Level Data

- Korean and Japanese researchers agree to construct intangible datasets for 27 industries
  - Unified definition of industry-level intangibles between Japan and Korea
  - KIP: 72 industries and JIP: 108 industries
  - 27 industries based on the industry classification of the Korean National Accounts (following ISIC rev. 4)



# Looking at Korean Industry-Level Data

- Sectoral differences: manufacturing vs. services
- Heterogeneity in composition of intangibles across industries
  - Scientific R&D to develop better equipment
  - Production development cost for new financial products
  - Advertising costs in food and beverages industries
  - Job training costs for workers in the software industry

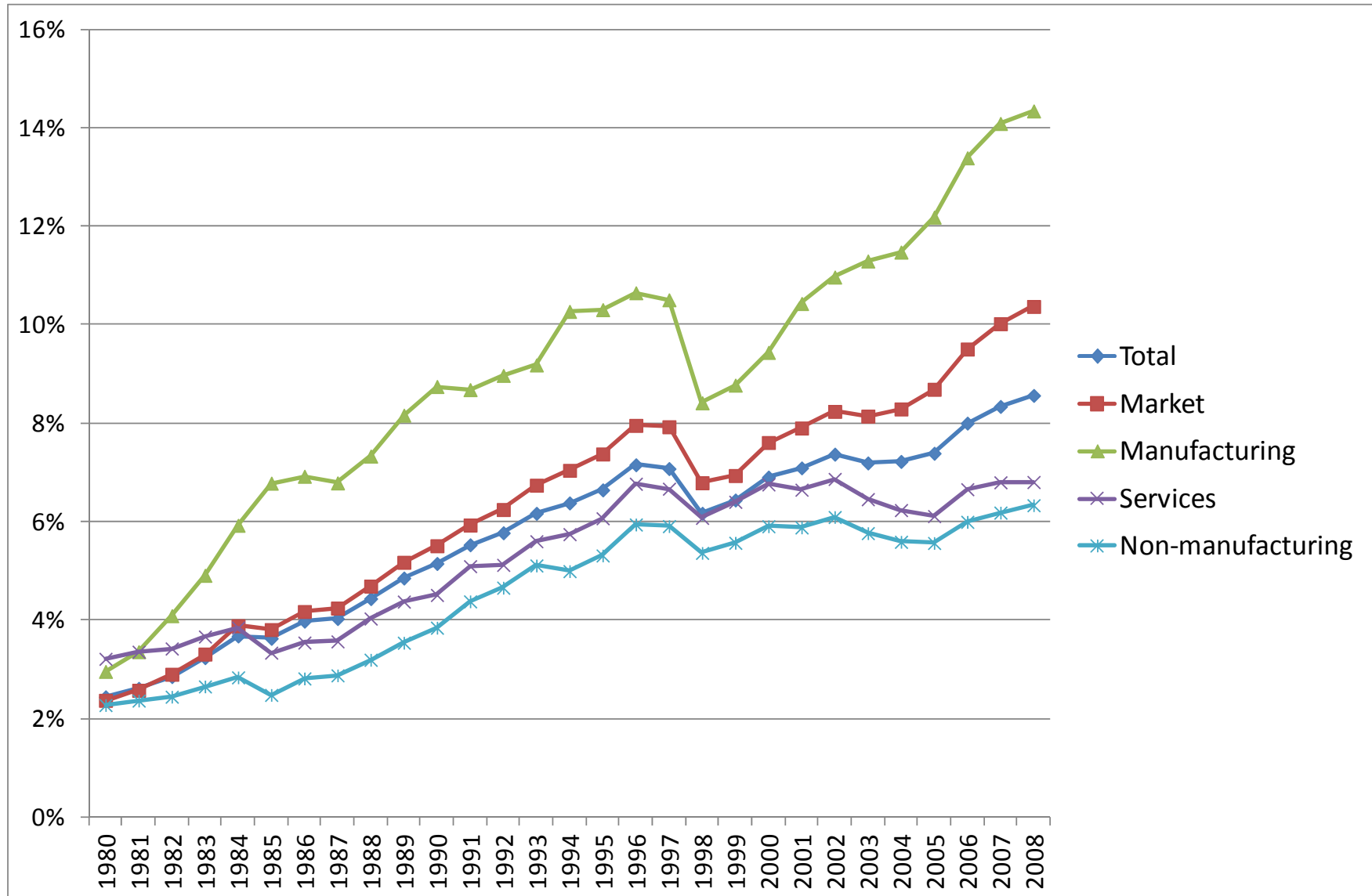
# 27-Industry Classification

No	Industry	No	Industry
1	Agriculture, forestry and fishing	14	Electricity, gas and water supply
2	Mining and quarrying	15	Construction
3	Food, beverages and tobacco	16	Wholesale and retail trade
4	Textiles and leather	17	Restaurants and hotels
5	Wood, paper, and printing	18	Transport and storage
6	Petroleum, coal and chemicals	19	Financial intermediation
7	Non-metallic mineral products	20	Real estate and renting
8	Metal, Fabricated metal products	21	Information and communication
9	Machinery equipment	22	Business services
10	Electrical and electronic equipment	23	Public administration and defense
11	Precision instruments	24	Education
12	Transport equipment	25	Health and social work
13	Furniture and other manufacturing	26	Culture and entertainment services
		27	Other service activities

