

Productivity Analysis and Industry Database in Japan

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1 Why is productivity so important for the recent Japanese economy?

2 TFP measurement in Japan

3 Industry database in Japan

4 Topics about productivity analysis

(1) TFP movements in business cycles

(2) Has the IT revolution contributed to the Japanese productivity growth?

1 Why is productivity so important for the recent Japanese economy?

- In the 1990s, the Japanese economy recorded 1% growth, while the U. S. economy continued 3% growth (in the second half, the U. S. economy attained 4% growth).
- Not only the U.S., the east Asian countries such as China and Korea recorded higher growth rate than Japan.

Table 1 Economic growth rate in the U. S., Korea, China and Japan

(%)

	1990/80	2000/90	1995/90	2000/95
The U. S.	3.2	3.2	2.4	4.0
Korea	8.6	6.2	7.5	4.9
China	9.3	10.1	12.0	8.3
Japan	4.1	1.4	1.4	1.4

Source: IMF International Financial Statistics

Why has the Japanese economy stagnated so long?

I Mismanagement of macroeconomic policies

- Inappropriate fiscal policies
- Inappropriate monetary policies

II Productivity slowdown (Hayashi and Prescott(2002))

- Malfunctions of financial intermediation system due to the huge bad loans → misallocation of the loan market led to the survival of low productivity firms (Caballero, Hoshi and Kashyap (2004)).
- The Japanese old industrial structure did not fit the IT revolution.
- Korea and China have caught up the technology level in Japan.

2 TFP measurement in Japan (1)

- Many empirical studies of TFP growth in Japan showed the productivity slowdown in the 1990s.
- However, there are several different results in industry base.
- Policies promoting productivity depend on which sector suffers from productivity slowdown.

Table 2 Comparison of Empirical Studies on Japan's TFP growth in 1990s (Inui and Kwon (2004))

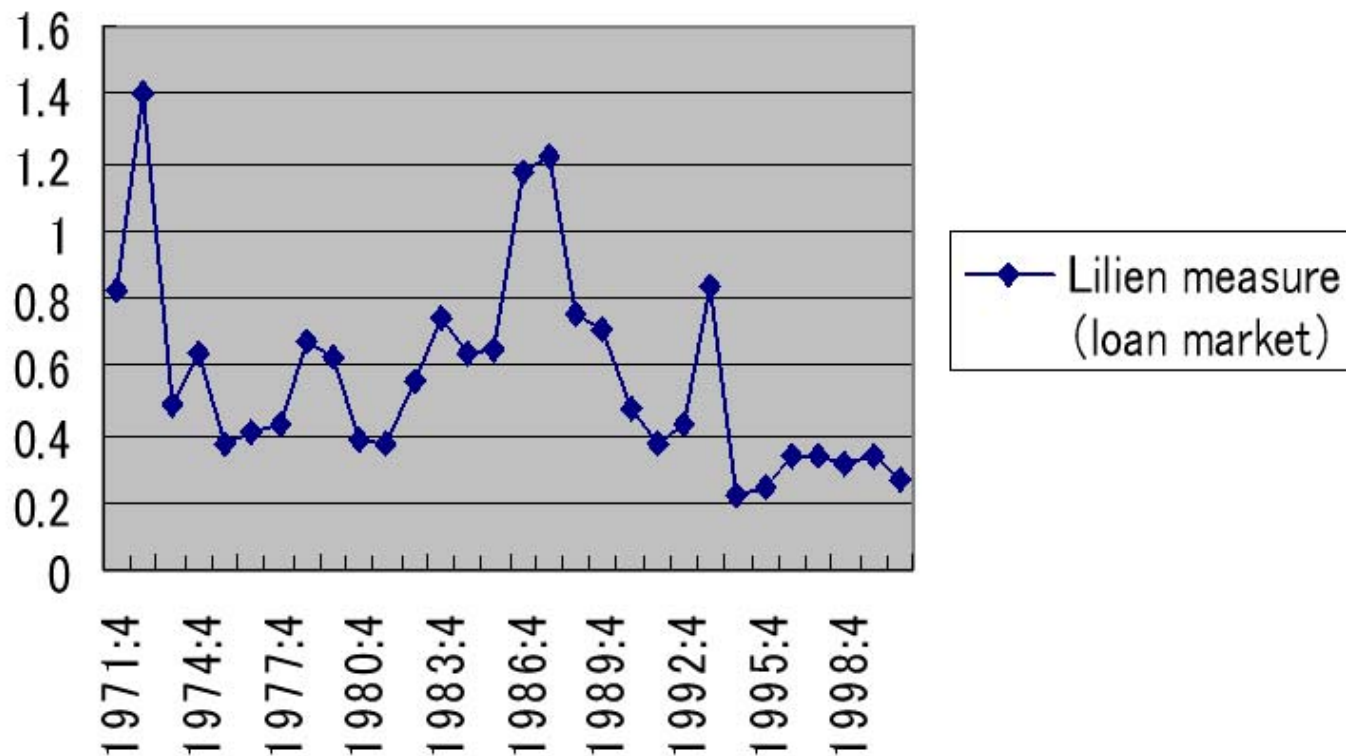
Study	Estimated annual TFP growth rate		
	Macro level	Manufacturing sector	Non-manufacturing sector
Hayashi and Prescott (2002)	1983-91: 2.36% 1991-00: 0.19%		
Yoshikawa and Matsumoto (2001)	1980-90: 1.20% 1990-98: -0.90%	1980-90: 2.5% 1990-98: 0.3%	1980-90: 0.5% 1990-98: -1.3%
Hattori and Miyazaki (2000)	1987-93: 1.20% 1994-97: -0.60%	1987-93: 1.61% 1994-97: 1.54%	1987-93: 1.61% 1994-97: -1.43%
Cabinet Office, Government of Japan (2002)	1981-90: 1.60% 1991-00: 0.20%	1981-90: 2.1% 1991-00: 1.8%	1981-90: 1.3% 1991-00: -0.3%
Nishimura and Minetaki (2004)		1981-89: 2.67% 1990-98: 0.30%	1981-89: 1.21% 1990-98: -0.26%
Miyagawa (2003)	1981-90: 1.63% 1991-99: 0.84%	1981-90: 2.81% 1991-99: 1.37%	1981-90: 1.18% 1991-99: 0.64%
Fukao, Inui, Kawai, and Miyagawa (2004)	1983-91: 0.40% 1991-98: 0.03%	1983-91: 0.78% 1991-98: -0.16%	1983-91: -0.15% 1991-98: 0.27%
Jorgenson and Motohashi (2003)	1975-90: 1.01% 1990-98: 0.89%		
Kawamoto (2004)	Private sector 1980-90: 1.9% Private sector 1990-98: 1.9%	Durable manufacturing 1980-90: 2.8% 1990-98: 1.4% Non-durable manufacturing 1980-90: 1.7% 1990-98: 1.9%	1980-90: 1.6% 1990-98: 2.1%

