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Assessing Japan's Industrial Competitiveness by International Productivity Level Comparison with China, Korea, Taiwan and United States[1]

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Abstract

This paper presents preliminary results of RIETI's ICPA project, comparing TFP growth and level of 5 countries, i.e., China, Korea, Japan, Taiwan and the United States. In this project, comparable KLEM and PPP datasets have been created by using common classification for industry and factor input type. This paper focuses on productivity level comparison among these countries. Relative TFP levels of Japan to other Asian countries as well as US provide useful information on international competitiveness of Japanese industries.

[1] This paper is based on preliminary results of ICPA (International Comparison of Productivity among Asian Countries) Project by RIETI (Research Institutes of Economy, Trade and Industry), Japan. All of original data in this paper come from numerous participants to this project, namely, Ruoen Ren and Ximing Yue for China, Masahiro Kuroda, Koji Nomura and Kasushige Shimpo for Japan, Hak Pyo for Korea, Chi-yuan Laing for Taiwan and Dale Jorgenson and Mun Ho for US. Relative output price data among these countries are provided by Bart van Ark, Ruoen Ren, Marcel Timmer and Gerard Ypma. Author thanks for all of these participants as well as financial supports from RIETI. Author thanks also for an excellent research assistance from Asako Okamura.
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1. Introduction

Economic growth in Japan dropped off sharply in the 1990s. This is thought to be in large part a cyclic phenomenon reflecting the collapse of the bubble economy in the late 1980s. But slow growth has continued, with average annual growth of 1.4% through the decade of the 1990s, prompting comment that structural factors may also be involved. Moreover, certain industries appear to be losing competitiveness. Japan's electronics industry, for example, boasted overwhelming export competitiveness into the 1980s, but manufacturers in South Korea, Taiwan and elsewhere in East Asia have been catching up, with the result that Japanese manufacturers now face serious competition, especially in the area of semiconductors and other information devices (Motohashi, 2003). And thanks to China's continued vigorous courting of foreign investment, foreign-invested enterprises are pouring in and helping China to gain ground on the developed nations in the IT sector. China already commands top share worldwide in the production of many consumer electronic items, where export competitiveness has plummeted.

This paper provides relative TFP levels of Japan to China, Japan, Korea, Taiwan and United States in order to assess Japan's industrial competitiveness to these countries. Higher relative productivity suggests superior production technology, which implies that the industry in question can supply international markets with more attractive goods and services. In addition, changes in relative TFP level show dynamics of international competitiveness. These statistics can directly address the question of whether and to what extent other Asian countries are catching up with Japan. In addition, benchmarking with US provides us further information on relative position of Asian countries to the world economy. Studies on productivity of Asian economies are available at macro level (Young, 1995), or at aggregated industry level (van Ark and Timmer, 2003). Therefore, industry level TFP levels in this study shed new light on dynamics of economic developments of East Asian countries.

The structure of this paper is as follows. The next section provides theoretical model to estimate industry productivity levels. This project is based on the KLEM framework, i.e., industry level data on capital (K), labor (L), energy (E) and material (M). Relative TFP is derived from relative prices of industry output as well as these inputs. A section for data and issues for relative prices is followed. Then, the results of TFP level estimation by industry and discussion on the results are provides. This paper concludes with summary of findings and agenda for future research.

2. Theory of TFP Level Estimation

The methodology is based on the growth accounting framework, with internationally comparable measurements of the service flow of labor, capital, and other intermediate inputs; gross output; and productivity at economy-wide and industry levels. The analytical framework on international comparison of TFP growth and level is provided in Kuroda et. al. (1996) and empirical works of this framework include Jorgenson and Kuroda (1990), Kuroda and Nomura (1999), Jorgenson et. al. (2002) and Keio University (1996). This framework must be consistently related to national accounts statistics and input-output tables of each country.

This framework starts with the following production function for industry "j" with multiple inputs, such as K, L, E and M.

$$Y^j = f^j(K^j, L^j, E^j, M^j, TFP(c)) \tag{1}$$

Y is gross output, and TFP(c) is TFP level of country "c". Taking derivative of log of equation (1) in terms of "c" gives the following equations.

$$d\log Y/dc = \sum_{X \in K,L,E,M} (\partial \log Y/\partial c)(d\log X/d c) + \partial \log TFP/\partial c \tag{2}$$

Therefore, relative TFP across countries can be defined as follows,

$$\partial \log TFP/\partial c = d\log Y/dc - \sum_{X \in K,L,E,M} (\partial \log Y/\partial c)(d\log X/d c) \tag{3}$$