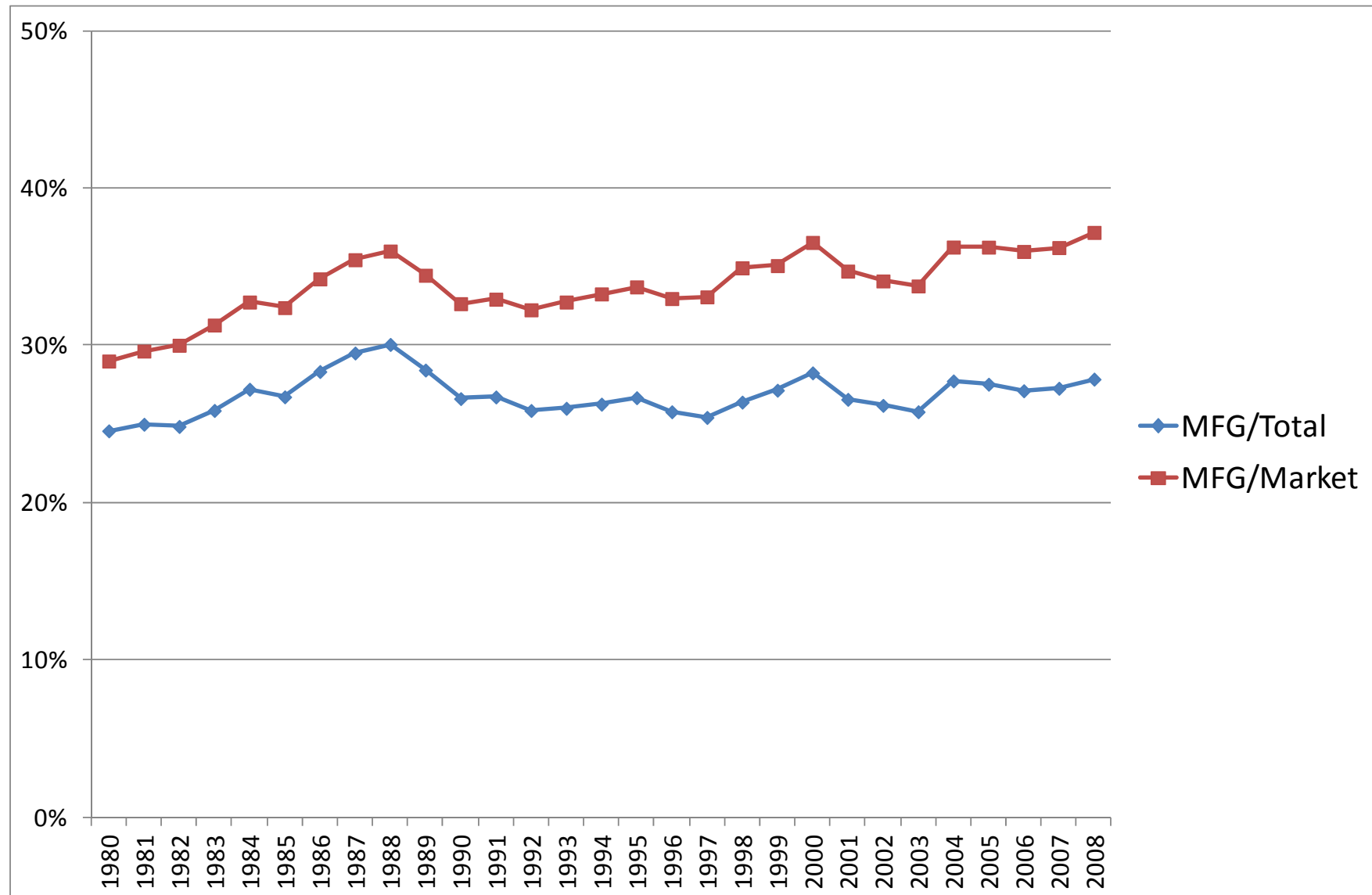
# Industry Classification

- Total Economy: 1-27
- Market Economy: excl. Real estate (20), Public administration (23), Education (24), Health and social work (25)
- Manufacturing: 3-13
- Services: 16-27
- Non-manufacturing: 1-2, 14-27

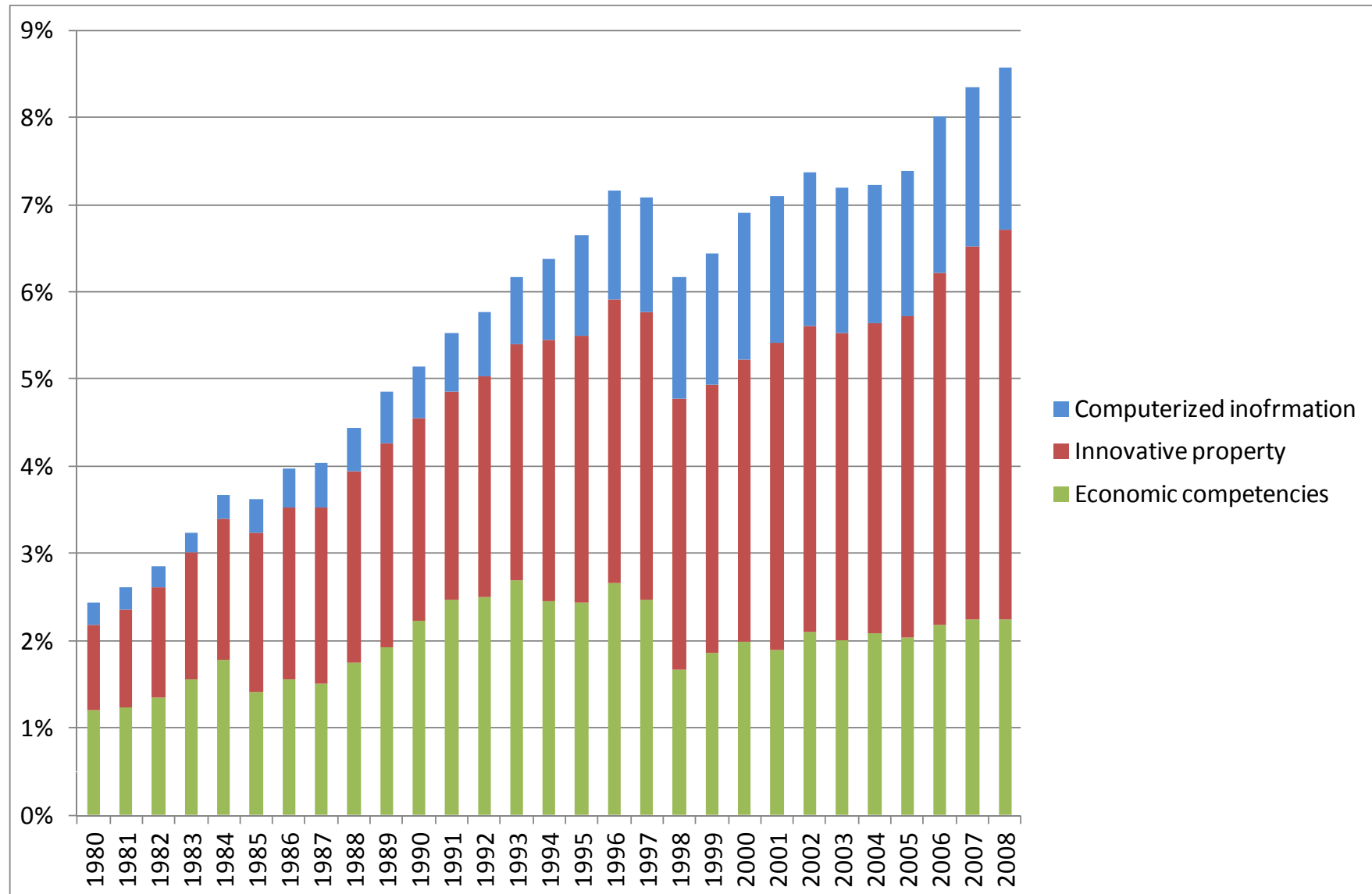
# Intangible Investment by Sector: Korea (percentage of GDP)