2 TFP measurement in Japan (2)

- Productivity slowdown is induced by not only the slowdown of technological progress, but also by misallocation of production factors and malfunction of financial intermediation system.
- We need official industry database to measure correct TFP.

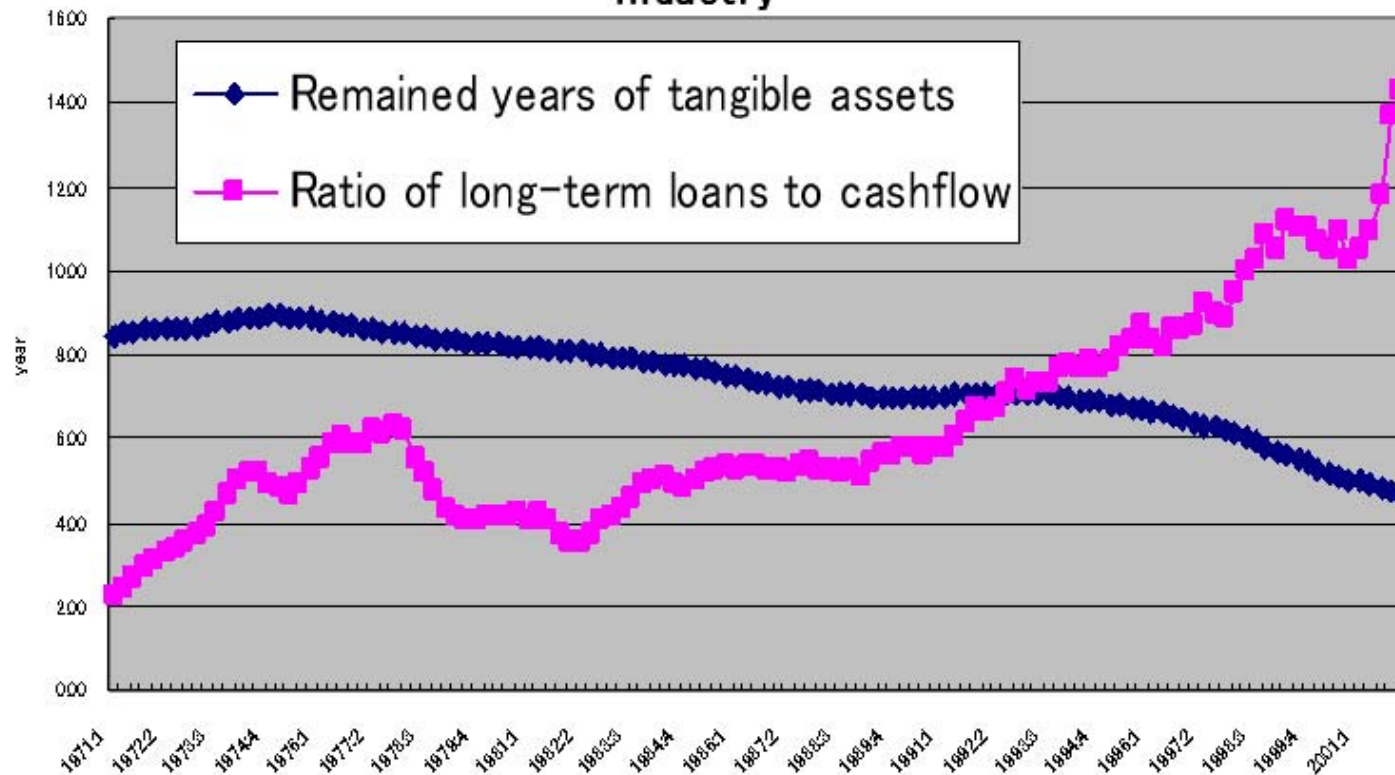
Productivity slowdown induced by misallocation of loan market

Figure 1 Lilien measure (loan market)



Debt-overhang generates in a low productivity industry

Figure 2 Debt-overhang in building and construction industry



3 Industry database in Japan(1)

- In Japan, academic researchers provide industry database. →KEO database and JIP database
- Recently, many researchers measure TFP and study the Japanese economy using the above databases.
- However, academic groups cannot extend these databases regularly.

