Productivity in the Japanese Economy: Growth Accounting, ICT Investment, and Resource Reallocation

Prepared for the Workshop on Productivity Database in China, Japan, and Korea

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1. Overview of Economic Growth and Productivity Improvement in EU KLEMS Database

- **The first public-release version of the EU KLEMS database became available online at the EU KLEMS website, http://www.euklems.net/ on March 15.**
- **There have been few studies which compare TFP growth and the impact of the ICT revolution in the major EU economies, Japan and the US (and Korea) at the industry level, probably because of the lack of appropriate data for a broad and rigorous international comparison.**

1. Overview (contd.)

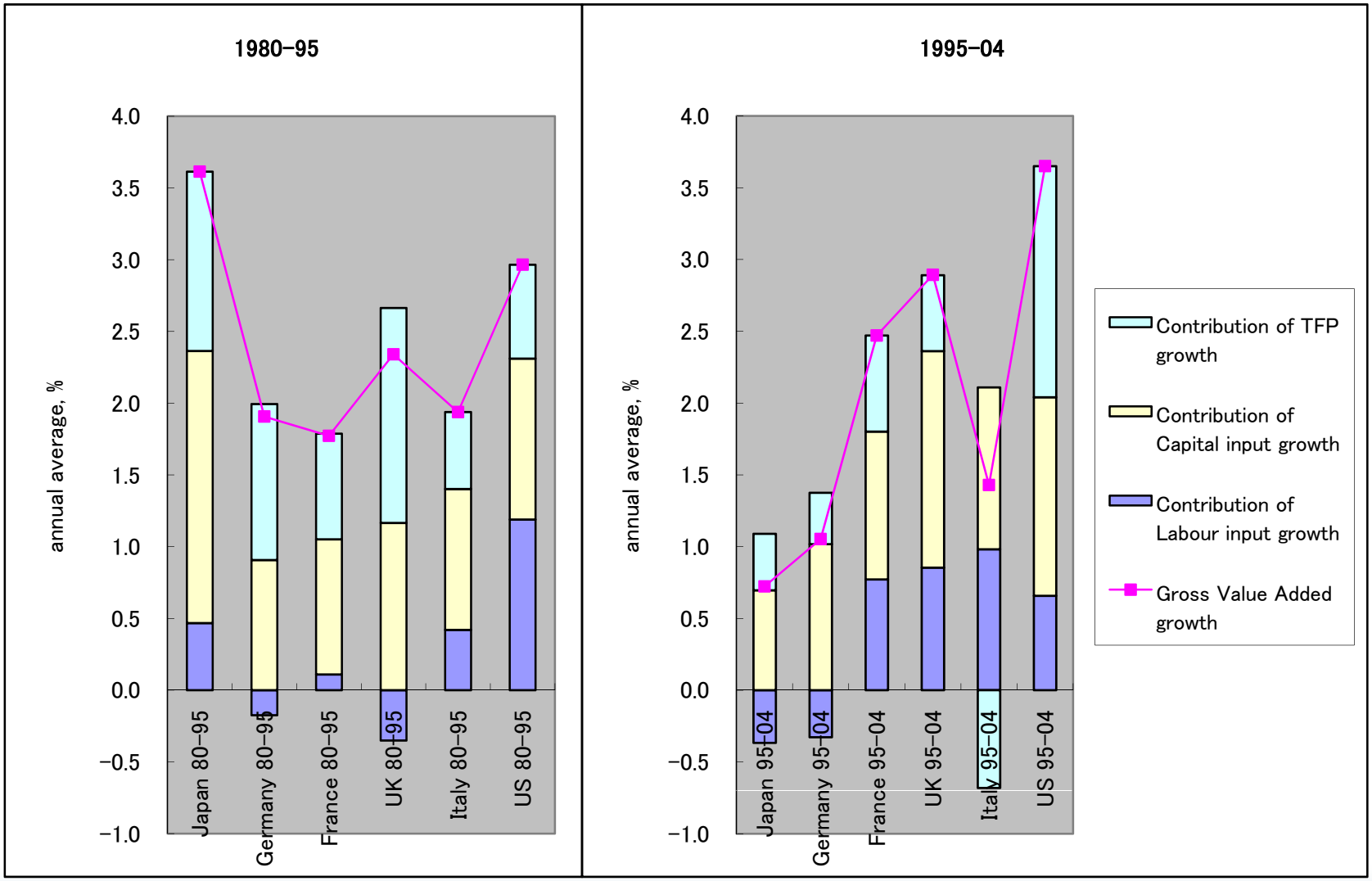
- **Japan's economic growth stalled:**

  1973-1995: 3.3%

  1995-2004: 1.0% (lowest among the US, Japan, Germany, France, the UK and Italy).

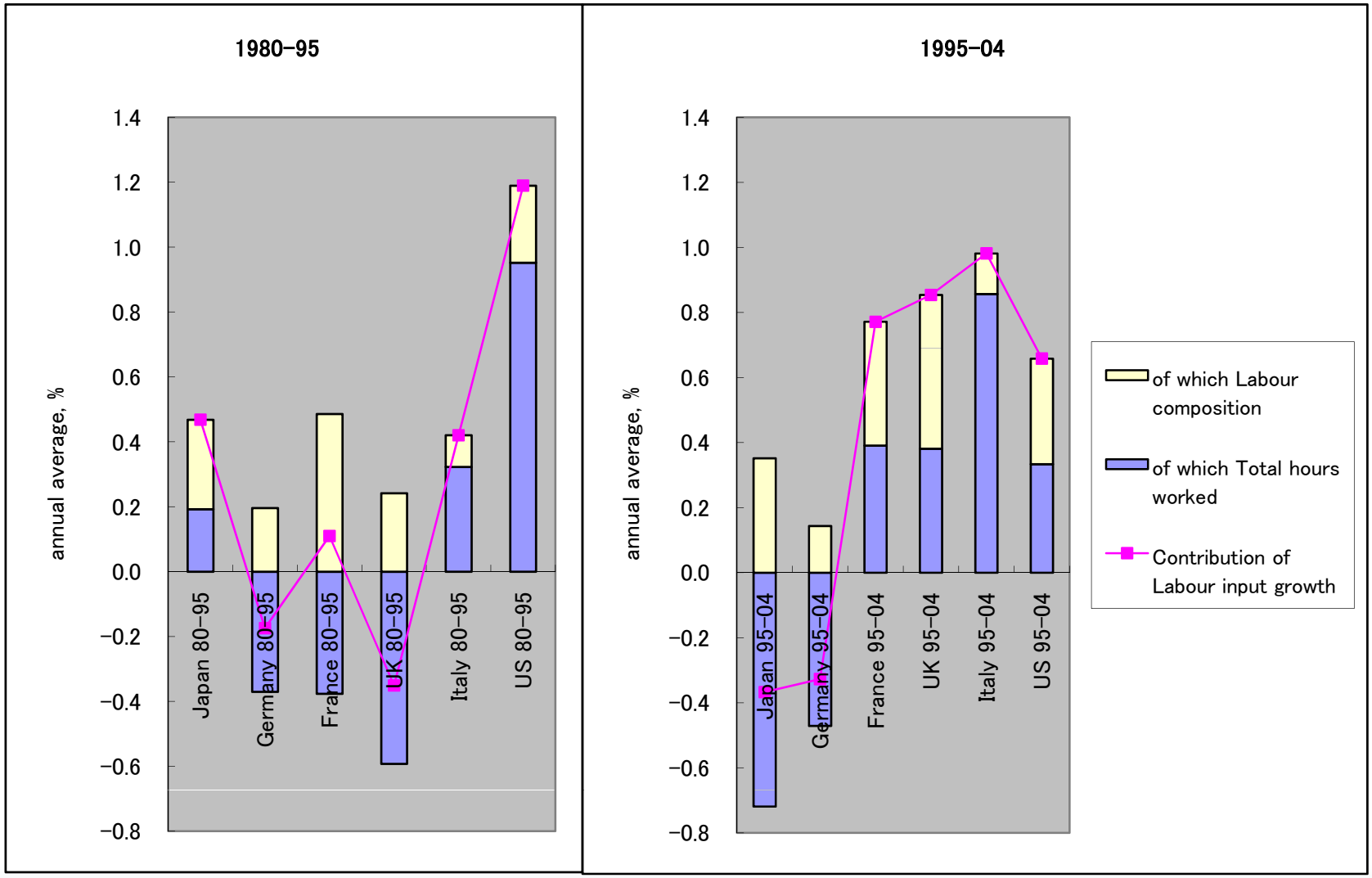
- **It is not the gap in TFP growth but differences in factor input growth that caused the large difference in the economic growth performance of France, the UK and Italy, which registered acceleration in economic growth after 1995, on the one hand and Japan on the other in the period after 1995.**

Figure 1. Growth Accounting of the Market Economy in Japan, US and EU Core Countries