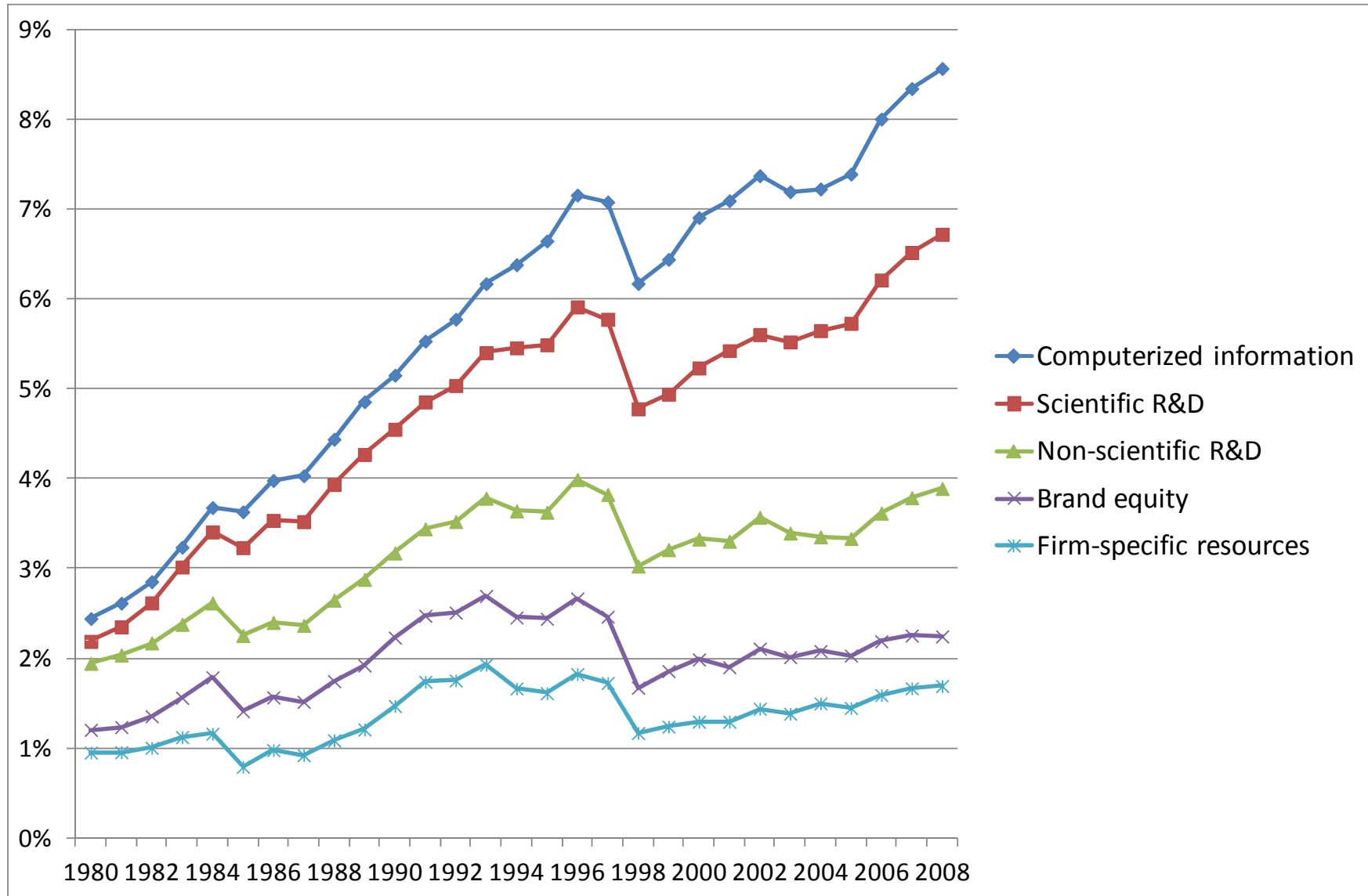
# Share of Manufacturing



# Intangible Investment by Type: Total Economy



# Intangible Investment by Type: Total Economy



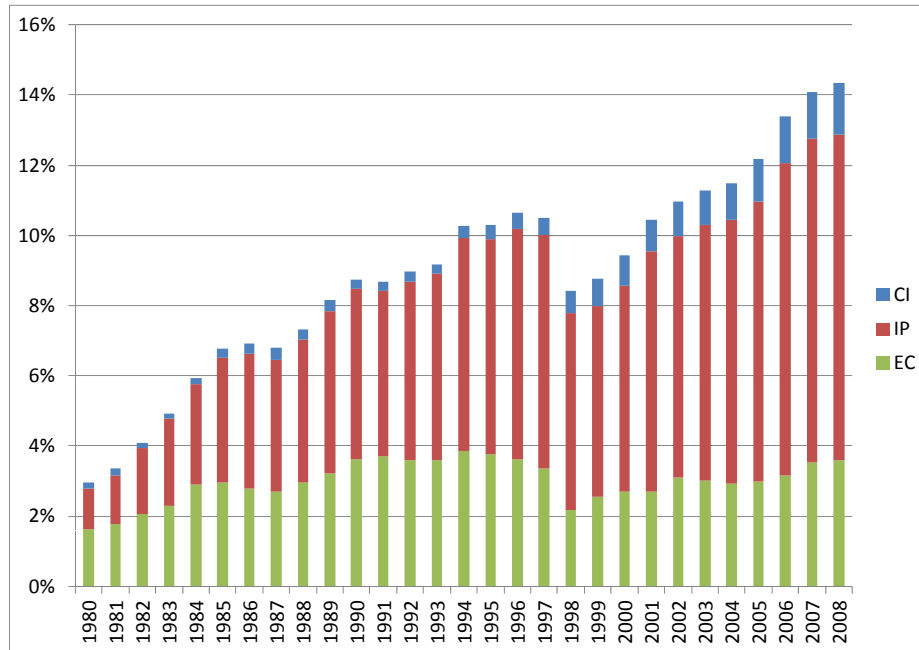
# Manufacturing versus Services

	1981-1990	1991-2000	2001-2008	1981-2008
<b>Total</b>				
CI	0.4%	1.1%	1.7%	1.0%
IP	1.8%	3.0%	3.8%	2.8%
EC	1.6%	2.3%	2.1%	2.0%
<b>Total</b>	<b>3.8%</b>	<b>6.4%</b>	<b>7.6%</b>	<b>5.9%</b>
<b>Manufacturing</b>				
CI	0.2%	0.5%	1.2%	0.6%
IP	3.3%	5.7%	8.0%	5.5%
EC	2.7%	3.3%	3.1%	3.0%
<b>Total</b>	<b>6.3%</b>	<b>9.5%</b>	<b>12.3%</b>	<b>9.2%</b>
<b>Services</b>				
CI	0.6%	1.7%	2.1%	1.4%
IP	1.7%	2.3%	2.6%	2.1%
EC	1.5%	2.1%	1.9%	1.8%
<b>Total</b>	<b>3.8%</b>	<b>6.0%</b>	<b>6.6%</b>	<b>5.4%</b>