Under the condition of constant rate of return, the value of output (Y*Py) is equal to the sum of value of inputs (K*Pk+L*Pl+E*Pe+M*Pm). In this case, relative TFP in equation (3) can be written by price information of output and inputs as follows,

$$\partial \log TFP/\partial c = \sum_{PX \in PK,PL,PE,PM} (\partial \log P_Y/\partial c)(d\log P_X/d c) - d\log P_Y/dc \tag{4}$$

Under the condition of perfect competition at output and factor input markets, equation (4) can be modified as follows,

$$\partial \log TFP/\partial c = \sum_{PX \in PK,PL,PE,PM} s_x (d\log P_X/d c) - d\log P_Y/dc \tag{5}$$

where Sx is the value share of factor input X. Finally, a discrete type approximation of (4), relative TFP of US to Japan in this case is as follows,

$$\log TFP_{US/JP} = \sum_{X \in K,L,E,M} \overline{Sx}(\log P_{X,US} - \log P_{X,JP}) - (\log P_{Y,US} - \log P_{Y,JP}) \quad (6)$$

where $\overline{S_X} = 1/2 * (S_{X,JP} + S_{X,US})$

In Equation (6), there are a couple of issues which should be noted. First, relative prices for output and input are derived as following equation.

$$P_{Y(orX),US/JP} = P_{Y(orX),US} \cdot e_{JP/US} \Big/ P_{Y(orX),JP} \quad (7)$$

where $e_{JP/US}$ is an exchange rate of Japanese yen per US dollar at the time of comparison.

For example, if the price of one box of tobacco is 1.2 US$ in the US and 100 yen in Japan and the exchange rate is 100yen/dollar, the relative price of this tobacco of US to Japan is calculated as 1.2 (1.2*100/100). In this case, this tobacco is 20% more expensive in the US than that in Japan.

Second, it is important to control for the quality of output and inputs in order to come up with relative prices. In the case of relative price for tobacco, it is important to find the same products in both countries. In addition, relative input prices should be controlled for cross country quality differences. In order to make such fair comparison, detail input data by type are prepared for this project. For example, labor data are cross classified by sex, educational attainment and age group. Detail information on the data used in this paper is provided in the following section.

DA relative wage of some industry between two countries is estimated as a Disivia index based on relative wages by each type of labor input, as follows.

3. Data Issues for Relative Output and Input Prices

In this study, relative TFP of China, Korea, Taiwan and US as compared to Japan is calculated by using equation (6). Industrial classification in this study is provided in Table A of Appendix. There are 33 sectors, but the data for all 33 sectors are not always available for some countries. For example, the data for sector 4 (oil and gas extraction) are not available in Japan, because industrial activities of this sector is so small. As is described in previous section, labor and capital input data are cross classified by its type as well as by industry, as is described in Table B and Table C of Appendix. As for labor data, there are 18 types (2 types of sex, 3 types of age category and 3 types of

educational attainment). As for capital data, there are 3 types, i.e., structure, equipment and vehicles. In this study, only depreciable assets are taken into account for capital inputs, and the data for land and inventory are not available for some countries. Detail discussion on data sources and issues are provided as follows,

(1) Output price

There are two types of methodology to come up with relative output prices across countries. One is called unit value ratios (UVRs) and the other one is called expenditure base PPPs (EPPPs). The unit value ratio is calculated by the ratio of unit value of one country to that of another. For example, manufacturing census in many countries usually provides values and quantities of sales by very detail product category. It is possible to come up with the value per unit (unit value) from these statistics, and if one can match this value to that of the same category in another countries, the ratio of unit value can be calculated. A group at GGDC (Groningen Growth and Development Center) at Groningen University has published numerous studies on UVRs among various countries.

Another approach called EPPPs is based on official statistics of PPP (Purchasing Power Parity) at expenditure side. OECD regularly conducts PPP survey for its member countries, and publishes the results. In order to come up with producer level relative prices to be used for productivity analysis, original data at expenditure side have to be modified. For example, distribution margin has to be “peeled off” from expenditure prices. In addition, adjustment associated with international trade has to be done, because original data may include substantial number of imported product prices. However, once proper adjustment has been done, EPPPs can be used as relative producer prices to be used for productivity analysis. Jorgenson and Kuroda (1990) and Kuroda and Nomura (1999) are some examples by using this methodology.

There are merits and demerits in both methodologies. For example, UVRs are strong for manufacturing products, while it is very difficult to come up with UVRs for services. EPPPs can be derived for final demand goods and services, but there is no PPP data for intermediate input goods and services. More detail discussions on comparing these two methodologies can be found in OECD (1996) and van Ark and Timmer (2002).