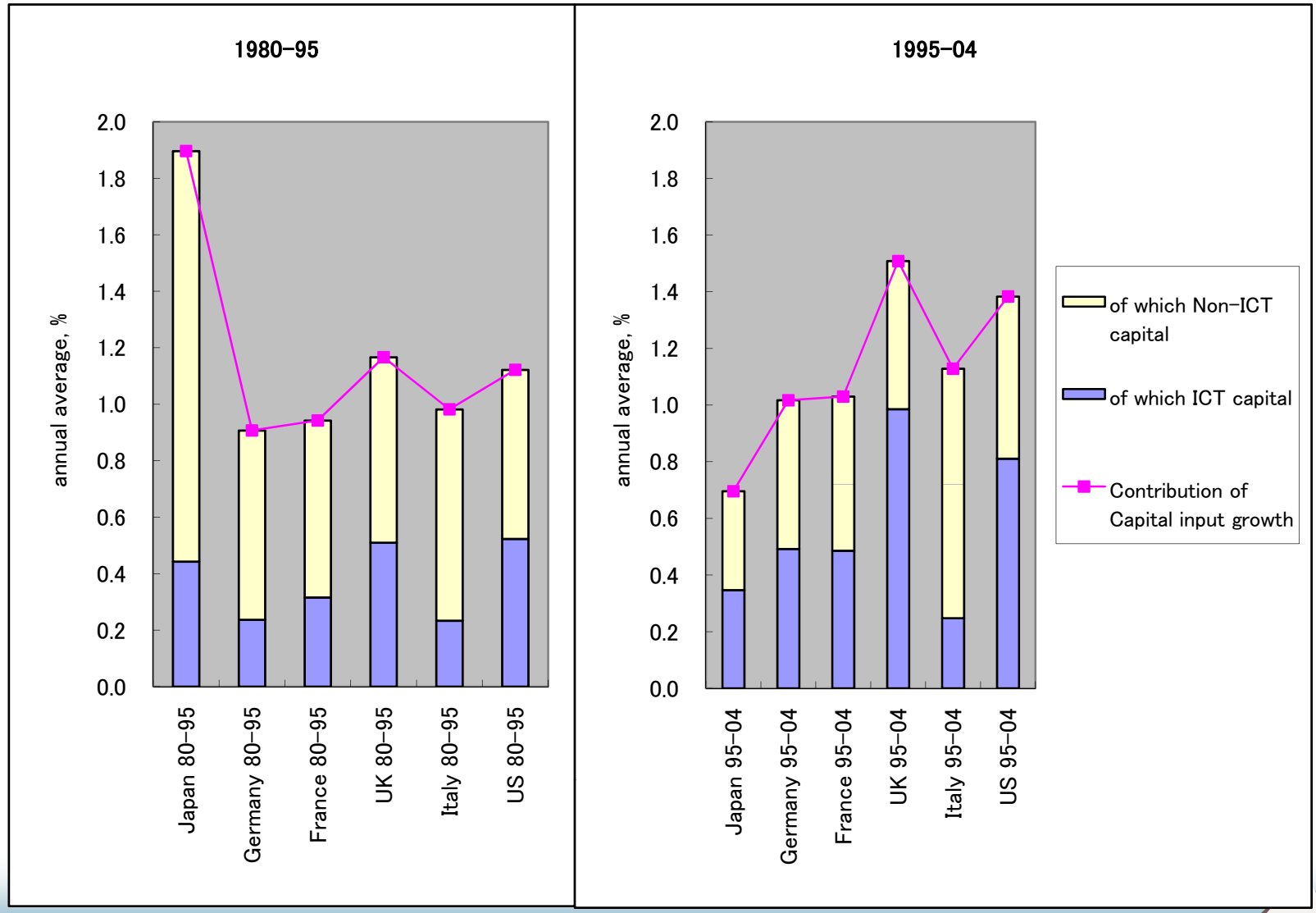
Source: EU KLEMS Database March 2007.

Figure 2. Contribution of Labor Input Growth: Japan, US and EU Core Countries



Source: EU KLEMS Database March 2007

Figure 3. Contribution of Capital Input Growth: Japan, US and EU Core Countries

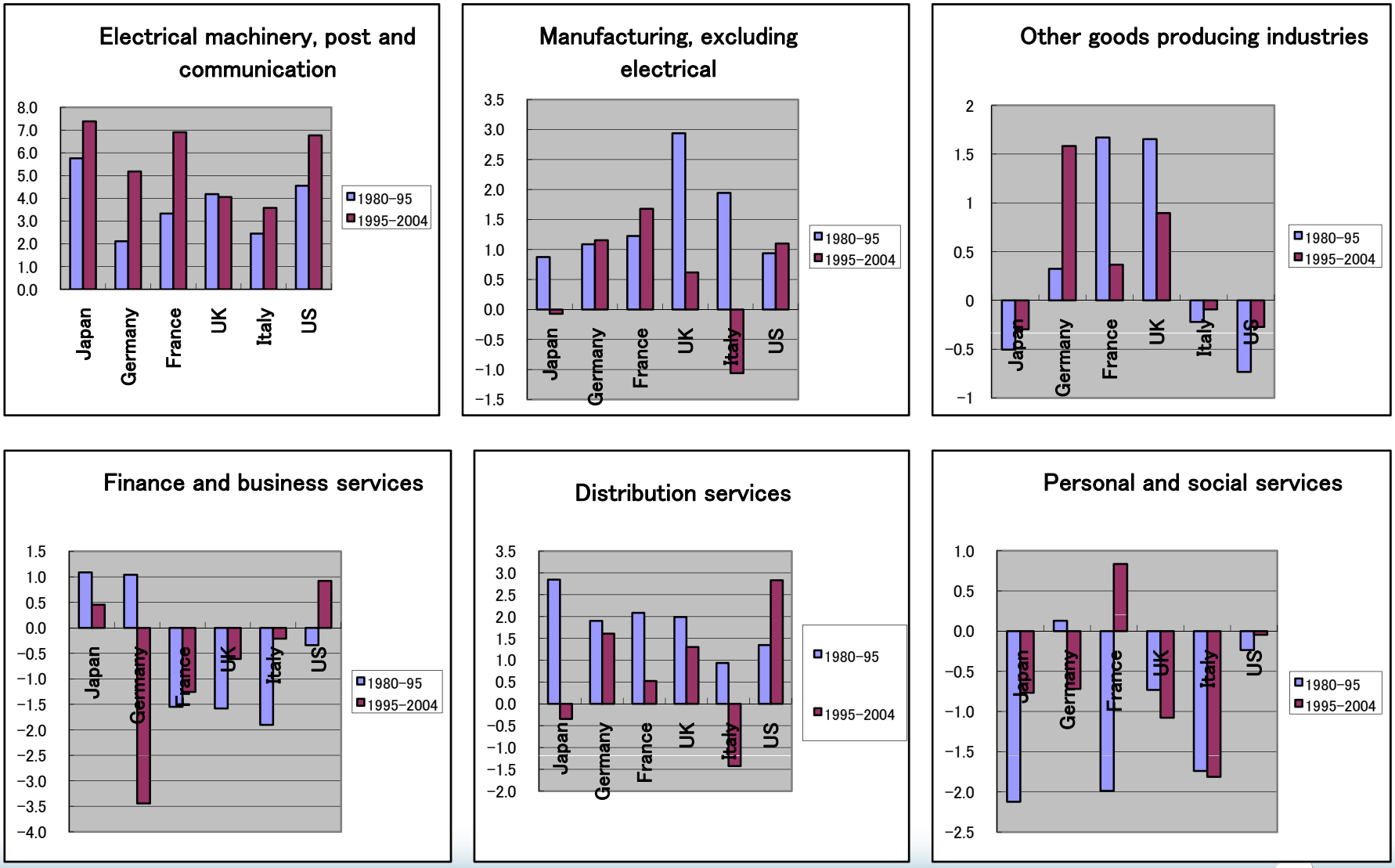


Source: EU KLEMS Database March 2007.

1. Overview (contd.)

- The four major EU economies (Germany, France, the UK and Italy) and Japan experienced a slowdown in TFP growth of a similar magnitude after 1995. Only the US accomplished an exceptional acceleration in TFP growth.
- TFP growth in the electrical machinery, post and communication sector was still highest in Japan among the six economies after 1995. However, like in other countries, the share of this sector in the economy overall is not very large. The average share of labor input in this sector in Japan's total labor input in 1995-2004 was 4.1%.
- The largest declines in TFP growth in Japan occurred in distribution services and in the rest of the manufacturing sector. The labor input shares of these two sectors were 23.4% and 16.8% respectively. The US and the major EU economies except Italy recorded higher TFP growth in these two sectors.