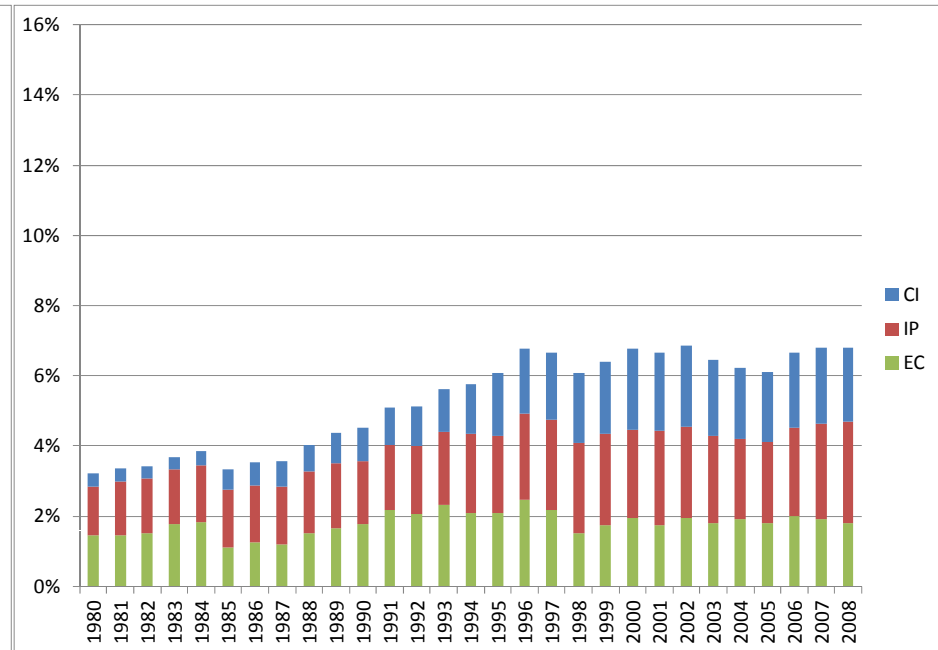


# Intangible Investment by Type: Manufacturing versus Services

## Manufacturing



## Services





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## Intangible Investment (percent of VA) in Korea: 27 industries

No	Industry	1980	1990	2000	2008
1	Agriculture, forestry and fishing	0.1%	0.2%	0.2%	0.3%
2	Mining and quarrying	1.3%	2.9%	4.4%	5.7%
3	Food, beverages and tobacco	4.7%	10.8%	10.2%	16.9%
4	Textiles and leather	1.8%	4.2%	4.0%	5.2%
5	Wood, paper, and printing	4.9%	3.4%	3.8%	5.1%
6	Petroleum, coal and chemicals	3.0%	11.6%	9.4%	12.7%
7	Non-metallic mineral products	1.1%	3.4%	2.3%	3.4%
8	Metal, Fabricated metal products	1.6%	2.8%	2.7%	4.3%
9	Machinery equipment	4.1%	9.1%	12.6%	13.6%
10	Electrical and electronic equipment	4.3%	18.7%	14.2%	29.5%
11	Precision instruments	1.4%	7.6%	9.7%	21.3%
12	Transport equipment	4.6%	9.3%	13.0%	12.1%
13	Furniture and other manufacturing industries	2.5%	5.4%	6.4%	5.3%
14	Electricity, gas and water supply	1.7%	1.8%	5.0%	13.7%
15	Construction	1.3%	4.1%	3.1%	3.1%
16	Wholesale and retail trade	1.3%	1.9%	4.1%	3.6%
17	Restaurants and hotels	5.1%	3.7%	1.5%	1.3%
18	Transport and storage	1.3%	1.5%	3.3%	2.6%
19	Financial intermediation	9.3%	15.0%	22.5%	23.0%
20	Real estate and renting	2.2%	3.9%	5.0%	2.3%
21	Information and communication	4.1%	5.1%	11.3%	16.1%
22	Business services	6.7%	8.9%	7.3%	6.3%
23	Public administration and defense	3.4%	3.8%	4.8%	3.7%
24	Education	2.8%	3.6%	4.5%	4.2%
25	Health and social work	1.9%	1.9%	2.2%	2.3%
26	Culture and entertainment services	2.3%	3.1%	4.7%	8.3%
27	Other service activities	2.4%	2.1%	4.3%	5.7%
	<b>Total Economy</b>	<b>2.4%</b>	<b>5.2%</b>	<b>6.9%</b>	<b>8.5%</b>

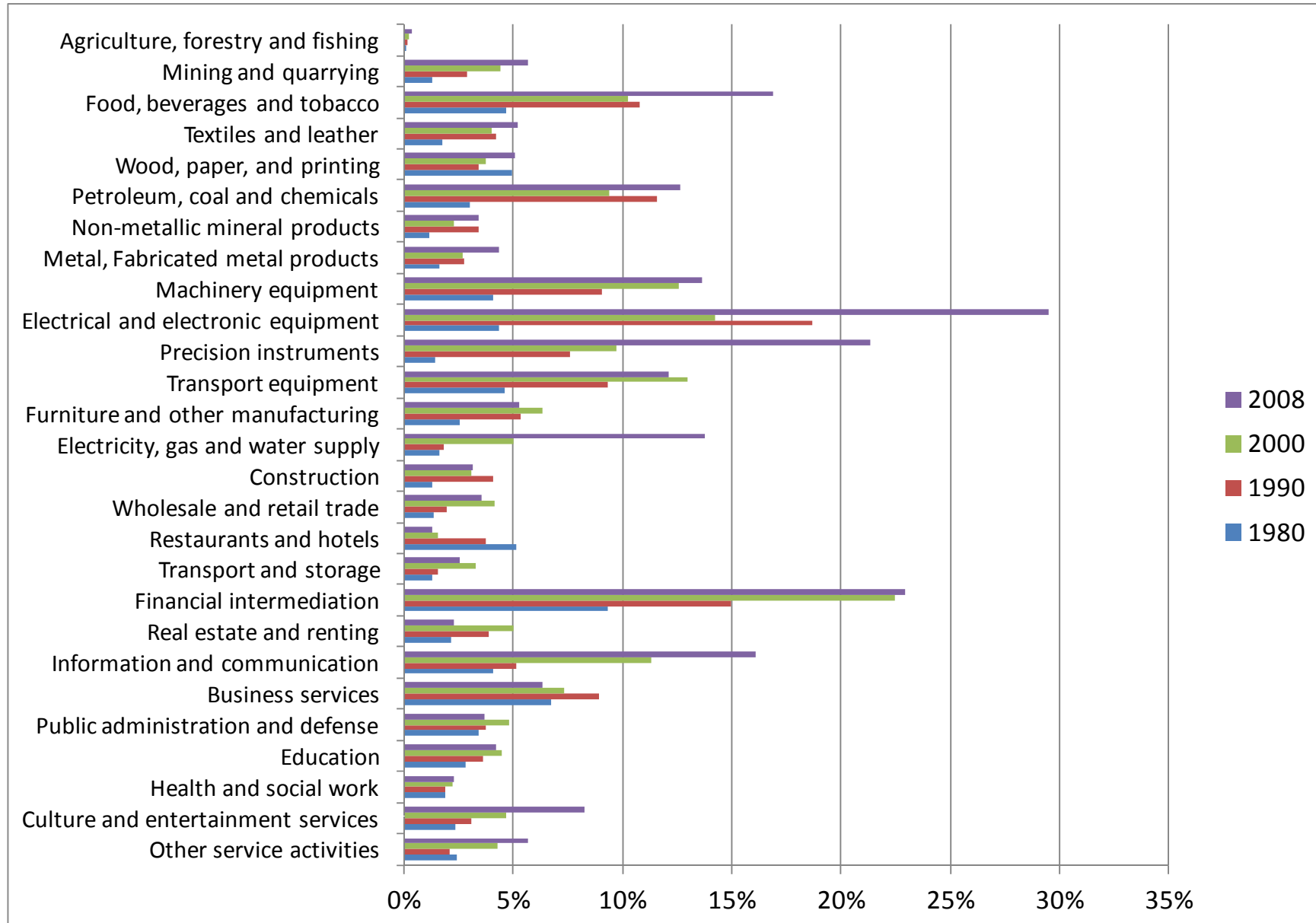
## Intangible investment (percent of VA) : 27 industries