In RIETI’s ICPA project this study, relative output prices of Korea, Taiwan and US are estimated by a team at GGDC, Groningen University (Timmer and Ypma, 2004). As for the price comparison with China, we use the data between China and U.S. in Zheng and Ren (2004). Basically, there studies rely on UVR methodology, because EPPPs cannot

be applied to China and Taiwan. The OECD-PPP data, the data source of EPPPs approach are not available for non OECD countries. In addition, OECD-PPPs for Korea are available only in 1999, because Korea joined in OECD recently. Therefore, UVR approach is a practical choice for this study. Relative output data from these studies are summarized in Table 1. In this study, a benchmark year of productivity level comparison is 1995, while the timings of data are 1997 in many sectors. We use 1997 data as they are, by assuming relative price changes from 1995 to 1997 across countries are not so large as compared to cross country differences.

It should be noted that producer prices derived from UVR approach are at commodity level. In order to estimate industry level productivity, we need the data by industry. Conversion from commodity to industry data can be conducted by using V table (make matrix) of input output tables. However, presumably, such adjustment does not make a big difference at fairly aggregated level of 33 sectors.[3] Therefore, we have not conducted V table adjustments in this study. Relative output prices used in this study are presented in Table 2.

(2) Relative Intermediate Input Prices

Relative input prices in equation (6) consist of prices for capital (PK), labor (PL), energy (PE) and material (PM). In this section, PE and PM (intermediate input prices) are discussed. Intermediate input prices can be derived by using information of U table (use matrix). First, we assume that relative output price at commodity level in Table 2 can be used as an input price of corresponding sector. Then, relative input price (PE and PM) of US to Japan can be estimated as follows,

$$P^{i}_{E(orM),US/JP} = \sum_{j \in E(orM)} 1/2 * (s^{US}_{i,j} + s^{JP}_{i,j}) \cdot P^{j}_{Y,US/JP} \qquad (8)$$

where sij is share of “j” commodity to total energy (or material) input of “i” industry in each country, and PYj is relative output price of “j” commodity. Among 33 sectors in Table A of Appendix, energy sector include sector 2 (coal mining), sector 4 (oil and gas extraction), sector 14 (petroleum and coal products), sector 28 (electric utilities) and sector 29 (gas utilities). The other sectors are classified as material inputs. In all countries except Taiwan, U tables in 1995 are available. In Taiwan, 1996 X table (commodity x commodity) is used, because IO table with detail industrial classification

[3] Sensitivity analysis of V table adjustment has been conducted by using relative price of Korea to Japan and V table in Japan. It is found that the degrees of changes are 4% at most, and they are within 1% level for most sectors.

is not available in 1995. Relative energy and material prices of 4 countries to Japan are presented in Table 4.

(3) Relative Labor Prices

Relative labor prices are derived from the data of per hour wage and labor compensation cross classified by labor type described in Table B of Appendix in 1995. In order to control for quality of labor inputs, disivia aggregate indices for relative labor input price in equation (8) is estimated as follows.

$$\log(P_{L,US/JP}) = \sum_{s,e,a} \bar{v}_{s,e,a} \ln(P^{s,e,a}_{L,US/JP}) \qquad (9)$$

where, $\bar{v}_{s,e,a} = \frac{1}{2}(v_{s,e,a,JP} + v_{s,e,a,US})$ and $v_{s,e,a}$ is the share of labor compensation of each category (sex="s", education="e" and age="a").

Results are presented in Table 5.

(4) Relative Capital Price

Relative capital prices are derived by the same methodology as labor prices. There are three categories of capital products, as is described in Table C of Appendix. Disivia aggregation is conducted by using relative rental prices and an average share of each capital products over comparing countries as follows.

$$\log(P_{K,US/JP}) = \sum_{i} \bar{v}_i \ln(P^{i}_{K,US/JP}) \qquad (10)$$

where, $\bar{v}_i = \frac{1}{2}(v_{i,JP} + v_{i,US})$ and v_i is the share of capital compensation of each category (capital type="i"). In this equation, relative rental service price (PK) can be decomposed into the following two parts.

$$P^{i}_{K,US/JP} = \frac{annualization\_factor_{US}}{annualization\_factor_{JP}} \cdot P^{i}_{I,US/JP} \qquad (11)$$

An annualization factor is a conversion factor of investment asset price to capital service price. The following is a typical capital service price formula, which consists of two parts, corresponding to each part of equation (11). An annualization factor depends on tax structure of each country, and estimated in each country.[4]

[4] In ICPA project, each of participating country has conducted TFP growth estimates separately. In this process, an annualization factor is calculated, and used for this study. For details of datasets used

$$P_k = (\frac{1-zu}{1-u} \cdot (r(1-\pi) + \delta - \pi) + \tau) \bullet P_I \qquad (12)$$

As for relative investment asset prices (PI) by type of asset, relative output prices by 33 sector are used as follows.