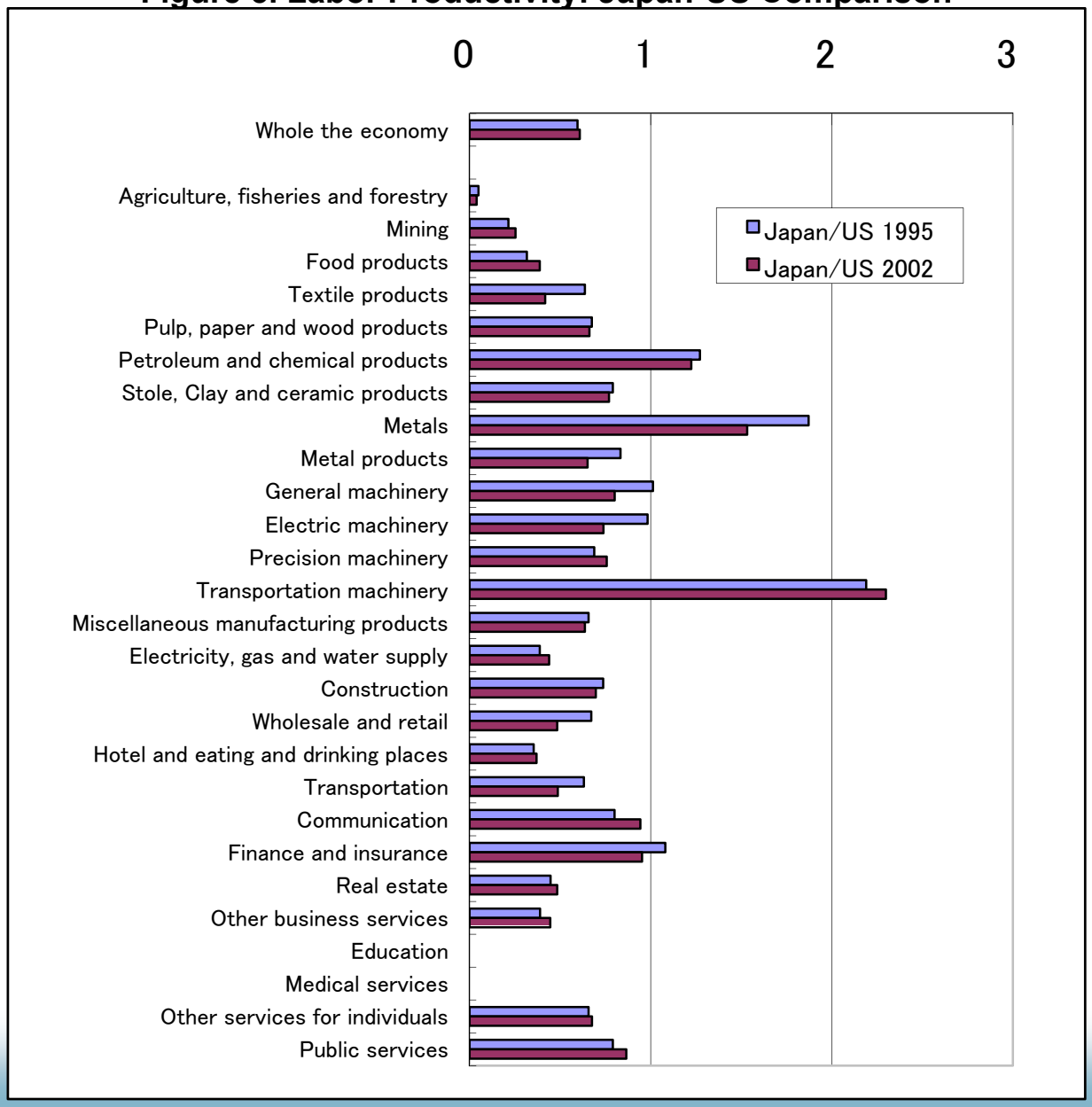
Figure 4. TFP Growth of the Market Economy: by Sector and by Country



Source: EU KLEMS Database March 2007.

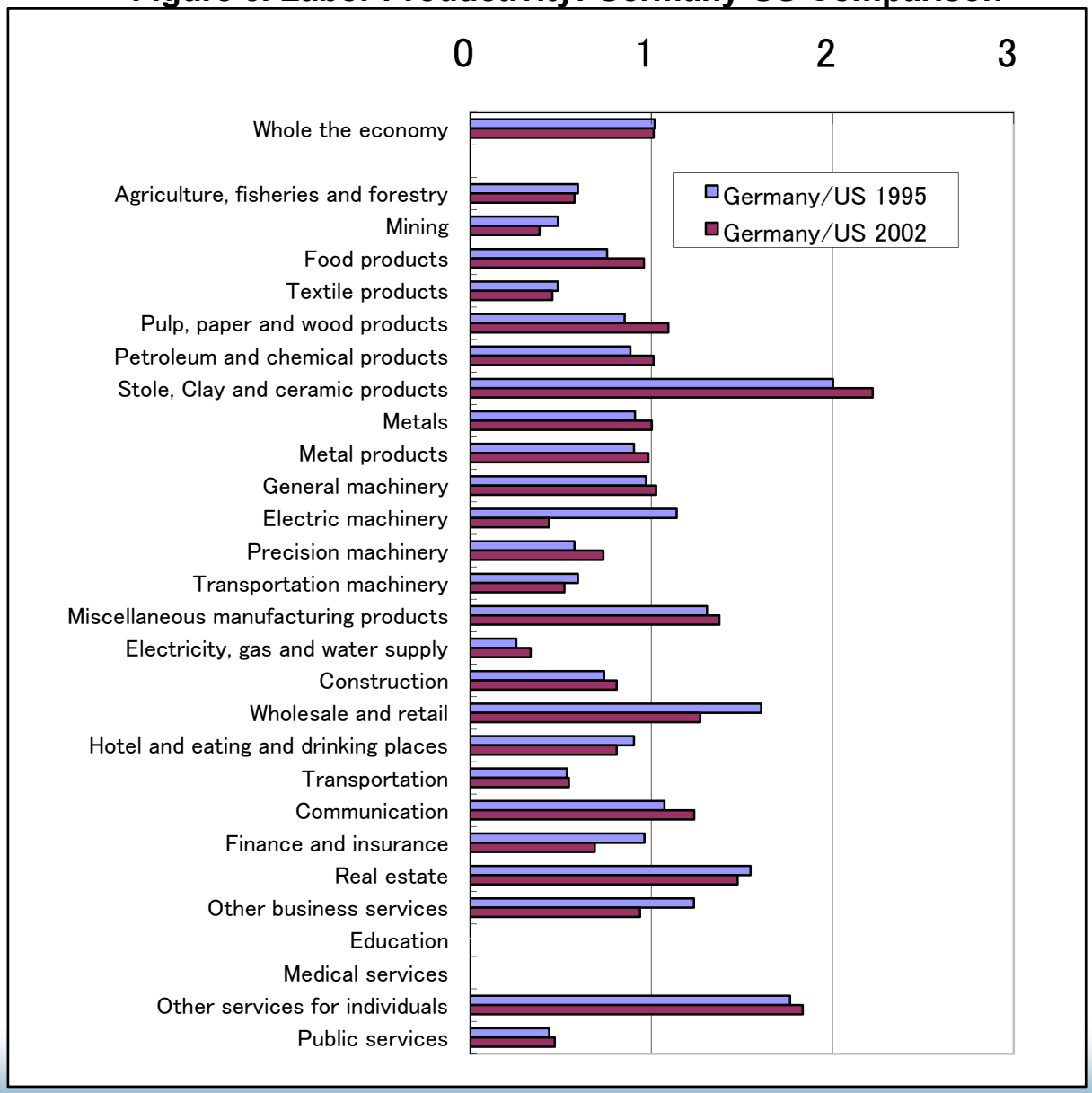
- **Inklaar et al. (2006) found that labor productivity levels in market services in continental Europe were on par with the US in 1997, but since then productivity growth in Europe has been much weaker, suggesting that the continental European countries need to do more to innovate and adjust economic structures to novel technologies.**
- **This observation raises the question: Is Japan in a similar situation as the continental European countries?**
- **We use the results of a comparison of labor productivity (real value added per man-hour) conducted by the Japan Economic Foundation (JEF) and the Japan Center for Economic Research (JCER) (JEF-JCER 2007).**