Comparison of the KEO database, JIP database, and various government statistics (National Accounts, SNA Input-Output-tables, Private capital stock Statistics)

		KEO database	JIP database	National accounts, SNA Input-Output Table, Private Capital Stock Statistics
Publishing organization		Institute for Economic and Industry Studies, Keio University	Economic and Social Research Institute, Cabinet Office, Government of Japan Research project "Japan's Potential Growth"	Economic and Social Research Institute, Cabinet Office, Government of Japan, Department of National Accounts
Deflator		1995 constant prices	1990 constant prices	Price of base year
Consistency with SNA		Yes	No	-
Production and intermediate inputs	Industry	43 categories (including waste recycling, crude oil, natural gas, steel, other non-competing imports)	84 categories (including some categories of social capital)	National Accounts: 24 categories (table V), SNA Input-Output Table: 89 categories (68SNA-based, before 1980 there exist only 63 categories)
	Periods	1960-2000	1970, 1973-1998	National Accounts: 1970 onwards; SNA Input-Output Table: 1955, 60, 65, 70, 75, 80, 85-2000
	Estimation method	KEO-RAS	RAS	SNA Input-Output Table: RAS
	Derivation of real values	Linked price indices of base years (1965, 1970, 1975, 1980, 1985) using the 1995 price index	Linked real series of 1980, 1990, 1995 prices	Fixed price index for the entire period

Labor	Categories	Industry	43 categories	89 categories	26 categories (23 categories for working hours)
		Sex	2 categories (male, female)	2 categories (male, female)	-
		Age	11 categories (15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-)	15 categories (15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85-)	-
		Status of employment	3 categories: Employees (regular employees+executives), Self-employed (self-employed employing others+self-employed not employing others+home workers), Family workers	2 categories: Salaried employees (regular employees+executives), Non-salaried employees (self-employed+family workers)	-
		Educational attainment	4 categories: Junior high school (formerly: Elementary school): High school (formerly: Middle school): Higher professional school, Two-year college, or University undergraduate	4 categories: Junior high school (formerly: Elementary school): High school (formerly: Middle school): Higher professional school, Two-year college, or University undergraduate	-
	Periods	1960-2000	1970-2000	1970 onwards	
	Estimation method	KEO-RAS	RAS	-	
	Data	Number of workers, Working hours, Wages	Number of workers, Working hours, Labor compensation	Number of workers, Working hours	
Capital	Categories	Industry	43 categories (including some categories of social capital)	84 categories (including some categories of social capital)	29 categories
		Capital goods	78 categories	37 categories (capital goods categories of BEA)	-
	Periods	1955-2000	1970-1998	1955 onwards	
	Treatment of fixed capital depreciation	Estimated based on <i>National Wealth Survey</i> (1960) and <i>National Wealth Survey</i> (1970). Depreciation rates of some assets are newly estimated	Depreciation rate used by BEA	Estimated using information on replacement and loss in <i>Financial Statements Statistics of Corporations</i>	
	Definition of capital stock	Net capital stock	Net capital stock	Gross capital stock	
	Estimation method	KEO-RAS (Double benchmark) perpetual inventory method	RAS, Single Benchmark year method	Double benchmark year method; other methods	
Supplementary tables			-	Trade statistics by industry and country; Inward and outward direct investment statistics; Service trade statistics by industry; Statistics on market structure, regulations, price differentials between import and domestic prices; Index of capacity utilization rate; R&D stock and cost of R&D stock	-

3 Industry database in Japan(2)

- Remaining problems to construct new industry database
 - (1) Correct measurement of output in the non-manufacturing sector
 - (2) Constructing capital stock reflecting appropriate production efficiency
 - (3) Measurement of software stock
 - (4) Measurement of operating rates in the non-manufacturing sector

3 Industry database in Japan(3)

- (4) Measurement of operating rates in the non-manufacturing sector
- (5) How to treat lease asset and workers in labor dispatching industry
- (6) Measurement of wage in self-employed workers
- (7) Measurement of human capital, especially how do we measure on the job training costs
- (8) Construction of deflator reflecting technological progress

4-1 TFP movements in business cycles (1)

- The previous database is annual time series.
- We cannot study cyclical features of productivity in these databases.
- Miyagawa, Sakuragawa, and Takizawa (2005) constructed TFP series by industry based on quarterly *Financial Statements Statistics of Corporations* data published by Ministry of Finance to check the cyclicity of TFP.

4-1 TFP movements in business cycles (2)

- TFP is procyclical in the Japanese economy.
- Procyclicality of TFP is induced not only by technological shocks, but also by increasing returns to scale, mark-up ratio, aggregate demand externality in the sense of Diamond (1982), and labor hoarding.
- Estimation results of Hall and Basu and Fernald type production function show that technological shocks are crucial in the Japanese economy.