- Structure: Relative output price of 5. Construction
- Machinery: Weighted average of 19. Machinery, 20. Electrical Machinery and 23. Precision Machinery
- Vehicle: Weighted average of 21 Motor vehicles and 22 Transporting Machinery

Relative capital service prices of 4 countries to Japan are calculated by using all of these data, and the results are presented in Table 6. In Table 6, some very large relative capital prices can be found. For example, capital price of leather sector in China is 48.75 times as high as that in Japan. Such large numbers come from high annualization factor in China, and more specifically, the rate of return (r) in this factor is very large. It is difficult to explain the rate of return in some particular sectors is very high, as compared to that of other factors. In such sectors, rental service formula based upon perfect competition at capital market may not be an appropriate.

4. Relative TFP Levels

Based on all of output and input prices described in previous section, relative TFP levels of China, Korea, Taiwan and US to Japan are calculated by using equation (6). Before getting into details at industry level, Table 7 and Table 8 summarize the results of relative prices and TFP. In Table 7, industry level results are aggregated to macro economy level, and Table 8 shows aggregated figures for manufacturing. In a process of coming up with these tables, TFP estimates for construction sector (sector 5) and other private services (sector 32) are deleted from the samples, because possible errors in these two sectors with large value added share may bias aggregated TFP significantly. In construction sector, unit price of buildings is used for relative output prices. However, relative land price is not controlled in this study. As is shown in Table 2, relative price of Japan is much higher than those of the other countries, which reflects higher land price in Japan. Without controlling for land price, Japanese relative TFP will be biased downward significantly. In addition, private services consist of heterogeneous activities, and these are difficult sectors to come up with UVRs. In addition, the observations with

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for this factor, please refer to each corresponding paper.

very high value for relative capital services, which has been pointed out previous section, are also taken out of the samples.

Table 8. Economy-wide relative prices and TFP

	China	Korea	Taiwan	US
Output Price	0.29	0.68	0.54	0.68
Capital Price	1.63	1.62	1.09	1.44
Labor Price	0.02	0.21	0.28	0.68
Energy Price	0.27	0.53	0.50	0.53
Material Price	0.30	0.57	0.46	0.60
TFP	0.76	0.84	0.87	1.09

Table 9. Manufacturing relative prices and TFP

	China	Korea	Taiwan	US
Output Price	0.45	0.75	0.56	0.78
Capital Price	2.41	1.50	0.86	1.96
Labor Price	0.03	0.23	0.30	0.80
Energy Price	0.27	0.52	0.53	0.51
Material Price	0.36	0.72	0.54	0.70
TFP	0.66	0.84	0.92	1.04

In general, prices in Japan are higher than those of the other countries, except capital service price. This is due to the fact that Japanese yen was relatively expensive as compared to other currencies at the benchmark year of 1995. In contrast, capital service price of Japan is lower, because sluggish economic activities in 1990's lowered rate of return from investment. At macro economy level, , TFP levels of China, Korea and Taiwan are 24%, 16% and 13% lower than that of Japan, respectively. On the other hand, US TFP level is 9% higher than that of Japan. Japan's relative position of manufacturing industry to China and US becomes better. However, Taiwan's relative position gets closer to Japan.

It is interesting to look at the results for China. Relative labor input price in China is very low, such 2 or 3 % of Japanese level. However, relative capital price is higher in China, reflecting higher rate of return on asset. At the end, relative TFP of China to Japan is not so low, such as 76% or 66%. This may be due to the result of economic reform in China toward market based system, and catching up with developed economies by attracting substantial amount of foreign direct investment.

There are a couple of data issues to interpret the results in Table 8 and 9, correctly. First one is possible impact of exchange rate volatility in productivity estimates. Due to

relatively expensive Japanese yen in 1995, Japanese prices look high in general. An average exchange rate to US dollar in 1995 is 94 yen per dollar, as compared to around 110 yen in 2005, and this is the case for the other currencies, pegged with US dollar. Although such fluctuation of exchange rate affects relative prices, relative TFP is not subject to be biased. As is shown in equation (6), changes in exchange rate in output and input prices will be cancelled out.

Second, the figures in these tables are those of bilateral comparison with Japan, instead of multilateral comparison. In Table 8, the relative position of Korean TFP is lower than that of Taiwan, when they are compared to that of Japan. However, this does not always imply that Taiwanese TFP is higher than Korean one. In bilateral comparison scheme presented in section 2, transitivity of index numbers (A-C can be derived from A-B and B-C) cannot be held. In order to make comparison between Taiwan and Korea, it is necessary to compare these two countries directly, instead of comparing indices to Japan. Or, it is possible to come up with multilateral comparative index. However a downside of multilateral index is loosing bilateral productivity information, because common denominators are getting smaller. Kuroda et. al (1996) provides more detail discussion on multilateral comparative index.