Figure 5. Labor Productivity: Japan-US Comparison



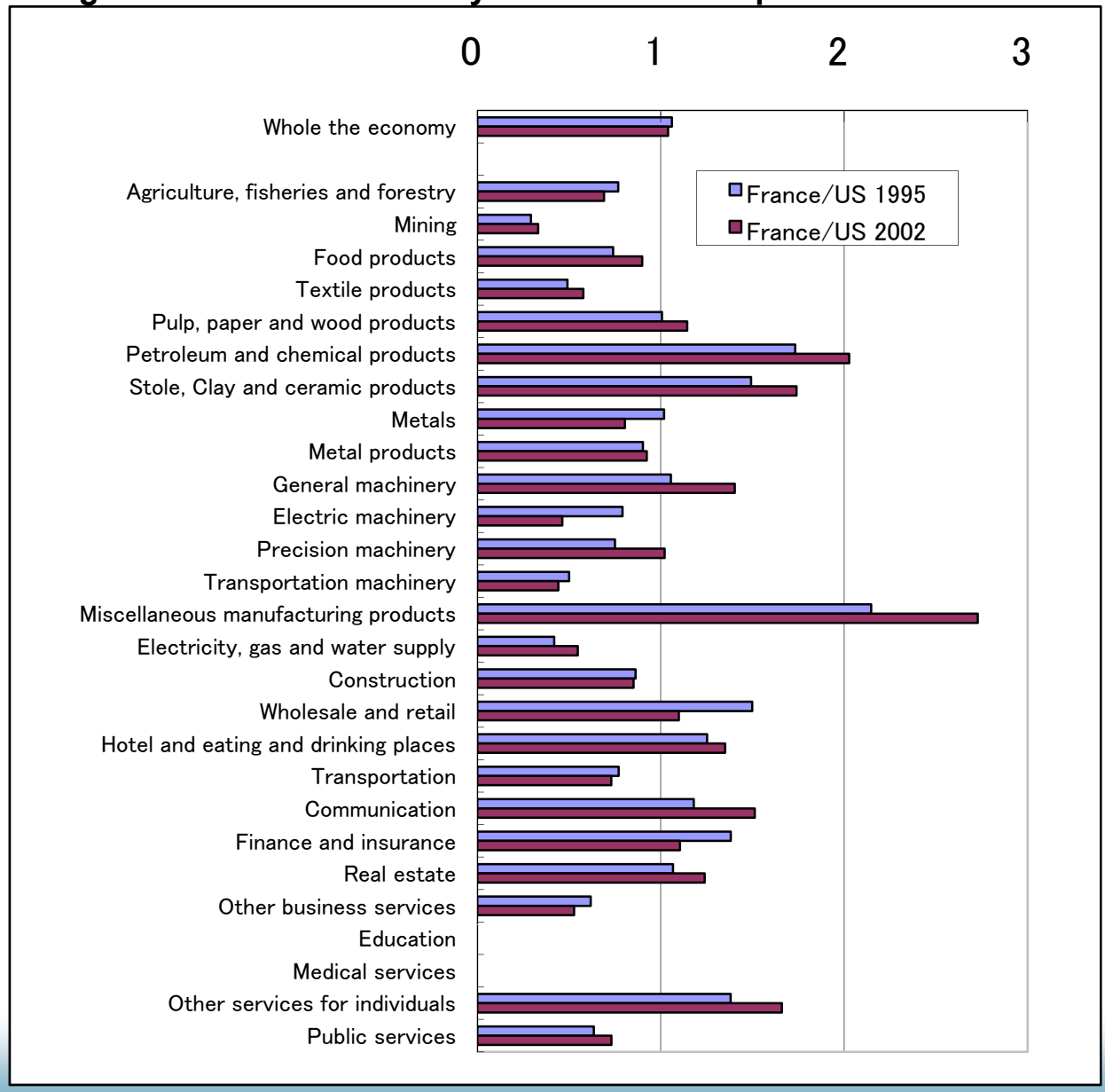
Source: JEF-JCER (2007)

Figure 6. Labor Productivity: Germany-US Comparison



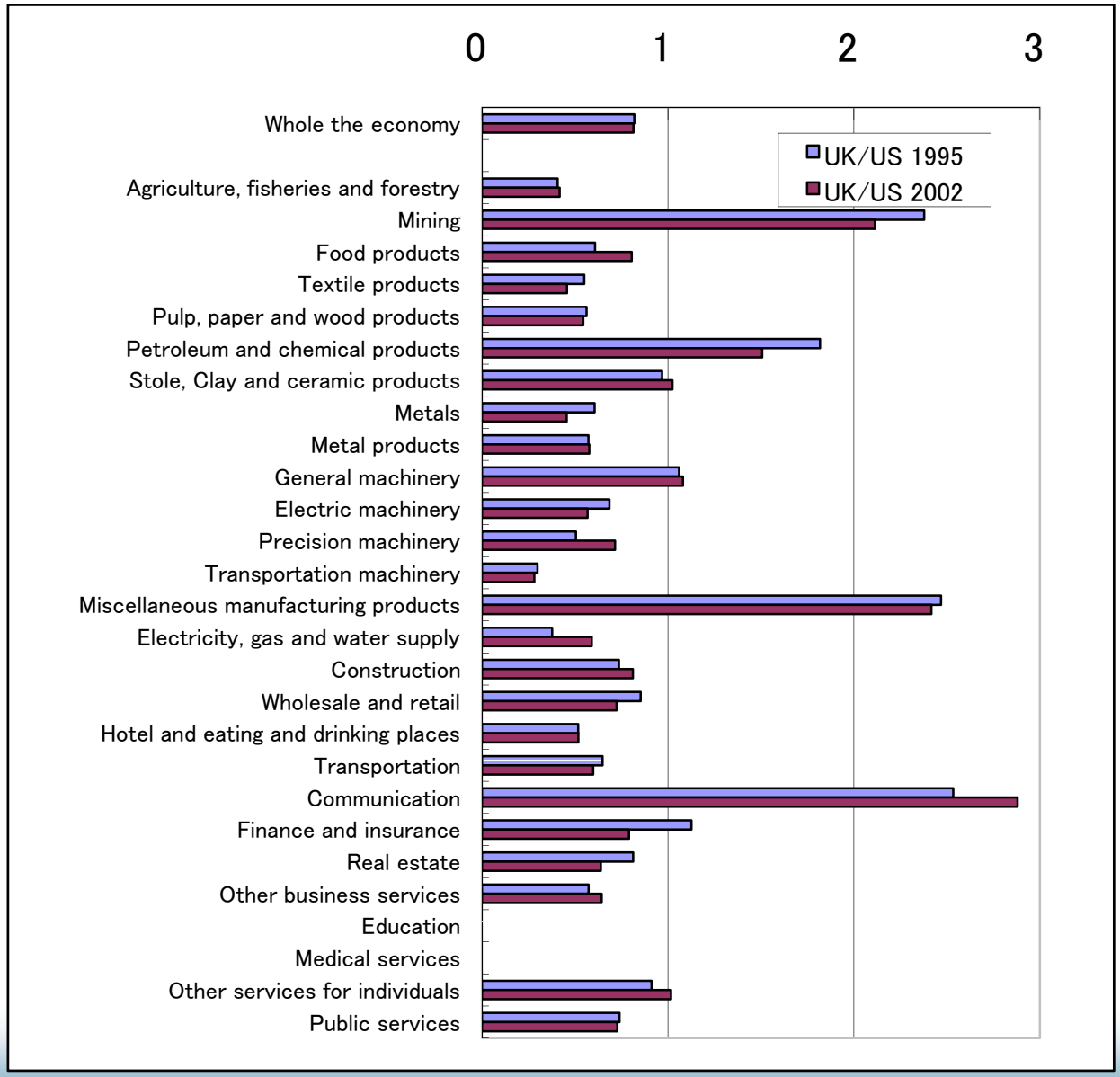
Source: JEF-JCER (2007)

Figure 7. Labor Productivity: France-US Comparison



Source: JEF-JCER (2007)

Figure 8. Labor Productivity: UK-US Comparison



Source: JEF-JCER (2007)

- **Productivity levels in Germany and France were very close to those in the US both in market services and manufacturing.**
- **Productivity levels in the UK were lower than in the two continental European countries.**
- **In manufacturing sectors, productivity levels in Japan were on par with those in the US, Germany and France.**
- **However, they were very low in comparison with the three countries both in market services and other goods-producing industries.**
- **It therefore seems that there is large room for improvement in Japan's productivity in market services and other goods-production services through the adoption of already existing technologies and better resource allocation.**

2. Contribution of ICT Capital Input to Economic Growth

- **The Japanese ICT investment in JIP database:**

→ICT investment in Japan grew at 9.8 % from 1970 to 2004. After the ICT revolution, its growth rate became slower (5.5% from 1995 to 2004).

→The amount of ICT investment was 32 trillion yen (250 trillion Korean won or 2 trillion Chinese yuan) in 2004. Its ratio to the total investment was 27%.

→The ratio of ICT investment to GDP in 2004 was 5.7%. Its movement was flat since the late 1990s