Solow residual and the Japanese business cycles

(Miyagawa, Sakuragawa, and Takizawa(2005))

	Expansion		Recession	
	GDP growth	Growth of Solow residual	GDP growth	Growth of Solow residual
1980:1–1983:1			2.83	-1.11
1983:1–1985:2	3.77	0.23		
1985:2–1986:4			3.19	0.55
1986:4–1991:1	5.42	-0.15		
1991:1–1993:4			0.73	-4.08
1993:4–1997:2	1.72	0.06		
1997:2–1999:1			0.45	-0.99
1999:1–2000:4	2.46	4.35		
2000:4–2002:1			-1.79	-5.34
2002:1–2002:4	3.18	1.54		

Correlation between growth of Solow residual and business cycle indices

	All industries	Manufacturing	Non-manufacturing
TFP growth & DI	0.260	0.134	0.240
	(2.785)	(1.395)	(2.558)
TFP growth & Difference of CI	0.401	0.260	0.348
	(4.531)	(2.791)	(3.834)

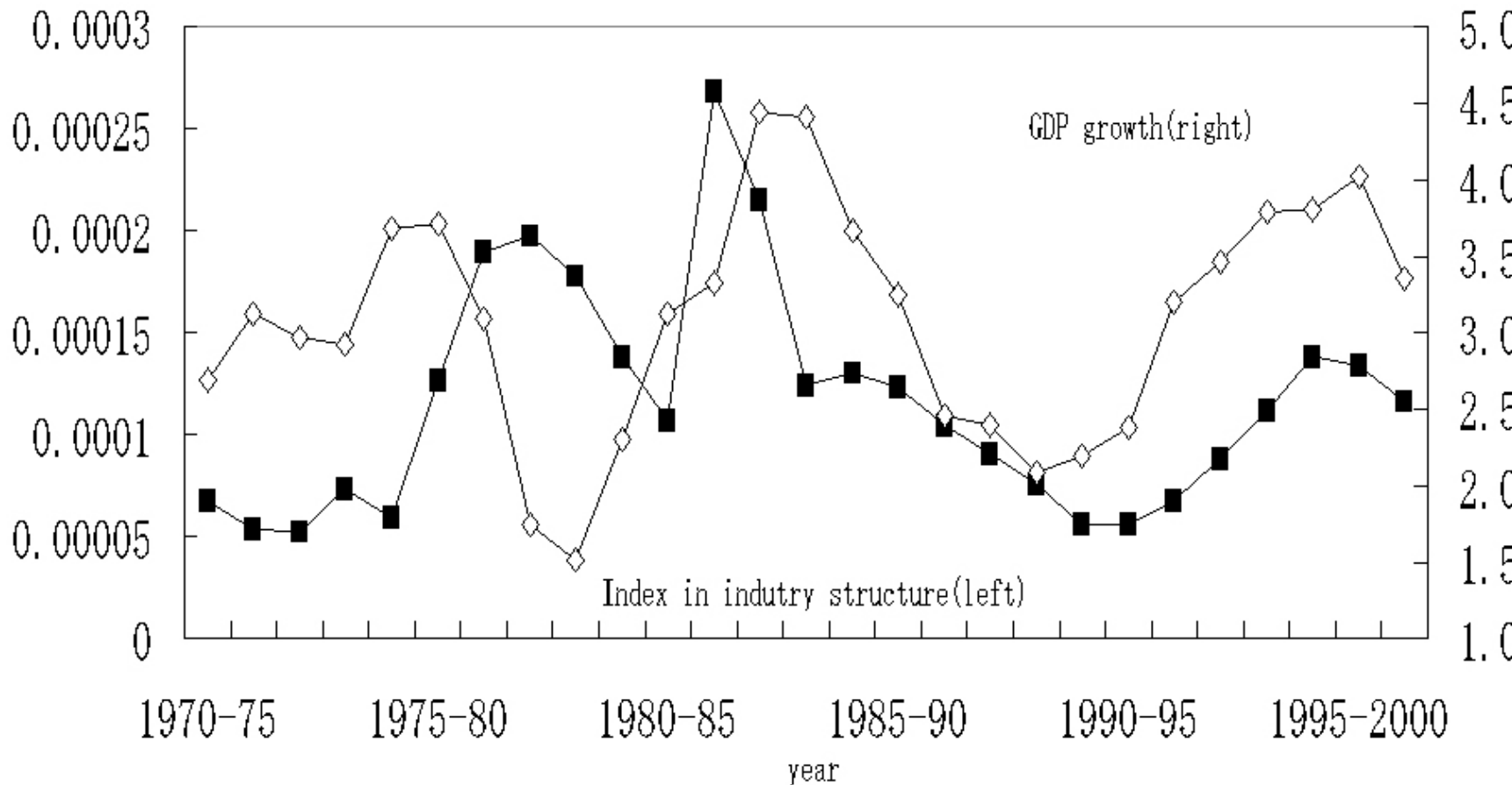
Note: The figures in parentheses are t ratios.

Source: Authors' calculations.

4-2 Has the IT revolution contributed to the Japanese productivity growth? (1)