Cross section information in Table 8 and Table 9 can be extended to time series information, based on TFP growth statistics in each country, provided by ICPA project participants. Figure 1 and Figure 2 show changes in relative TFP position for five countries for whole economy and manufacturing sector, respectively.

Figure 1: Changes in relative TFP positions for whole economy (Japan, 1995=1)

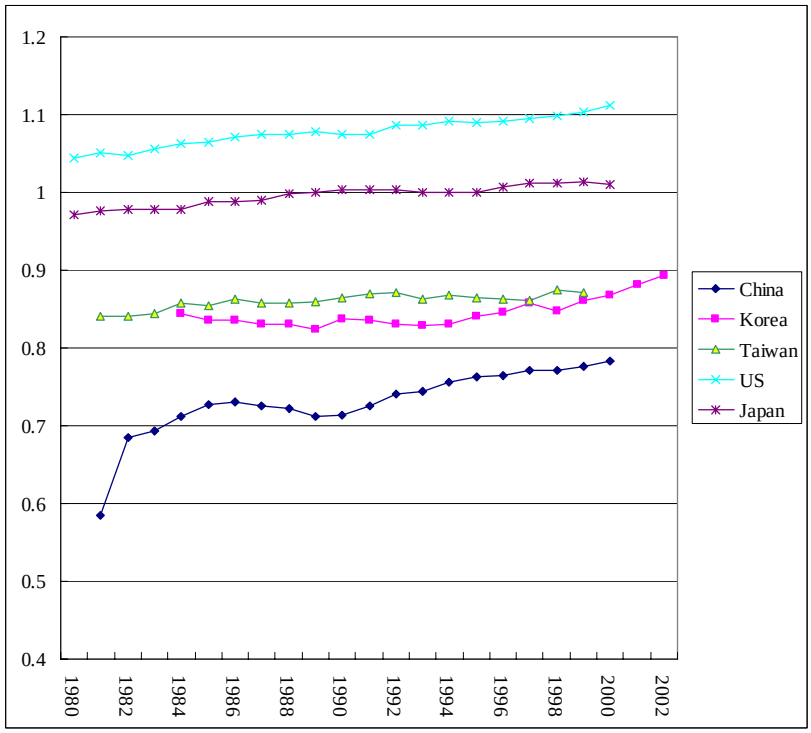
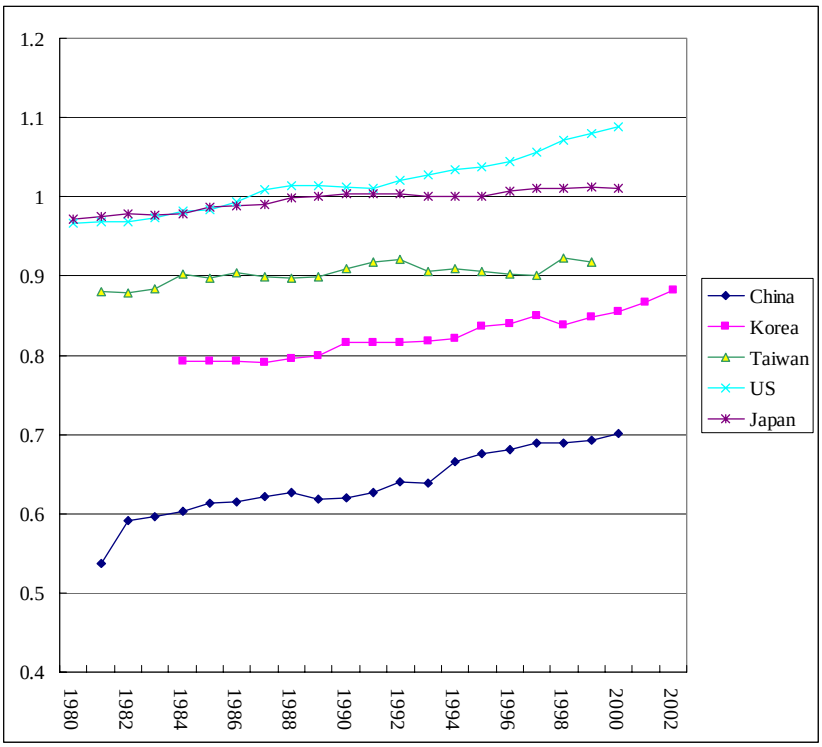


Figure 2: Changes in relative TFP positions for manufacturing (Japan, 1995=1)



Within a period of about 20 years, it is difficult to see a long term trend of TFP of each country. However, China, Taiwan and Korea look like catching up with Japan, while the difference between Japan and the United States are getting larger. This is due to the fact that Japan's TFP growth rate became slower in 1990's. However, the productivity differences between Japan and other Asian countries are still large, and it will take substantial time for them to catch up with Japan's levels.