Figure 9 ICT Investment in Japan

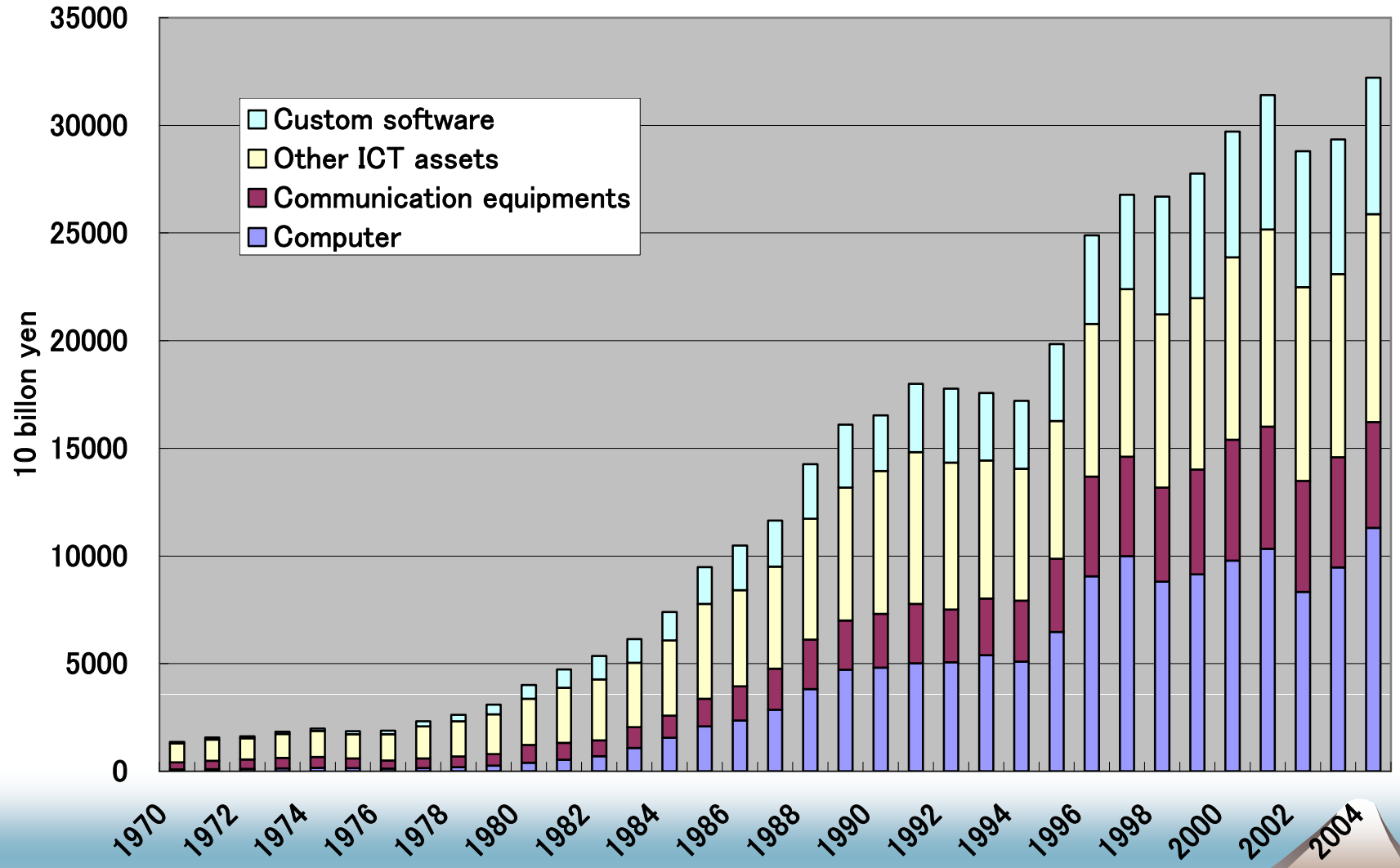
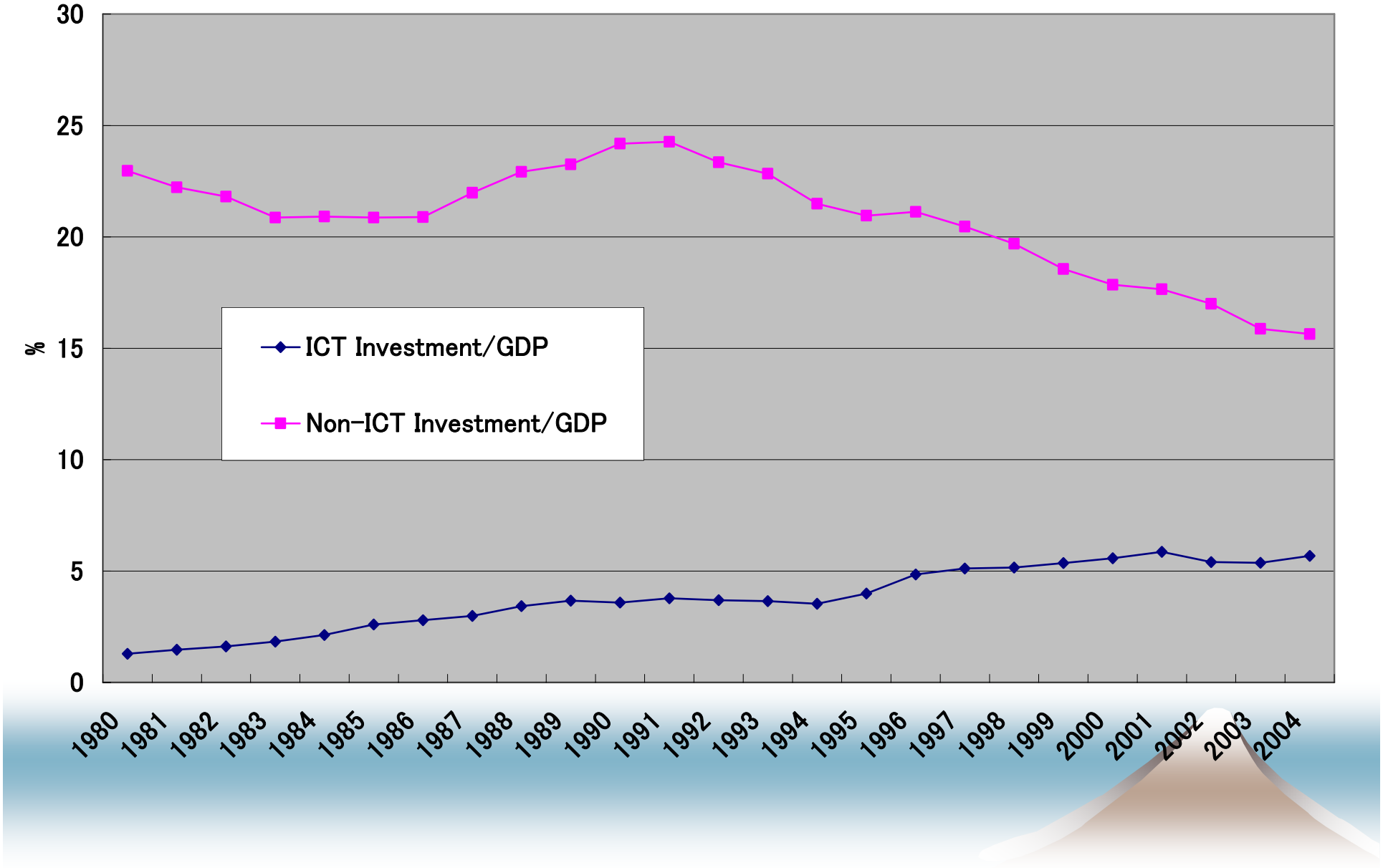


Figure 10 Investment/GDP Ratio



2. Contribution of ICT Capital Input to Economic Growth (contd.)

We compare ICT investment of the six major developed countries using the EU KLEMS database.

We found that the six countries can be categorized into the following three groups:

(1) Front runners: the US and the UK→16-17% growth in ICT capital service input per annum from 1995 to 2004.

(2) Intermediate group: Germany and France→12% growth per annum from 1995 to 2004.

(3) Laggards: Japan and Italy →ICT capital service input level in 2004 was less than twice as high as the 1995 level →Japan did not catch up the trend of downsizing in the 90s.

The contribution of ICT capital service input to economic growth in Japan was lower than in the other countries except Italy.

Figure 11. Growth in ICT service (Market Economy)