No	Industry	1980	1990	2000	2008
1	Agriculture, forestry and fishing	0.1%	0.2%	0.2%	0.3%
2	Mining and quarrying	1.3%	2.9%	4.4%	5.7%
3	Food, beverages and tobacco	4.7%	10.8%	10.2%	16.9%
4	Textiles and leather	1.8%	4.2%	4.0%	5.2%
5	Wood, paper, and printing	4.9%	3.4%	3.8%	5.1%
6	Petroleum, coal and chemicals	3.0%	11.6%	9.4%	12.7%
7	Non-metallic mineral products	1.1%	3.4%	2.3%	3.4%
8	Metal, Fabricated metal products	1.6%	2.8%	2.7%	4.3%
9	Machinery equipment	4.1%	9.1%	12.6%	13.6%
10	Electrical and electronic equipment	4.3%	18.7%	14.2%	29.5%
11	Precision instruments	1.4%	7.6%	9.7%	21.3%
12	Transport equipment	4.6%	9.3%	13.0%	12.1%
13	Furniture and other manufacturing	2.5%	5.4%	6.4%	5.3%

# Intangible Investment (percent of VA) : 27 industries

No	Industry	1980	1990	2000	2008
14	Electricity, gas and water supply	1.7%	1.8%	5.0%	13.7%
15	Construction	1.3%	4.1%	3.1%	3.1%
16	Wholesale and retail trade	1.3%	1.9%	4.1%	3.6%
17	Restaurants and hotels	5.1%	3.7%	1.5%	1.3%
18	Transport and storage	1.3%	1.5%	3.3%	2.6%
<b>19</b>	<b>Financial intermediation</b>	<b>9.3%</b>	<b>15.0%</b>	<b>22.5%</b>	<b>23.0%</b>
20	Real estate and renting	2.2%	3.9%	5.0%	2.3%
<b>21</b>	<b>Information and communication</b>	<b>4.1%</b>	<b>5.1%</b>	<b>11.3%</b>	<b>16.1%</b>
<b>22</b>	<b>Business services</b>	<b>6.7%</b>	<b>8.9%</b>	<b>7.3%</b>	<b>6.3%</b>
<b>23</b>	<b>Public administration and defense</b>	<b>3.4%</b>	<b>3.8%</b>	<b>4.8%</b>	<b>3.7%</b>
24	Education	2.8%	3.6%	4.5%	4.2%
25	Health and social work	1.9%	1.9%	2.2%	2.3%
26	Culture and entertainment services	2.3%	3.1%	4.7%	8.3%
27	Other service activities	2.4%	2.1%	4.3%	5.7%
	<b>Total Economy</b>	<b>2.4%</b>	<b>5.2%</b>	<b>6.9%</b>	<b>8.5%</b>

## Intangible investment (percent of VA) in Korea: 27 industries





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## Intangible investment (percent of VA) by Types, 2000-2008

No	Industry	CI	IP	EC	Total
1	Agriculture, forestry and fishing	0.0%	0.1%	0.1%	0.3%
2	Mining and quarrying	0.0%	4.7%	0.3%	5.0%
3	Food, beverages and tobacco	2.0%	2.4%	7.8%	12.2%
4	Textiles and leather	0.7%	1.2%	2.9%	4.7%
5	Wood, paper, and printing	0.9%	1.6%	2.1%	4.6%
6	Petroleum, coal and chemicals	1.0%	5.3%	3.8%	10.1%
7	Non-metallic mineral products except petroleum & coal	0.2%	1.6%	1.3%	3.1%
8	Metal, Fabricated metal products	0.3%	1.4%	1.8%	3.4%
9	Machinery equipment	1.3%	7.8%	4.0%	13.1%
10	Electrical and electronic equipment	1.9%	17.4%	3.5%	22.7%
11	Precision instruments	1.8%	9.0%	2.2%	13.0%
12	Transport equipment	0.9%	10.4%	1.7%	13.0%
13	Furniture and other manufacturing industries	0.8%	2.0%	2.2%	5.0%
14	Electricity, gas and water supply	4.3%	1.2%	1.6%	7.1%
15	Construction	0.5%	1.1%	1.5%	3.1%
16	Wholesale and retail trade	1.1%	0.9%	1.9%	3.9%
17	Restaurants and hotels	0.1%	0.2%	1.1%	1.4%
18	Transport and storage	0.5%	0.5%	1.7%	2.7%
19	Financial intermediation	3.5%	14.1%	2.6%	20.1%
20	Real estate and renting	3.2%	0.1%	0.3%	3.6%
21	Information and communication	4.8%	3.4%	5.5%	13.7%
22	Business services	2.5%	2.4%	1.4%	6.3%
23	Public administration and defense	1.2%	0.4%	2.5%	4.2%
24	Education	2.8%	0.8%	1.0%	4.6%
25	Health and social work	1.1%	0.3%	0.8%	2.3%
26	Culture and entertainment services	1.4%	1.8%	3.6%	6.8%
27	Other service activities	0.9%	3.3%	0.8%	5.0%
	<b>Total Economy</b>	1.7%	3.8%	2.1%	7.6%