Finally, Table 9 presents industry level relative TFP, and Figure 3 is a graph presenting productivity differences as compared to Japan. In general, TFP levels of manufacturing industries in Japan are higher than the other countries. Exceptions include food production, lumber and wood, petroleum and coal products, and leather. In addition, TFPs in the US and Korea are higher than that of Japan in fabricated metals, and Japan's productivity in machinery is almost par with those of US, Korea and Taiwan. On the other hand, Japan keeps a top position for primary metals, electrical machinery, motor vehicles, and instruments.

Outside manufacturing sectors, relative TFP data look a little noisy. There is a large variation of data in mining, trade and other services sectors. Japan's TFPs in transportation, communication, and gas utility sectors are relatively high, while it is lower in finance and insurance sector. TFP levels in construction sector are low in Japan, but this figure will be under biased due the problem with not controlling for land price.

(Figure 3)

5. Conclusion

In this paper, relative productivity levels of Japan to China, Korea, Taiwan and US are estimated to assess Japan's industrial competitiveness. Under the RIETI's ICPA project, comparable KLEM dataset have been constructed in these five countries. Relative output and input price data are matched with this KLEM data, and relative TFP levels by 33 industries are estimated. This cross section information in 1995 are extended by using TFP growth estimates by each countries, to see dynamics of Japan's position among Asian countries and US.

It is found that TFP growth rate in Japan have slowed down after the burst of economic bubbles, and China, Korea and Taiwan are catching up with Japan, particularly in 1990's. In addition, US productivity level is higher than that of Japan, and the difference has widened since 1990's. These findings suggest loosing competitiveness position of Japan in East Asia as well as in the world.

However, it is also found that the productivity differences between Japan and three other Asian countries are still large. From 1981 to 2000, TFP growth rate of China is about 0.8%, while that of Japan is 0.2%. The productivity gap between these two countries is 23.5% in 2000. Then, it will take 45 years for China to catch up with Japan by simple trend estimate.

Once such macro level findings are decomposed into industry level observations, Japan is relatively strong in manufacturing sectors, particularly electrical machinery, motor vehicles and instruments. However, it is also true that Japanese industry have caught up with Korea and Taiwan in fabricated metals and general machinery. In this paper, a great heterogeneity in productivity performance across industries can be found. Therefore, catching up of Asian countries to Japan is not a simple story of macro level trend. It is important to analyze changes of productivity levels in detail by industry.

In order to come up with robust conclusions from industry level productivity performance, more efforts for international comparability is needed. The industrial classification of ICPA project is still broad. Even though relative output prices are derived from detail commodity level UVRs, further efforts in controlling for quality differences have to be made. In addition it is important to keep in mind that there is a substantial difference in data methodology in statistical offices across countries. It is found that differences in the methodology of IT price index between Japan and US make a significant change in growth accounting results (Jorgenson and Motohashi, 2005). RIETI's ICPA project is a first attempt to analyze industry level productivity performance in Asian countries and US. This is a great step to shed new light on structural changes and dynamics of Asian economies, but this is an initial step which needs further developments.

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Table 1: Relative Output Price (Original Data)

		Year	Yen/US$ GGDC	Won/US$ GGDC	NT$/US$ GGDC	RMB/US$ Ruoen
1	Agriculture	1995	653	2880	59.1	7.16
2	Coal mining	1997	656	2180	139.8	4.34
3	Metal and nonmetallic mining	1997	132	1096	28.9	1.88
4	Oil and gas extraction	1997	362	1322	80.7	8.05
5	Construction	1997	218	799	15.9	3.68
6	Food and kindred products	1997	293	1439	34.2	4.09
7	Textile mill products	1997	150	930	24.4	4.67
8	Apparel	1997	169	1399	25	4.14
9	Lumber and wood	1997	261	999	26	5.79
10	Furniture and fixtures	1997	154	653	23.6	5.79
11	Paper and allied	1997	159	974	24.3	4.56
12	Printing,publishing and allied	1997	159	974	24.3	4.56
13	Chemicals	1997	167	947	23.1	6.13
14	Petroleum and coal products	1997	265	962	23.1	6.13
15	Leather	1997	213	928	19.6	1.94
16	Stone, clay, glass	1997	127	679	21	4.53
17	Primary metal	1997	130	986	24.8	5.1
18	Fabricated metal	1997	177	789	25.9	5.1
19	Machinery, non-elect	1997	153	705	17.7	5.59
20	Electrical machinery	1997	103	798	19.2	3.67
21	Motor Vehicles	1997	111	816	31.4	5.59
22	Transportation equipment and ordnance	1997	156	816	31.4	5.59
23	Instruments	1997	103	836	24.3	3.67
24	Rubber and misc plastics	1997	115	726	24.3	2.37
25	Misc manufacturing	1997	154	882	23.6	4.93
26	Transportation	1997	205	802	46.7	3.32
27	Communication	1997	139	874	12.5	4.34
28	Electrical utilities	1997	236	967	31.9	4.35
29	Gas utilities	1997	94	1000	59.1	1.43
30	Trade	1997	186	1029	22.2	1.08
31	Finance Insurance and Real Estate	1997	205	871	13.6	4.32
32	Other private services	1997	316	685	21.6	0.73
33	Public service	1997	167	553	41.1	1.03