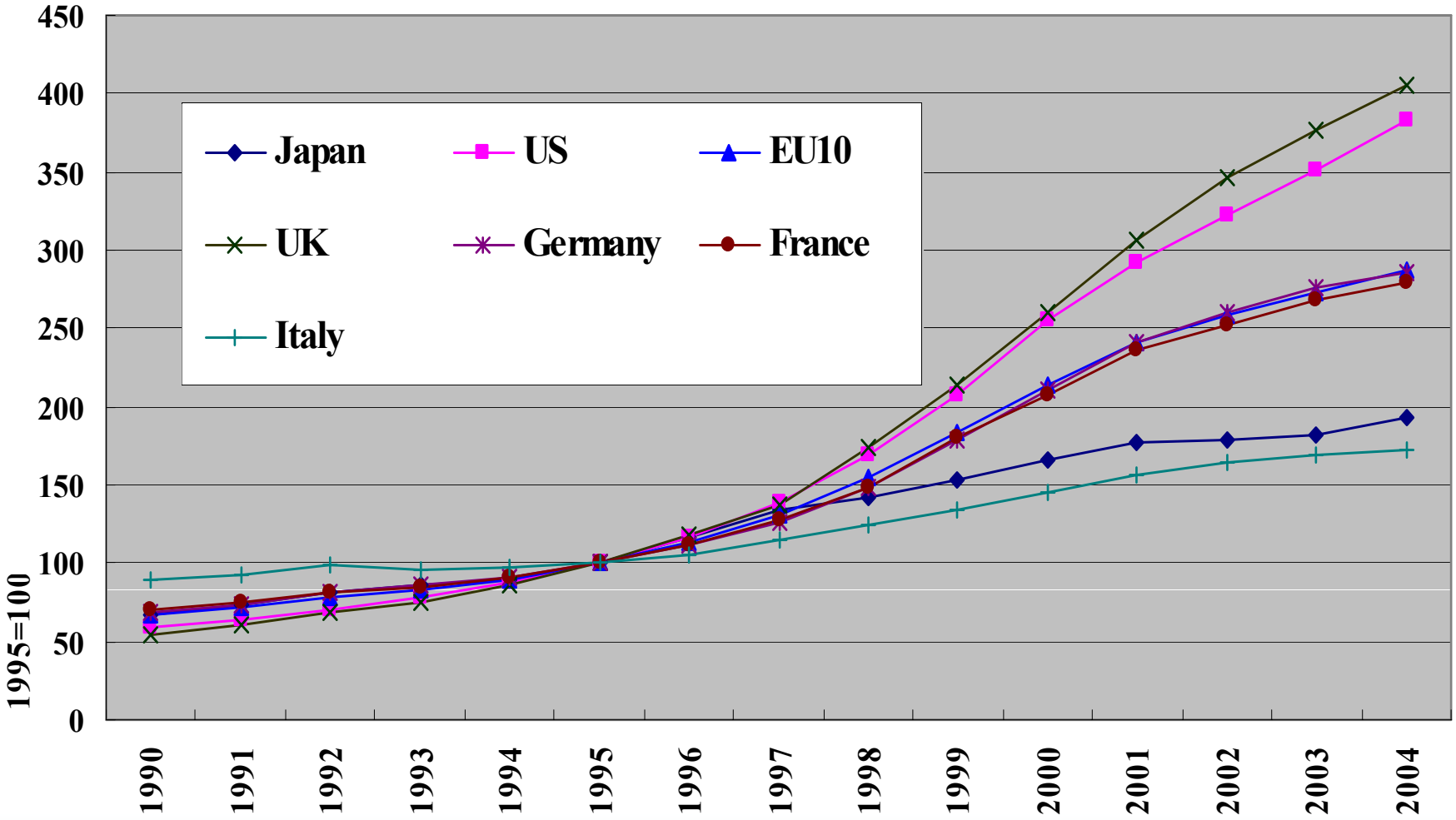


Table 1. Contributions of ICT Capital Service Input to Economic Growth

	1995-2004					
	Japan	US	France	Germany	Italy	UK
Market economy total	0.3	0.8	0.5	1.0	0.2	1.0
Electrical machinery, post and communication	1.0	1.5	0.8	2.7	0.2	2.7
Manufacturing, excluding electrical	0.1	0.4	0.3	0.5	0.1	0.5
Other goods-producing industries	0.1	0.2	0.2	0.1	0.0	0.1
Distribution services	0.1	1.0	0.3	0.8	0.2	0.8
Finance and business services	1.2	1.2	1.0	1.8	0.7	1.8
Personal and social services	0.2	0.4	0.0	0.5	0.3	0.5

Source: EU KLEMS Database, March 2007.

2. Contribution of ICT Capital Input to Economic Growth (contd.)

- **Retail industry: The increase of ICT capital input in the US was extremely high. In contrast, the growth rate of ICT capital service input in Japan was very low.**
- **Financial intermediation sector: The UK showed the highest accumulation of ICT capital. ICT capital accumulation in the other countries except Italy was almost the same.**

Figure 12. Growth rate in ICT service (Retail)

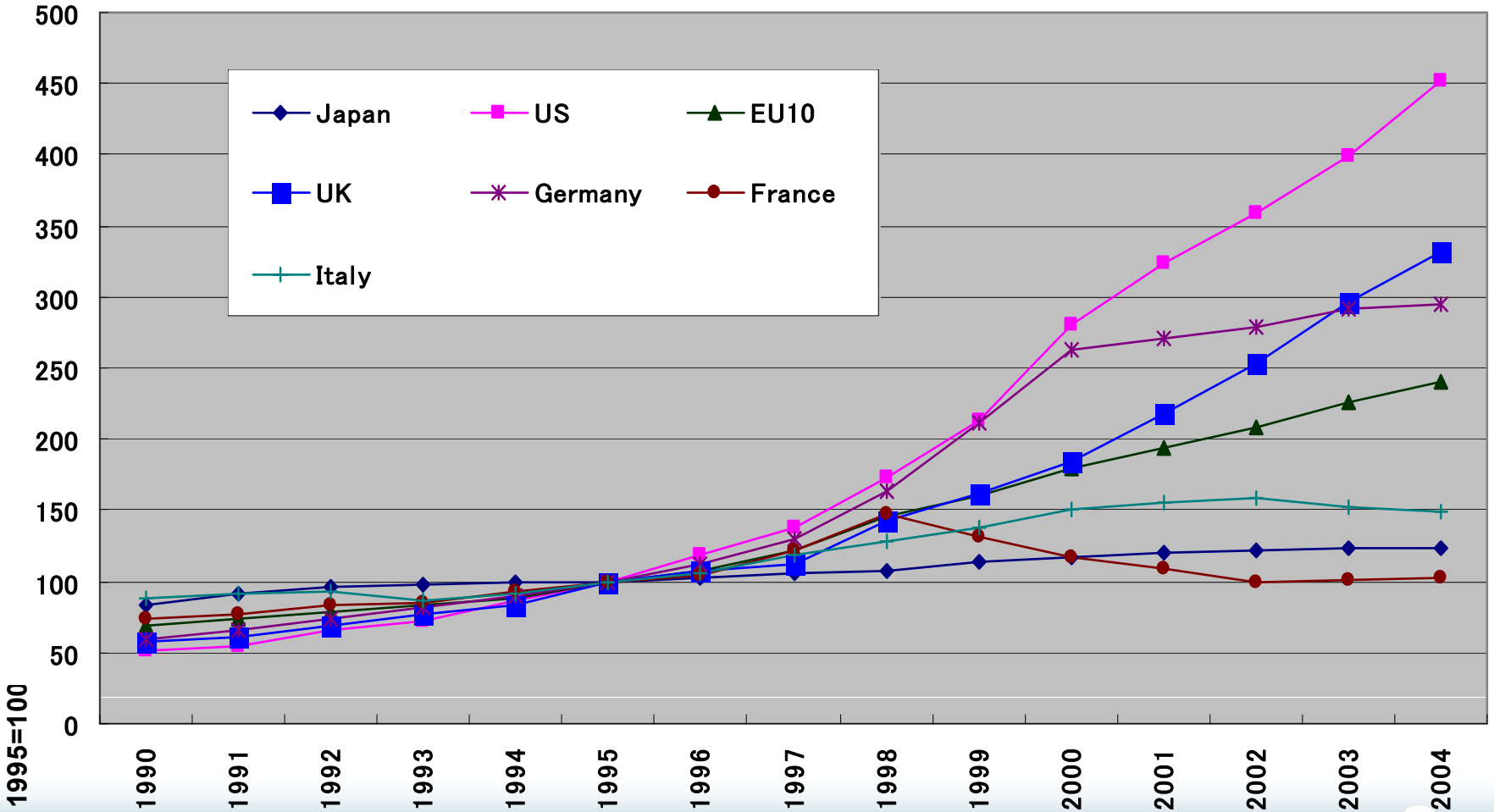
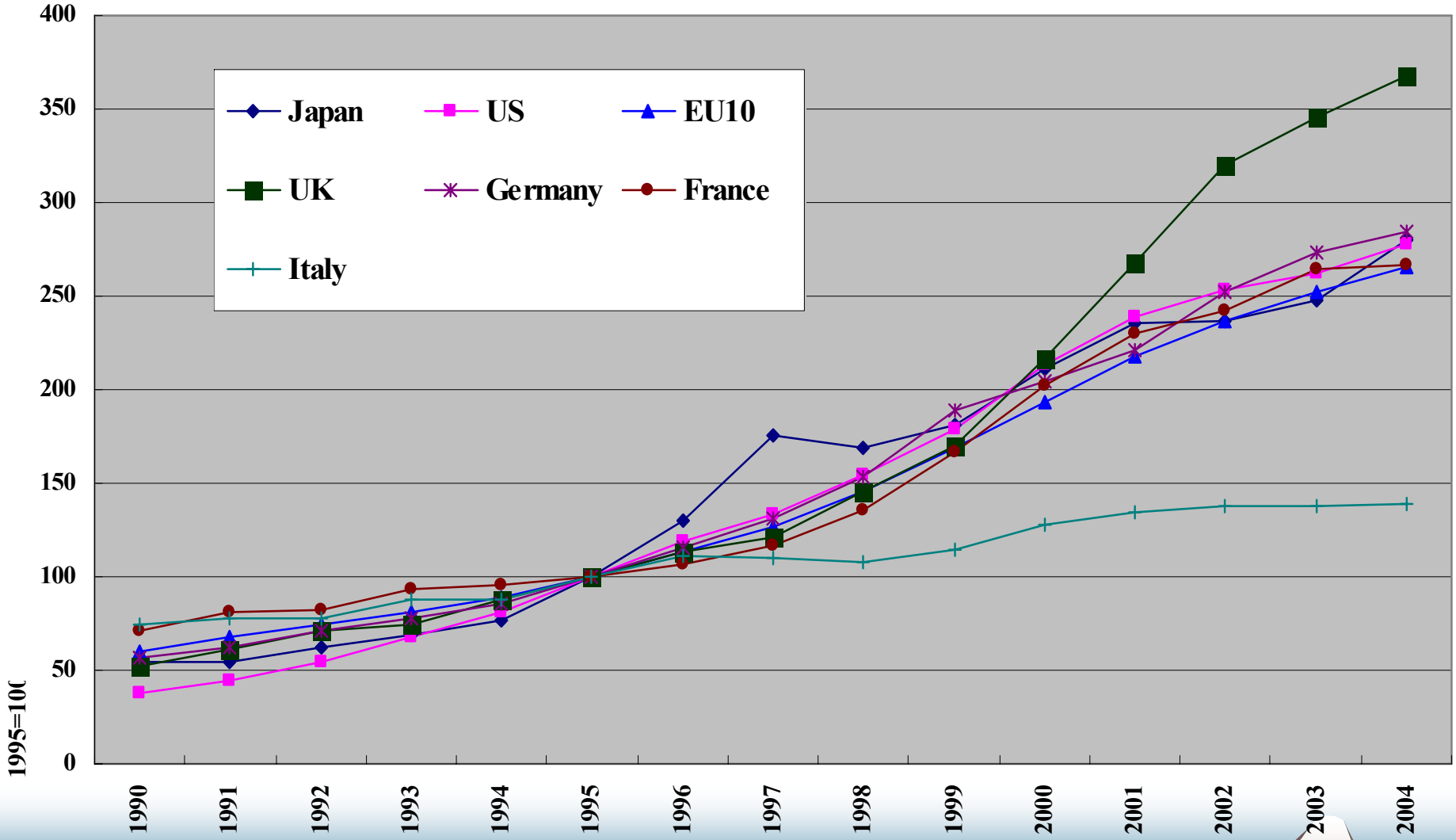