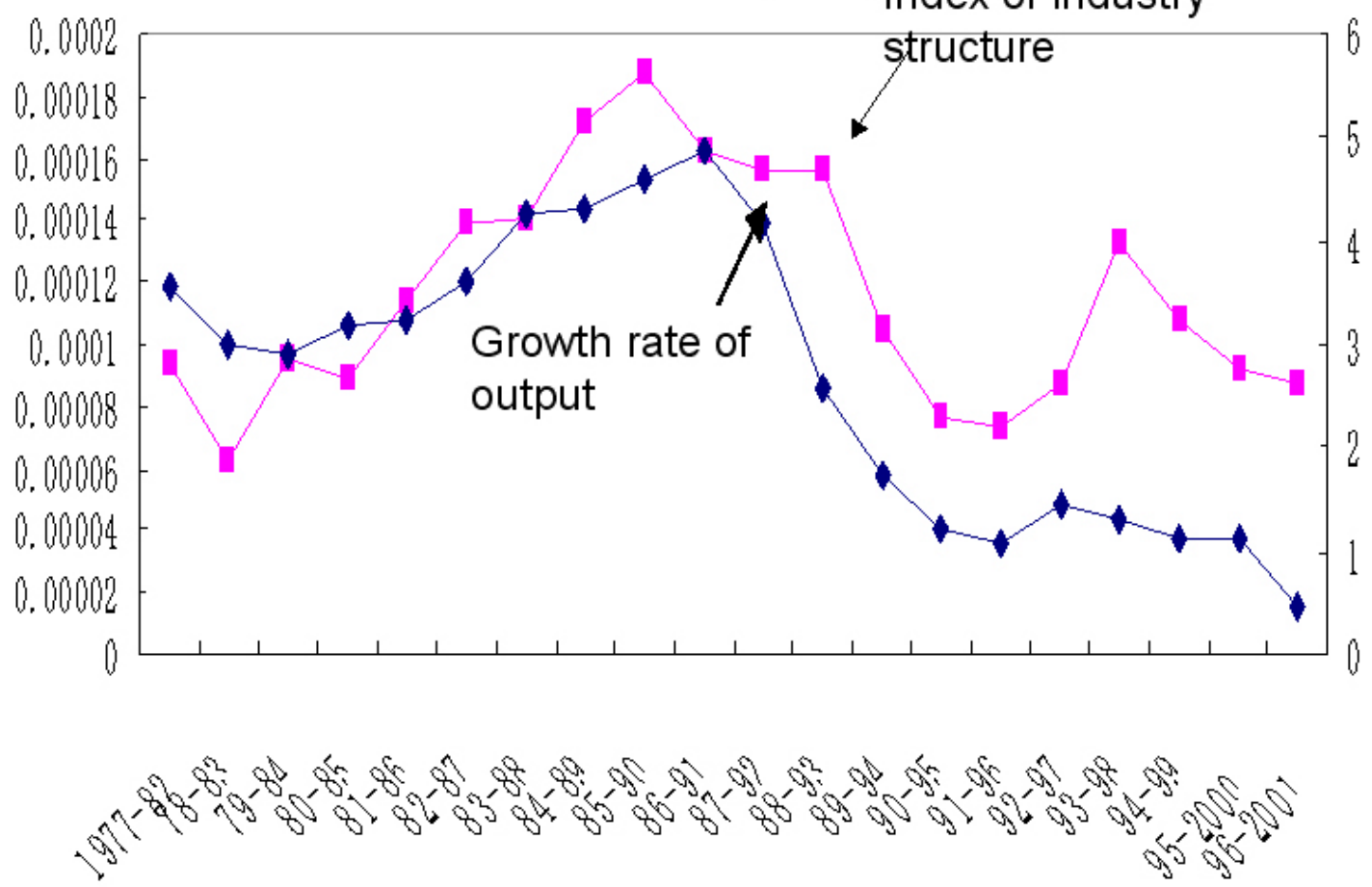
- When the share of high productivity industries rises, the economic growth in the whole economy is stimulated.
- In the US, the IT revolution promoted the reform in industry structure and the high economic growth rate in the 90s was attained.
- On the other hand, the change in industry structure was very small.

Figure 3 Change in industry structure and economic growth (US) %



%

Figure 4 Change in industry structure and economic growth (Japan)



4-2 Has the IT revolution contributed to the Japanese productivity growth? (2)

- IT investment in Japan (private sector) reached 27 trillion yen. It dominates 30% of total private capital formation.
- However, it has not increased monotonically. Since 1990, its movement has seemed cyclical.
- However, its share has increased monotonically since the second half of the 90s.