Note GGDC data: 1997 data except Agriculture in 1995
Ruoen data: 1995

(1) Wood Product, Furniture, and Fixture
(2) Paper, printing and publishing
(3) Chimical (incl. Oil Refinery)
(4) Basic and Fablicated Metals
(5) Machinery & Trasporting Equipment
(6) Electrical Machinery

Table 2: Relative Output Price (JP=1.00)

		China	Korea	Taiwan	US
1	Agriculture	0.12	0.54	0.32	0.14
2	Coal mining	0.10	0.42	0.79	0.18
3	Metal and nonmetallic mining	0.21	1.06	0.82	0.92
4	Oil and gas extraction	0.32	0.46	0.83	0.33
5	Construction	0.24	0.47	0.27	0.56
6	Food and kindred products	0.20	0.62	0.43	0.41
7	Textile mill products	0.45	0.79	0.60	0.81
8	Apparel	0.36	1.06	0.55	0.72
9	Lumber and wood	0.32	0.49	0.37	0.46
10	Furniture and fixtures	0.55	0.54	0.57	0.79
11	Paper and allied	0.42	0.78	0.56	0.76
12	Printing,publishing and allied	0.42	0.78	0.56	0.76
13	Chemicals	0.53	0.72	0.51	0.72
14	Petroleum and coal products	0.34	0.46	0.32	0.46
15	Leather	0.13	0.56	0.34	0.57
16	Stone, clay, glass	0.52	0.68	0.61	0.95
17	Primary metal	0.57	0.97	0.71	0.93
18	Fabricated metal	0.42	0.57	0.54	0.68
19	Machinery, non-elect	0.53	0.58	0.43	0.79
20	Electrical machinery	0.52	0.99	0.69	1.18
21	Motor Vehicles	0.73	0.93	1.04	1.09
22	Transportation equipment and ordnance	0.52	0.67	0.74	0.78
23	Instruments	0.52	1.04	0.88	1.18
24	Rubber and misc plastics	0.30	0.80	0.78	1.05
25	Misc manufacturing	0.46	0.73	0.57	0.79
26	Transportation	0.24	0.50	0.85	0.59
27	Communication	0.45	0.80	0.33	0.87
28	Electrical utilities	0.27	0.52	0.50	0.51
29	Gas utilities	0.22	1.35	2.32	1.28
30	Trade	0.08	0.70	0.44	0.65
31	Finance Insurance and Real Estate	0.30	0.54	0.25	0.59
32	Other private services	0.03	0.28	0.25	0.38
33	Public service	0.09	0.42	0.91	0.72

Table 3: Relative Energy Price (JP=1.00)

		China	Korea	Taiwan	US
1	Agriculture	0.31	0.50	0.40	0.51
2	Coal mining	0.25	0.52	0.50	0.39
3	Metal and nonmetallic mining	0.30	0.50	0.38	0.53
4	Oil and gas extraction	-	-	-	-
5	Construction	0.32	0.52	0.41	0.49
6	Food and kindred products	0.26	0.63	0.62	0.67
7	Textile mill products	0.26	0.63	0.58	0.60
8	Apparel	0.27	0.56	0.51	0.60
9	Lumber and wood	0.27	0.54	0.49	0.55
10	Furniture and fixtures	0.28	0.57	0.51	0.58
11	Paper and allied	0.26	0.55	0.54	0.60
12	Printing,publishing and allied	0.27	0.57	0.55	0.60
13	Chemicals	0.28	0.52	0.49	0.56
14	Petroleum and coal products	0.27	0.46	0.62	0.41
15	Leather	0.27	0.56	0.47	0.59
16	Stone, clay, glass	0.26	0.52	0.62	0.60
17	Primary metal	0.28	0.51	0.47	0.55
18	Fabricated metal	0.27	0.56	0.53	0.62
19	Machinery, non-elect	0.27	0.56	0.53	0.60
20	Electrical machinery	0.27	0.59	0.50	0.58
21	Motor Vehicles	0.27	0.56	0.51	0.59
22	Transportation equipment and ordnance	0.28	0.55	0.52	0.58
23	Instruments	0.27	0.63	0.55	0.59
24	Rubber and misc plastics	0.27	0.55	0.51	0.58
25	Misc manufacturing	0.27	0.58	0.46	0.58
26	Transportation	0.32	0.49	0.40	0.49
27	Communication	0.28	0.57	0.58	0.61
28	Electrical utilities	0.23	0.58	0.52	0.49
29	Gas utilities	0.23	0.78	1.02	0.74
30	Trade	0.30	0.53	0.47	0.55
31	Finance Insurance and Real Estate	0.26	0.64	0.63	0.61
32	Other private services	0.28	0.66	0.77	0.65
33	Public service	0.28	0.59	0.51	-