Figure 13. Growth rate in ICT service (Financial intermediation)



3. Resource Reallocation in Japan

- **Two approaches to measurement in reallocation of economic resources**

  - Aoki (2006) assumes that factor price equalization among sectors does not hold due to the differences in tax rates in each industry or credit constraints. He measured inefficiency of reallocation in an economic factor as a gap between allocation under market price and allocation where factor price in each industry deviates from market price.

  -Basu and Fernald (2002) also measured the degree of misallocation. In contrast to Aoki (2006) who assumed perfect competition in product markets, they allowed that firms have a monopolistic power.

3. Resource Reallocation in Japan (contd.)

- **Aoki (2006)'s inefficiency measure**

$$\frac{TAE_L}{(1-\mu_K)} = -\sum_i \frac{(1-\mu_{Ki})q_iV_i}{(1-\mu_K)qV} \ln\left(\frac{(1-\mu_{Ki})q_iV_i}{(1-\mu_K)qV} \Big/ \frac{L_i}{L}\right)$$

where μ_{Ki} is a revenue share of capital in industry i

and $\mu_K = \sum_i \frac{q_iV_i}{qV}\mu_{Ki}$.

- **If resource allocation is efficient, labor (capital) allocation in industry i is equal to the ratio of labor compensation (capital compensation) in industry i to that in the total economy. Hence, the left hand side in the above equation becomes zero. We measure the degree of inefficient allocation in economic resources as a deviation from zero.**

3. Resource Reallocation in Japan (contd.)

- **According to Aoki (2006)'s measure, the inefficiency in resource reallocation in Japan decreased until 1996. However, it has expanded since 1997. This expansion was induced by the increase in inefficiency in the capital market.**
- **When we consider two types of labor; skilled labor and unskilled labor and measure the inefficiency in the two markets, the inefficiency in the unskilled labor market has overcome that in the skilled labor market.**

Figure 14. TAE （allocational efficiency indexes）

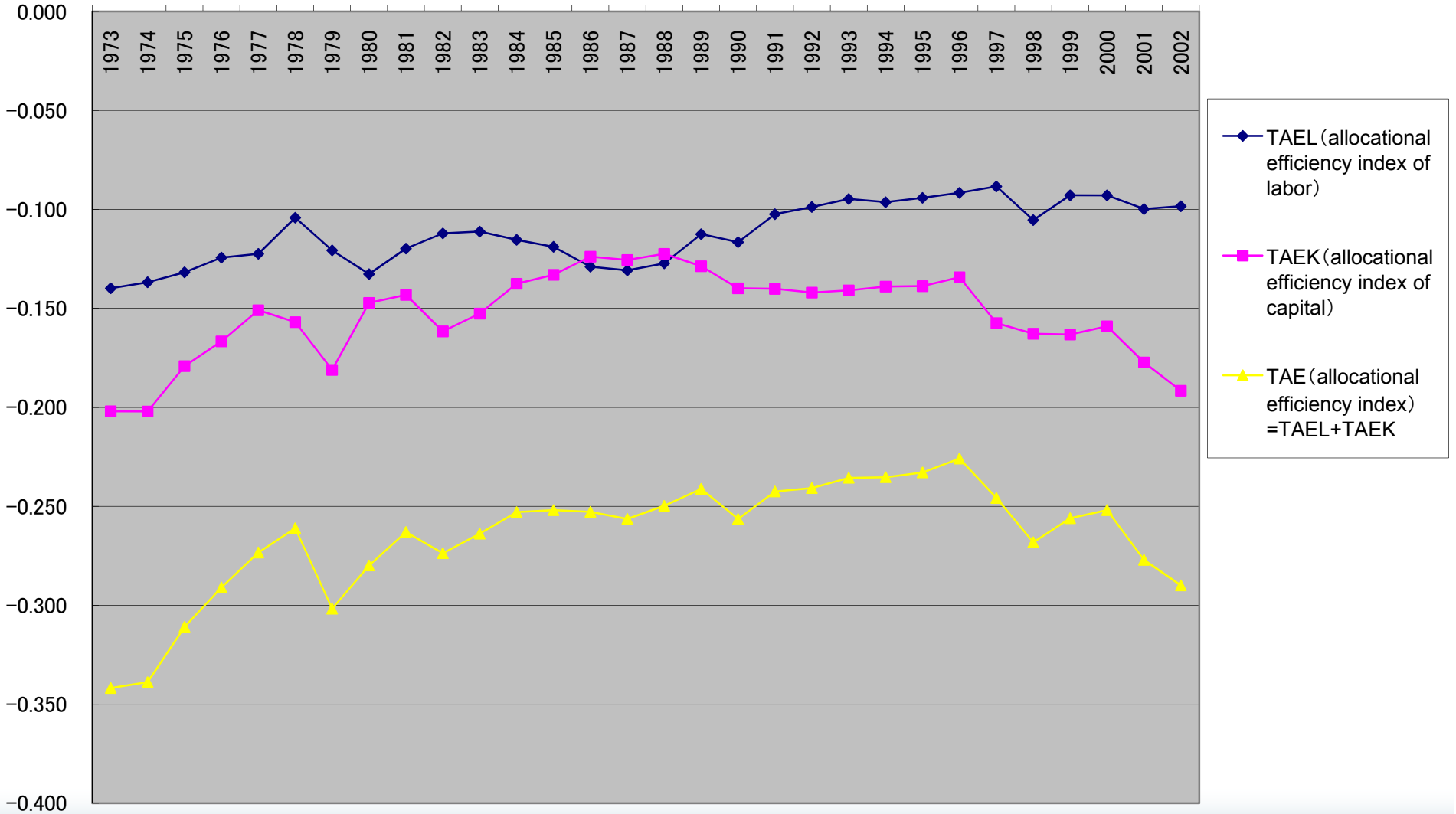
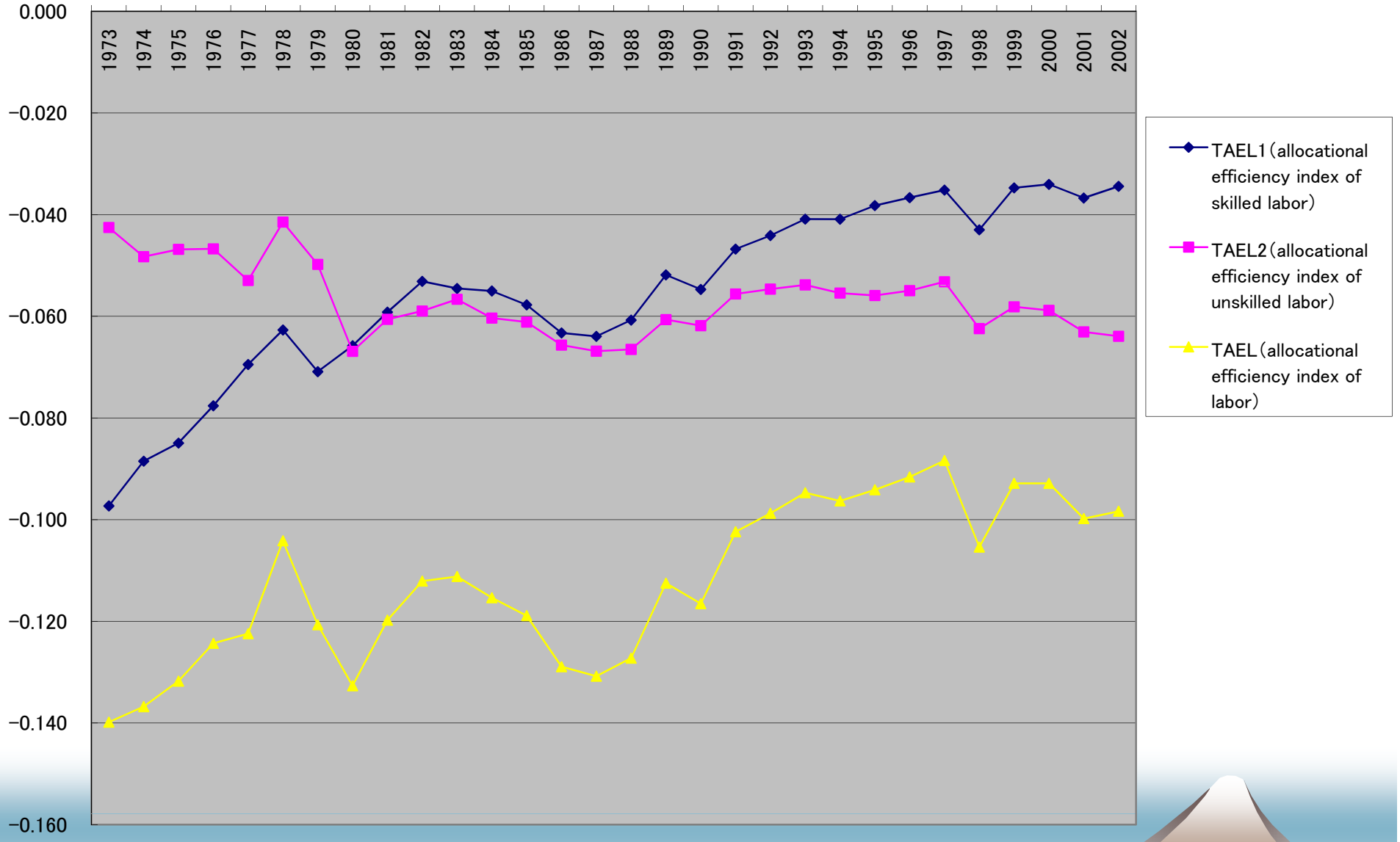