# Intangible Investment by Types, 2000-2008

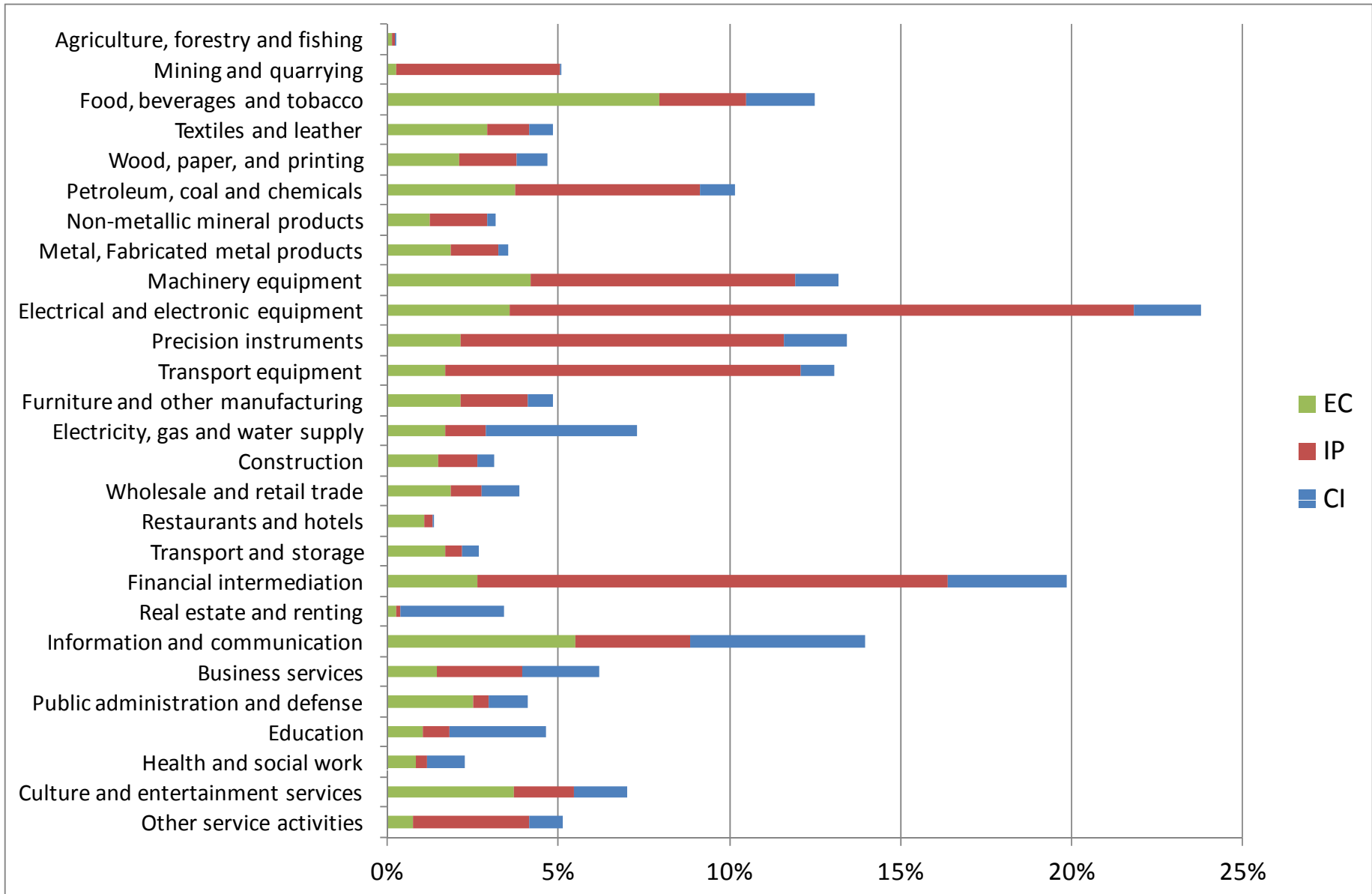
No	Industry	CI	IP	EC	Total
1	Agriculture, forestry and fishing	0.0%	0.1%	0.1%	0.3%
2	Mining and quarrying	0.0%	4.7%	0.3%	5.0%
3	Food, beverages and tobacco	2.0%	2.4%	7.8%	12.2%
4	Textiles and leather	0.7%	1.2%	2.9%	4.7%
5	Wood, paper, and printing	0.9%	1.6%	2.1%	4.6%
6	Petroleum, coal and chemicals	1.0%	5.3%	3.8%	10.1%
7	Non-metallic mineral products	0.2%	1.6%	1.3%	3.1%
8	Metal, Fabricated metal products	0.3%	1.4%	1.8%	3.4%
9	Machinery equipment	1.3%	7.8%	4.0%	13.1%
10	Electrical and electronic equipment	1.9%	17.4%	3.5%	22.7%
11	Precision instruments	1.8%	9.0%	2.2%	13.0%
12	Transport equipment	0.9%	10.4%	1.7%	13.0%
13	Furniture and other manufacturing	0.8%	2.0%	2.2%	5.0%

# Intangible Investment by Types, 2000-2008

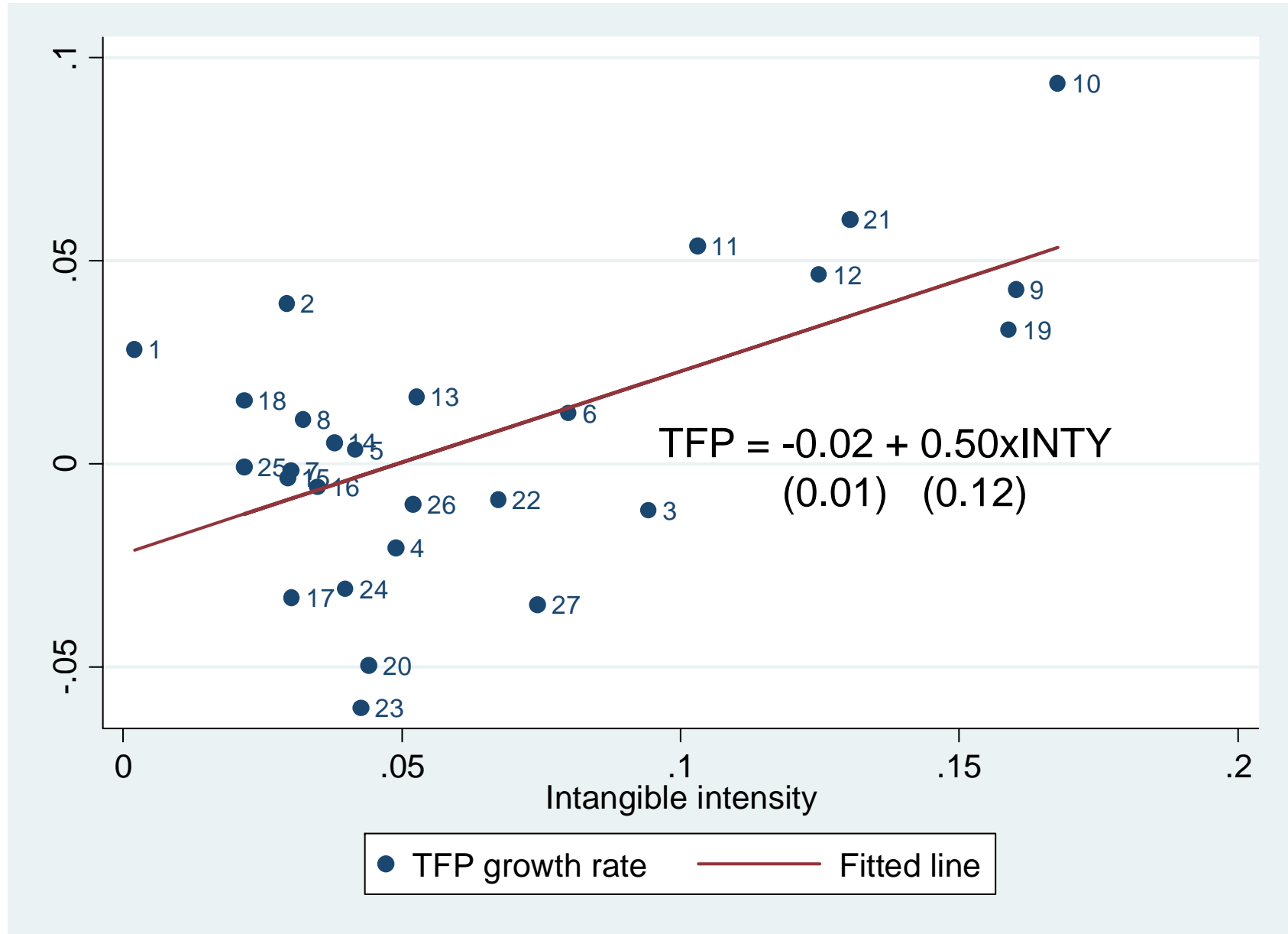
No	Industry	CI	IP	EC	Total
14	Electricity, gas and water supply	4.3%	1.2%	1.6%	7.1%
15	Construction	0.5%	1.1%	1.5%	3.1%
16	Wholesale and retail trade	1.1%	0.9%	1.9%	3.9%
17	Restaurants and hotels	0.1%	0.2%	1.1%	1.4%
18	Transport and storage	0.5%	0.5%	1.7%	2.7%
19	Financial intermediation	3.5%	14.1%	2.6%	20.1%
20	Real estate and renting	3.2%	0.1%	0.3%	3.6%
21	Information and communication	4.8%	3.4%	5.5%	13.7%
22	Business services	2.5%	2.4%	1.4%	6.3%
23	Public administration and defense	1.2%	0.4%	2.5%	4.2%
24	Education	2.8%	0.8%	1.0%	4.6%
25	Health and social work	1.1%	0.3%	0.8%	2.3%
26	Culture and entertainment services	1.4%	1.8%	3.6%	6.8%
27	Other service activities	0.9%	3.3%	0.8%	5.0%
	<b>Total Economy</b>	1.7%	3.8%	2.1%	7.6%