Figure 5 IT investment in Japan

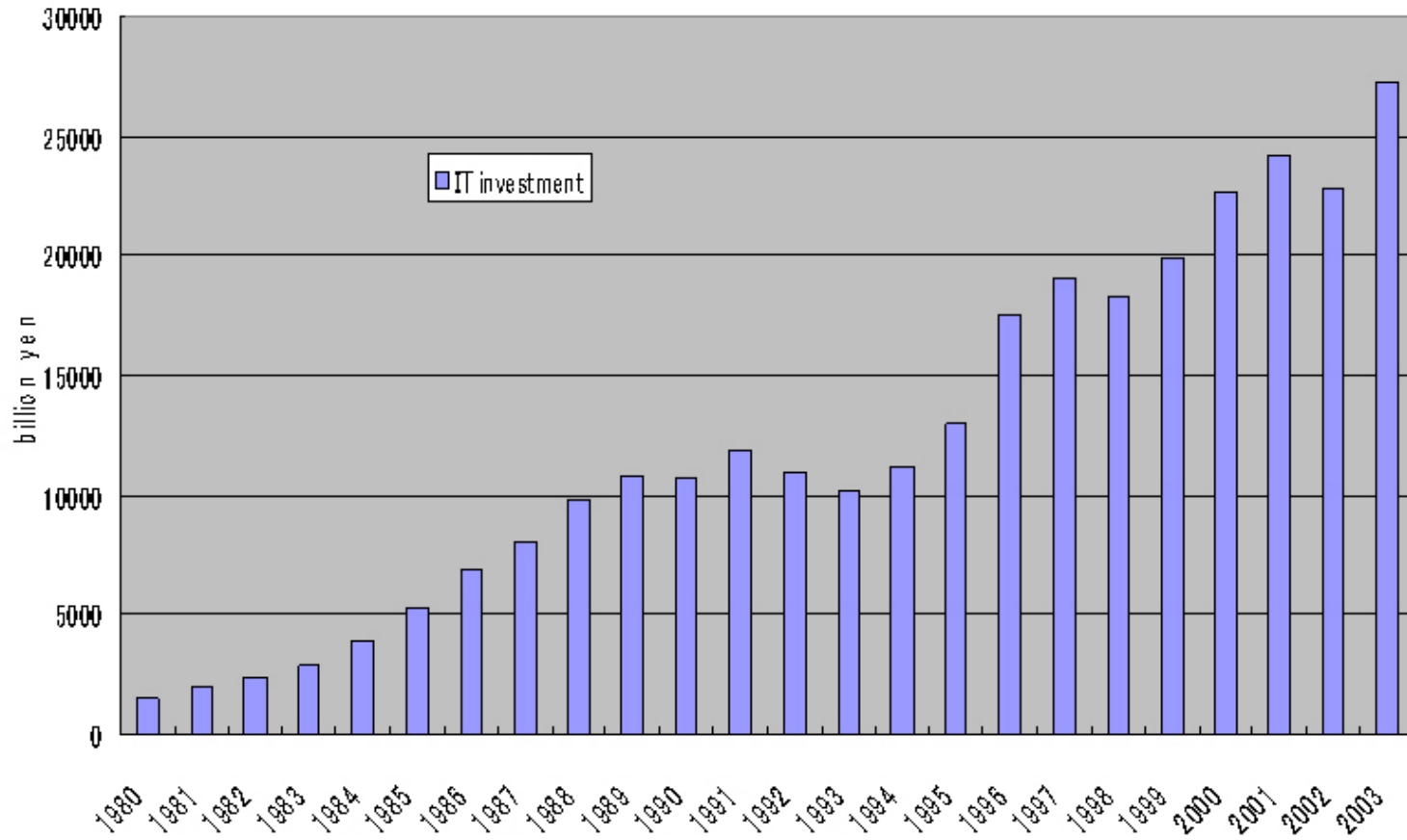
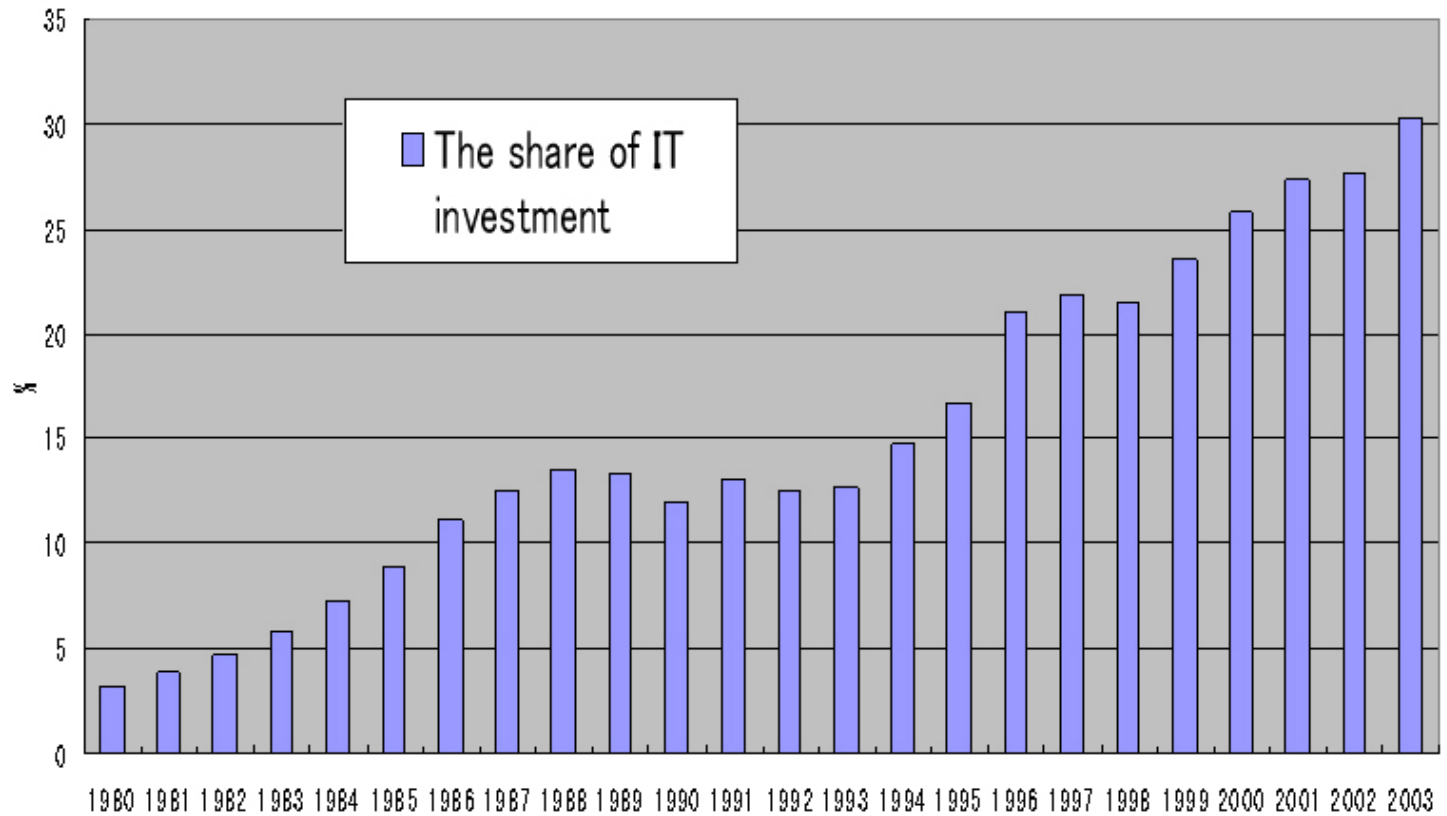