Figure 15. TAEL （allocational efficiency indexes of labor）



- **Production function in industry i in Basu and Fernald (2002)**

$$Q_i = F(X_i, L_{1i}, L_{2i}, K_i, T_i)$$

- **Considering market power in a product market, output change is expressed as follows**

$$\frac{\dot{Q}_i}{Q_i} = m_i(\mu_{Xi}\frac{\dot{X}_i}{X_i} + \mu_{L1i}\frac{\dot{L}_{1i}}{L_{1i}} + \mu_{L2i}\frac{\dot{L}_{2i}}{L_{2i}} + \mu_{Ki}\frac{\dot{K}_i}{K_i}) + \frac{\dot{A}_i}{A_i}$$

where m_i is a markup in industry i.

- **Change in value added in industry i is expressed as follows;**

$$\frac{\dot{V}_i}{V_i} = m_i^V \frac{\dot{Z}_i^V}{Z_i^V} + \left(m_i^V - 1\right)\left(\frac{\mu_{Xi}}{1-\mu_{Xi}}\right)\left(\frac{\dot{X}_i}{X_i} - \frac{\dot{Q}_i}{Q_i}\right) + \frac{\dot{A}_i^V}{A_i^V}$$

where $m_i^V = m_i\left(\frac{1-\mu_{Xi}}{1-m_i\mu_{Xi}}\right)$

$$\frac{\dot{Z}_i^V}{Z_i^V} = \left(\frac{\mu_{L1i}}{1-\mu_{Xi}}\right)\frac{\dot{L}_{1i}}{L_{1i}} + \left(\frac{\mu_{L2i}}{1-\mu_{Xi}}\right)\frac{\dot{L}_{2i}}{L_{2i}} + \left(\frac{\mu_{Ki}}{1-\mu_{Xi}}\right)\frac{\dot{K}_i}{K_i}$$

$$\frac{\dot{A}_i^V}{A_i^V} = \left(\frac{1}{1-m_i\mu_{Xi}}\right)\frac{\dot{A}_i}{A_i} \quad .$$

- **Because Solow residual in Basu and Fernald is defined as** $\frac{\dot{SR}_i^V}{SR_i^V} = \frac{\dot{V}_i}{V_i} - \frac{\dot{Z}_i^V}{Z_i^V}$ **,**

it leads to

$$\frac{\dot{SR}_i^V}{SR_i^V} = \left(m_i^V - 1\right)\frac{\dot{Z}_i^V}{Z_i^V} + \left(m_i^V - 1\right)\left(\frac{\mu_{Xi}}{1-\mu_{Xi}}\right)\left(\frac{\dot{X}_i}{X_i} - \frac{\dot{Q}_i}{Q_i}\right) + \frac{\dot{A}_i^V}{A_i^V}$$

- **Aggregation**

-Value added

$$\frac{\dot{V}}{V} = \sum \frac{q_i V_i}{q V} \frac{\dot{V}_i}{V_i}$$

-Factor inputs

$$\frac{\dot{Z}^V}{Z^V} = \sum \frac{q_i V_i}{qV} \frac{w_1 L_{1i}}{q_i V_i} \frac{\dot{L}_{1i}}{L_{1i}} + \sum \frac{q_i V_i}{qV} \frac{w_2 L_{2i}}{q_i V_i} \frac{\dot{L}_{2i}}{L_{2i}} + \sum \frac{q_i V_i}{qV} \frac{rK_i}{q_i V_i} \frac{\dot{K}_i}{K_i}$$

$$= \sum \frac{q_i V_i}{q V} \frac{\dot{Z}_i^V}{Z_i^V} - R_{L1} - R_{L2} - R_K$$

where $R_{L1} = \sum \frac{q_i V_i}{q V} \mu_{L1i}^V \left(\frac{w_{1i} - w_1}{w_{1i}} \right) \frac{\dot{L}_{1i}}{L_{1i}}$, $R_{L2} = \sum \frac{q_i V_i}{q V} \mu_{L2i}^V \left(\frac{w_{2i} - w_2}{w_{2i}} \right) \frac{\dot{L}_{2i}}{L_{2i}}$, $R_K = \sum \frac{q_i V_i}{q V} \mu_{Ki}^V \left(\frac{r_i - r}{r_i} \right) \frac{\dot{K}_i}{K_i}$.

-Solow residual consists of change in factor inputs, reallocation terms, and TFP growth rate.

$$\frac{\dot{SR}^V}{SR^V} = \left(\overline{m}^V - 1 \right) \frac{\dot{Z}^V}{Z^V} + R_m + R_X + \overline{m}^V R_{L1} + \overline{m}^V R_{L2} + \overline{m}^V R_K + \frac{\dot{A}^V}{A^V}$$

- **Following Basu and Fernald (2002), we measure reallocation in the Japanese economy.**
- **Results show that reallocation in labor and capital improved until the mid-90s. However, the contributions of reallocation terms in labor and capital to aggregate Solow residual has decreased since the late 90s.**
- **The contribution of the total reallocation to the Solow residual increased from the 80s to the 90s, because the share of high mark-up industry expanded in the 90s.**

Table 2. Aggregate Solow Residual, Technology and Reallocation by Component（Average Annual Rate）

$$\frac{\dot{SR}^V}{SR^V} = (\overline{m}^V - 1)\frac{\dot{Z}^V}{Z^V} + R_m + R_X + \overline{m}^V R_{L1} + \overline{m}^V R_{L2} + \overline{m}^V R_K + \frac{\dot{A}^V}{A^V}$$

	$\frac{\dot{SR}^V}{SR^V}$ (Solow Residual)	$(\overline{m}^V - 1)\frac{\dot{Z}^V}{Z^V}$ (Average Markup Effect)	R (Sum of the Reallocation Terms)	$\frac{\dot{A}^V}{A^V}$ (Aggregate technology)
1975-1980	3.15	2.12	-2.88	3.91
1980-1985	1.73	2.29	-0.67	0.11
1985-1990	3.01	1.36	-1.72	3.37
1990-1995	0.53	0.54	-0.99	0.97
1995-2002	0.38	0.16	-0.33	0.54

	R_m (Markup Reallocation Rerm)	R_X (Materials Reallocation Term)
1975-1980	-1.59	-1.49
1980-1985	1.56	-2.58
1985-1990	0.83	-2.91
1990-1995	-0.69	-0.42
1995-2002	-0.80	0.46

	$R_L + R_K$	R_{L1} (Skilled Labor Reallocation term)	R_{L2} ıskilled Labor Reallocation term)	R_K (Capital Reallocation term)
1975-1980	0.10	-0.02	0.05	0.06
1980-1985	0.20	-0.03	0.09	0.14
1985-1990	0.25	-0.02	0.02	0.24
1990-1995	0.09	-0.02	-0.02	0.14
1995-2002	0.00	-0.03	-0.04	0.08

Note: $R = R_m + R_X + \overline{m}^V R_{L1} + \overline{m}^V R_{L2} + \overline{m}^V R_K$