# Intangible Investment (percent of VA) by type in Korea: 27 industries, 2000-2008



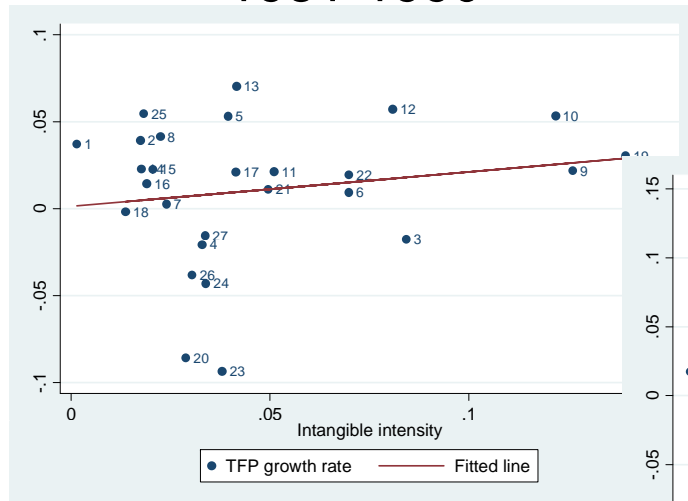
# A Correlation between TFP growth and Positive Intangible investment, 1981-2008



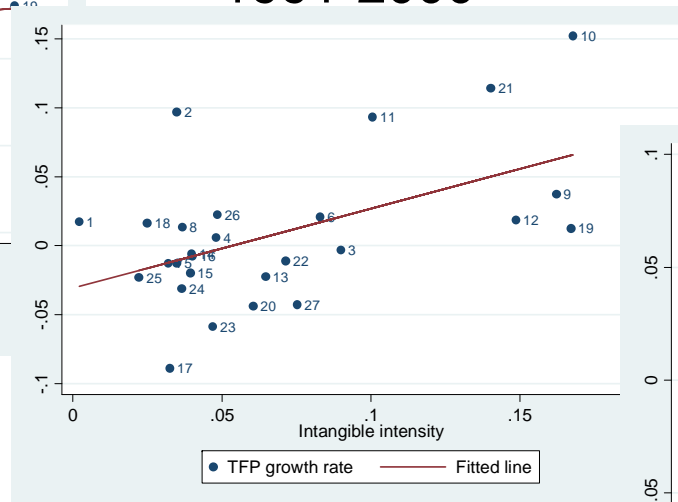
# Correlations between TFP growth and Intangible investment

- Insignificant correlation in the 1980s
- Significant and positive correlations in the 1990s and 2000s