Figure 6 The share of IT investment



4-2 Has the IT revolution contributed to the Japanese productivity growth? (3)

- In the U. S., the contribution rate of IT capital to annual labor productivity growth was about 35% in the first half of the 90s, and about 40% in the second half of the 90s.
- In European countries, the contribution rate of IT capital in the 90s was from 10% to 20%.
- According to the study by Cabinet Office, the contribution rate of IT capital in the 90s was 18% in Japan. However, the rate increased drastically in the second half of the 90s.

Table 4

Author(s)	Country Coverage	Time Period	Contribution of ICT Capital to		Contribution of TFB in ICT Production to	
			Annual GDP Growth	Annual Labor Productivity Growth	Annual GDP Growth	Annual Labor Productivity Growth
Oliner and	U.S.	1991–95	0.57 out of 2.8	0.51 out of 1.5		
Sichel (2000)		1996–99	1.10 out of 4.8	0.96 out of 2.6		
Jorgenson (2001)	U.S.	1990–95		0.43 out of 1.2		0.25 out of 1.2
		1995–99		0.89 out of 2.1		0.50 out of 2.1
Mairesse, Cette,	France	1989–95	0.16 out of 1.3			
and Kocoglu		1995–99	0.27 out of 2.2			
(2000)						
Oulton (2001)	U.K.	1989–94		0.39 out of 2.6		
		1994–98		0.62 out of 1.6		
Jalava and	Finland	1990–95	0.3 out of –0.3	0.5 out of 4.4	0.7 out of –0.3	0.7 out of 4.4
Pohjola (2001)		1995–99	0.7 out of 5.6	0.6 out of 3.2	1.2 out of 5.6	1.2 out of 3.2

Notes: All estimates refer to total economy GDP, except for Oliner and Sichel (2000) which refers to business sector GDP; all estimates on the contribution of ICT capital include software except for CPB (2000).

Author(s)	Country Coverage	Time Period	Contribution of ICT Capital to		Contribution of TFP in ICT Production to Annual Labor Productivity Growth
			Annual GDP Growth	Annual Labor Productivity Growth	
Schreyer (2000)	Canada	1990-96	0.28 out of 1.7		
	France	1990-96	0.17 out of 0.9		
	Germany	1990-96	0.19 out of 1.8		
	Italy	1990-96	0.21 out of 1.2		
	Japan	1990-96	0.19 out of 1.8		
	U.K.	1990-96	0.28 out of 2.1		
	U.S.	1990-96	0.42 out of 3.0		
European Commission (2000)	EU	1991-95		0.2-0.3 out of 2.0	0.1 out of 2.0
	EU	1995-99		0.3-0.5 out of 1.5	0.2 out of 1.5

Table 5 Contribution of IT Capital Stock to Labor Productivity Growth (Miyagawa, Ito and Harada (2004))

	1980-90	1980-85	1985-90	1990-2000	1990-95	1995-2000
Labor Productivity	3.8	2.8	4.8	1.1	1.7	0.6
Intra-Sectoral Capital Deepening	1.7	1.6	1.8	1.0	1.2	0.9
IT Capital Deepening	0.6	0.4	0.7	0.2	0.1	0.3
Efficiency Effects of Capital Deepening	0.0	-0.1	0.0	0.0	-0.1	0.0
IT Capital Deepening	0.0	0.0	0.0	0.0	0.0	0.0
Efficiency Effects of Labor Shifts	0.2	0.9	-0.4	-0.4	0.4	-1.2
Intra-sectoral TFP Growth	1.8	0.3	3.4	0.6	0.2	0.9

4-2 Has the IT revolution contributed to the Japanese productivity growth? (4) -The network effect of IT

- The network effect is ambiguous in the U. S.
- Miyagawa, Ito and Harada (2004) showed positive network effects partly.
- The recent study of Cabinet office estimated that the contribution rate of network effect was 13-14% from 1995 to 2003.

Table 6 Decomposition of Labor Productivity (Cabinet Office)

	IT capital	Non-IT capital	Network effect	Others
1980-85	18.8%	77.3%	17.9%	-14.0%
85-90	25.6%	41.2%	20.9%	12.2%
90-95	21.3%	88.7%	6.7%	-16.7%
95-2000	40.9%	49.2%	13.5%	-3.5%
2000-03	59.4%	64.3%	14.8%	-38.6%

Summary (1)

- 1 To understand the long-term stagnation of the Japanese economy, the productivity is a key factor.
- 2 However, recent researches depend on the databases which academic researchers constructed.
- 3 We need official industry database to provide suitable policies promoting productivity.

Summary (2)

- 4 To construct new industry database, we have to overcome several problems generated by the change in the recent industrial structure.
- 5 In Japan, procyclicality of TFP is induced by technological shocks.
- 6 The recession in the first half of the 90s delayed the IT revolution in Japan.
- 7 However, IT capital accumulation has contributed to labor productivity growth since 1995.