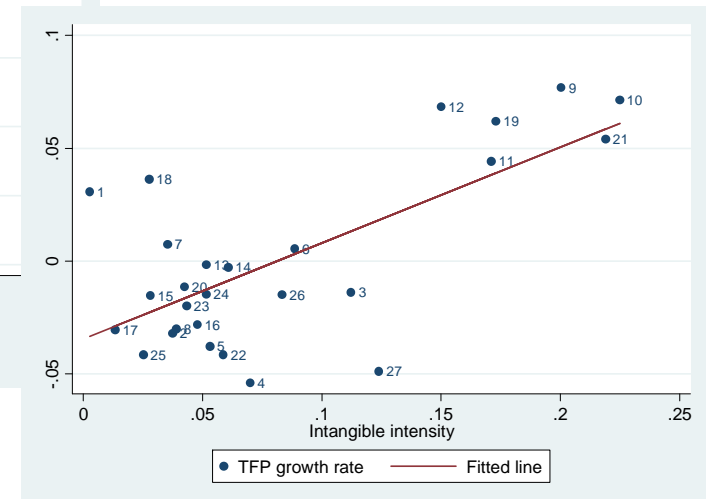
1981-1990



1991-2000

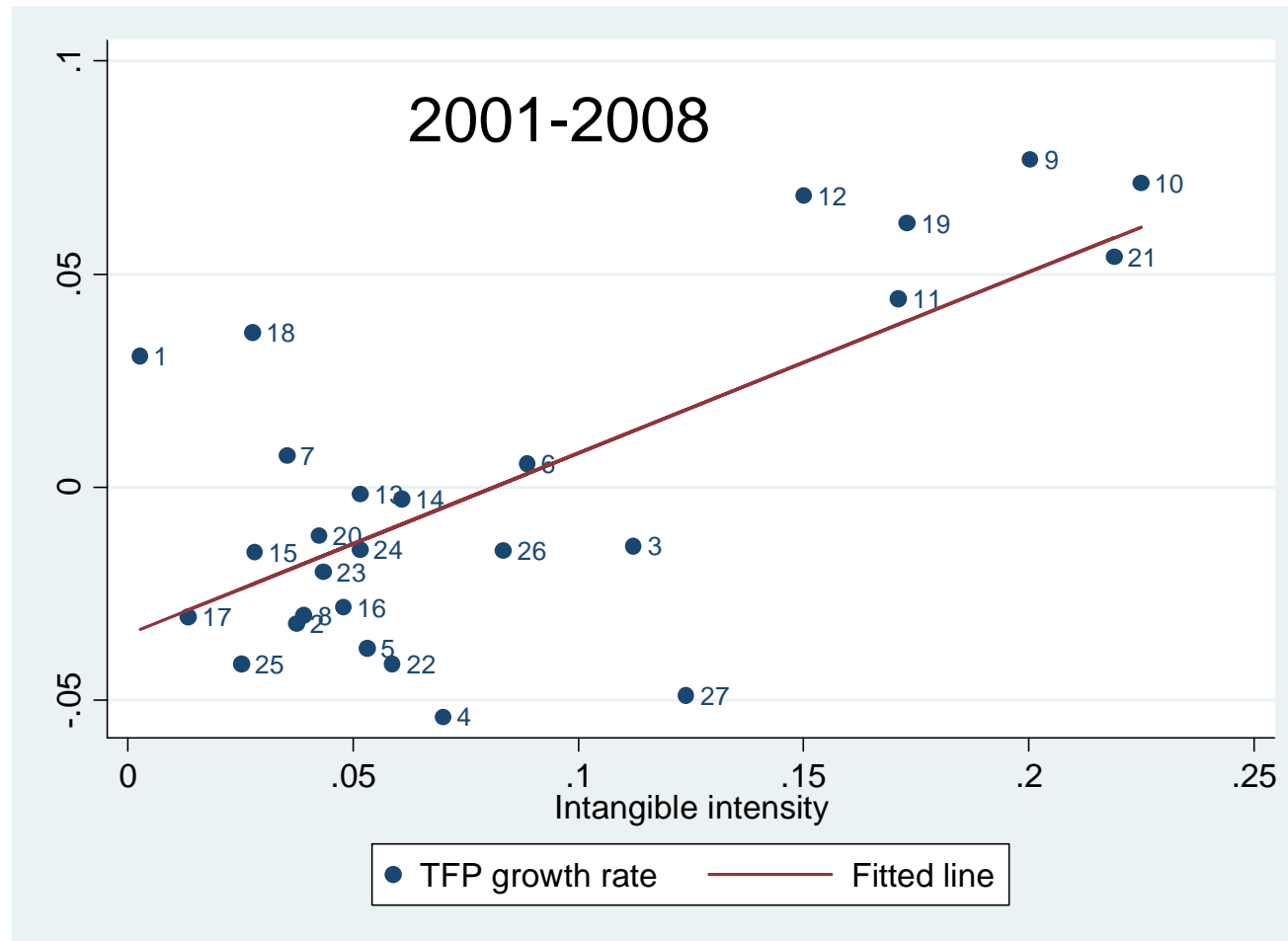


2001-2008



# Correlations between TFP growth and Intangible investment in the 2000s

- Increased TFP growth gap between intangible intensive and intangible less-intensive industries



# Regression Analysis: TFP Growth and Intangible Investment

- **Specification**

$$\Delta \ln TFP_{i,t} = \alpha + \beta \frac{I_{i,t-1}}{Y_{i,t-1}} + \mu_i + \eta_t + \varepsilon_{i,t}$$

- **Panel regressions**

- **Dependent variable: TFP growth rates**
- **Independent variable: real intangible investment (I) over real value-added (Y)**
- **Both industry and time fixed effects**

# Regression Analysis: TFP Growth and Intangible Investment

- Specification

$$\Delta \ln TFP_{i,t} = \alpha + \beta \frac{I_{i,t-1}}{Y_{i,t-1}} + \mu_i + \eta_t + \varepsilon_{i,t}$$

- **Use intangible investment-output ratio rather than intangible capital growth in order to**
  - **Estimate (excess) marginal product of intangible capital**
  - **Reduce measurement errors due to imprecise initial capital stock and depreciation rate**

# Regression Analysis: TFP Growth and Intangible Investment

- Specification

$$\Delta \ln TFP_{i,t} = \alpha + \beta \frac{I_{i,t-1}}{Y_{i,t-1}} + \mu_i + \eta_t + \varepsilon_{i,t}$$

- TFP growth over two adjacent yrs, 3-yr interval, & 5-yr interval
- Long-difference approach to reduce measurement errors
- DY(t, t-1) and X(t-1); DY(t, t-2) and X(t-3,t-5); DY(t, t-4) and X(t-5,t-9);

# Regression Results: TFP Growth and Intangible Investment

	(1)	(2)	(3)	(4)	(5)	(6)
	1-yr	1-yr	3-yr	3-yr	5-yr	5-yr
INT/Y	<u>0.147</u>		<u>0.360*</u>		<u>0.478***</u>	
	(0.145)		(0.181)		(0.142)	
CI/Y		0.718		0.923		1.043
		(0.436)		(0.857)		(0.958)
IP/Y		0.200		<u>0.475*</u>		0.498*
		(0.228)		(0.268)		(0.279)
EC/Y		-0.048		0.027		0.306
		(0.187)		(0.221)		(0.205)
Obs.	729	729	216	216	135	135
Adj. R2	0.125	0.126	0.160	0.162	0.116	0.106

INT: total intangibles; CI: computerized information;  
 IP: innovative property; EC: economic competencies  
 \*, \*\*, \*\*\* significant at the 10, 5%, 1% level, respectively



# Regression Results: 1981-1995 versus 1996-2008

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	1yr	1yr	1yr	1yr	3yr	3yr	3yr	3yr	5yr	5yr	5yr	5yr
	1981- 1995	1981- 1995	1996- 2008	1996- 2008	1981- 1995	1981- 1995	1996- 2008	1996- 2008	1981- 1995	1981- 1995	1996- 2008	1996- 2008
INT/Y	0.299 (0.276)		<u>0.503**</u> (0.209)		0.401 (0.280)		<u>0.619**</u> (0.246)		0.427 (0.586)		<u>0.788***</u> (0.233)	
CI/Y		0.571 (0.990)		-0.087 (0.532)		-0.338 (1.261)		-0.425 (0.715)		0.372 (2.137)		0.207 (0.550)
IP/Y		<u>0.672*</u> (0.393)		<u>0.614*</u> (0.324)		<u>1.056***</u> (0.297)		<u>0.582**</u> (0.275)		<u>1.632**</u> (0.634)		<u>0.821**</u> (0.387)
EC/Y		-0.088 (0.193)		0.390 (0.411)		-0.483** (0.223)		0.716 (0.488)		-0.202 (0.221)		<u>0.751**</u> (0.358)
Obs.	378	378	351	351	108	108	108	108	54	54	81	81
Adj. R2	0.096	0.100	0.190	0.188	0.036	0.122	0.342	0.339	-0.003	0.170	0.243	0.227

\*, \*\*, \*\*\* significant at the 10, 5%, 1% level, respectively

# Summary

- **Role of Intangibles in productivity growth in Korea**
  - **Significant in the recent period of 1996-2008 compared to the earlier period**
  - **Significant only for innovative property investment**
  - **Significant for both IP and EC only in the recent period**
- **Overall, the increased importance of intangibles in productivity growth of the Korean economy**

## Next Step

- Construct stock variables
  - Deflators
  - Depreciation rate
- Growth accounting analysis
  - Tangible versus intangible investments
  - Manufacturing versus services
- Investigating
  - The role of intangible investment in the production structure: substitutability or complementarity
  - Relationship between intangibles and productivity growth