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Comparison of Empirical Studies on Japan's TFP growth in 1990s

Study	Period	Outputs	Capital services		Labor Services			Share	Adjustment of deflator for IT products	Assumptions on market structure	Production technology	Estimated annual TFP growth rate		
			Capital stock and capital service prices	Capital utilization	Labor quality	Hours worked	Macro level					Manufacturing sector	Non-manufacturing sector	
Hayashi and Prescott (2002)	1960-2000	GNP (based on 1968 SNA)	Net capital stock estimated by the perpetual inventory method. Net foreign assets and inventories are included in the capital stock.	Unadjusted	Unadjusted	Adjusted by total hours worked	Income share within value added (fixed)	Unadjusted	Perfect competition in both output and input markets	Constant returns to scale (CRS)	1983-91: 2.36% 1991-00: 0.19%			
Yoshikawa and Matsumoto (2001)	1980-1999	GDP (based on 1968 SNA), sectoral value added	Gross capital stock of private enterprises (statistics published by the Cabinet Office)	Unadjusted	Unadjusted	Not reported	Income share within value added (fixed)	Unadjusted	Perfect competition in both output and input markets	CRS	1980-90: 1.20% 1980-90: 2.5% 1980-90: 0.5% 1990-98: -0.90% 1990-98: 0.3% 1990-98: -1.3%			
Hattori and Miyazaki (2000)	1978-1997	GDP (based on 1968 SNA), sectoral value added	Gross capital stock of private enterprises (statistics published by the Cabinet Office)	Adjusted by capacity-utilization rate only in the case of manufacturing sectors	Unadjusted	Adjusted by total hours worked	Income share within value added (fixed)	Unadjusted	Perfect competition in both output and input markets	CRS	1987-93: 1.20% 1987-93: 1.61% 1987-93: 1.61% 1994-97: -0.60% 1994-97: 1.54% 1994-97: -1.43%			
Cabinet Office, Government of Japan (2002)	1981-2000	GDP (based on 1993 SNA), sectoral value added	Gross capital stock of private enterprises (statistics published by the Cabinet Office)	Adjusted by capacity-utilization rate both in the manufacturing sectors and in the non-manufacturing sectors	Unadjusted	Adjusted by hours worked in each sector	Income share within value added (fixed)	Unadjusted	Perfect competition in both output and input markets	CRS	1981-90: 1.60% 1981-90: 2.1% 1981-90: 1.3% 1991-00: 0.20% 1991-00: 1.8% 1991-00: -0.3%			
Nishimura and Minetaki (2003)	1975-1998	Sectoral value added (based on 1968 SNA)	Net capital stock and service prices of five capital goods (JCER database)	Adjusted by assuming that the capital is a quasi-fixed factor	Adjusted by age, education attainment, and type of occupation	Adjusted by hours worked in each sector	Cost share	Adjusted by IT deflator of the US ("harmonized approach")	Perfect competition in input markets	CRS	1981-89: 2.67% 1981-89: 1.21% 1990-98: 0.30% 1990-98: -0.26%			
Miyagawa (2003)	1981-1999	GDP (based on 1993 SNA), sectoral value added	Net capital stock and service prices of five capital goods (JCER database)	Adjusted by capacity-utilization rate in the case of manufacturing sectors and adjusted by information on electricity input in the case of non-manufacturing sectors	Unadjusted	Adjusted by hours worked in each sector	Income share within value added (fixed)	Unadjusted	Perfect competition in both output and input markets	CRS	1981-90: 1.63% 1981-90: 2.81% 1981-90: 1.18% 1991-99: 0.84% 1991-99: 1.37% 1991-99: 0.64%			
Fukao, Inui, Kawai, and Miyagawa (2003)	1970-1998	GDP (based on 1968 SNA), sectoral gross output	Net capital stock and service prices of 37 capital goods (JIP database)	Adjusted by capacity-utilization rate in the case of manufacturing sectors and adjusted by diffusion indices on excess capacity (BOJ) in the case of non-manufacturing sectors (JIP Database)	Adjusted by gender, age and education attainment (JIP database)	Adjusted by hours worked in each sector	Cost share	Unadjusted	Perfect competition in input markets	CRS	1983-91: 0.40% 1983-91: 0.78% 1983-91: -0.15% 1991-98: 0.03% 1991-98: -0.16% 1991-98: 0.27%			
Jorgenson and Motohashi (2003)	1975-1998	Based on their own definition of GDP	Net capital stock and service prices of 62 capital goods plus input of land, inventory stock, software, and durable consumption goods	Not explicitly adjusted	Adjusted by gender, age, education attainment, and type of occupation (KEO database)	Adjusted (KEO database)	Cost share	Adjusted by IT deflator of the US ("harmonized approach")	Perfect competition in input markets	CRS	1975-90: 1.01% 1990-98: 0.89%			
Kawamoto (2004)	1973-1998	GDP (based on 1968 SNA), sectoral gross output	Net capital stock and service prices of 37 capital goods (JIP database)	Changes in hours per worker is used as a proxy for unobserved changes in both labor effort and capital utilization	Adjusted by gender, age and education attainment (JIP database)	Adjusted by hours worked in each sector (statistics published by the Ministry of Welfare and Labor)	Cost share	Unadjusted	Perfect competition in input markets	CRS is not assumed.	Private sector 1980-90: 1.9 Durable manufacturing 1980-90: 2.8% 1980-90: 1.6% 1990-98: 1.4% Non-durable manufacturing 1980-90: 1.7% 1990-98: 2.1% 1990-98: 1.9%			

Source: Inui and Kwon (2004) and the papers listed.