Table 4: Relative Material Price (JP=1.00)

		China	Korea	Taiwan	US
1	Agriculture	0.23	0.59	0.41	0.42
2	Coal mining	0.30	0.49	0.39	0.61
3	Metal and nonmetallic mining	0.32	0.54	0.56	0.71
4	Oil and gas extraction	-	-	-	-
5	Construction	0.37	0.62	0.53	0.68
6	Food and kindred products	0.18	0.57	0.39	0.40
7	Textile mill products	0.37	0.69	0.50	0.68
8	Apparel	0.36	0.69	0.51	0.70
9	Lumber and wood	0.26	0.54	0.39	0.45
10	Furniture and fixtures	0.35	0.61	0.45	0.68
11	Paper and allied	0.33	0.70	0.50	0.68
12	Printing,publishing and allied	0.35	0.66	0.50	0.68
13	Chemicals	0.37	0.64	0.48	0.65
14	Petroleum and coal products	0.28	0.72	0.61	0.72
15	Leather	0.22	0.61	0.42	0.61
16	Stone, clay, glass	0.34	0.70	0.57	0.74
17	Primary metal	0.44	0.88	0.63	0.82
18	Fabricated metal	0.44	0.77	0.58	0.78
19	Machinery, non-elect	0.46	0.68	0.53	0.81
20	Electrical machinery	0.43	0.81	0.59	0.90
21	Motor Vehicles	0.54	0.82	0.79	0.90
22	Transportation equipment and ordnance	0.47	0.70	0.61	0.79
23	Instruments	0.41	0.73	0.62	0.86
24	Rubber and misc plastics	0.36	0.66	0.50	0.68
25	Misc manufacturing	0.37	0.67	0.52	0.72
26	Transportation	0.32	0.52	0.53	0.59
27	Communication	0.29	0.51	0.36	0.61
28	Electrical utilities	0.27	0.56	0.41	0.60
29	Gas utilities	0.27	0.58	0.44	0.60
30	Trade	0.26	0.53	0.35	0.57
31	Finance Insurance and Real Estate	0.27	0.48	0.29	0.55
32	Other private services	0.28	0.55	0.41	0.59
33	Public service	0.26	0.53	0.49	-

Table 5: Relative Labor Price (JP=1.00)

		China	Korea	Taiwan	US
1	Agriculture	0.01	0.47	0.45	0.71
2	Coal mining	0.02	0.18	0.26	0.60
3	Metal and nonmetallic mining	0.04	0.34	-	1.00
4	Oil and gas extraction	0.07	-	-	0.97
5	Construction	0.08	0.36	0.39	0.84
6	Food and kindred products	0.04	0.26	0.35	0.87
7	Textile mill products	0.03	0.31	0.36	0.93
8	Apparel	0.04	0.32	0.36	0.82
9	Lumber and wood	0.02	0.30	0.30	0.80
10	Furniture and fixtures	0.02	0.22	0.27	0.68
11	Paper and allied	0.04	0.22	0.29	0.80
12	Printing,publishing and allied	0.02	0.19	0.28	0.65
13	Chemicals	0.02	0.13	0.14	0.58
14	Petroleum and coal products	0.06	0.32	0.42	1.06
15	Leather	0.09	0.33	0.38	0.95
16	Stone, clay, glass	0.04	0.25	0.31	0.83
17	Primary metal	0.06	0.22	0.29	0.83
18	Fabricated metal	0.04	0.25	0.30	0.86
19	Machinery, non-elect	0.02	0.23	0.28	0.82
20	Electrical machinery	0.04	0.22	0.31	0.82
21	Motor Vehicles	0.03	0.18	-	0.97
22	Transportation equipment and ordnance	0.01	0.20	0.25	0.66
23	Instruments	0.01	0.23	-	0.97
24	Rubber and misc plastics	0.04	0.25	0.29	0.76
25	Misc manufacturing	0.04	0.27	0.35	0.84
26	Transportation	0.02	0.14	0.23	0.47
27	Communication	0.03	0.19	-	0.61
28	Electrical utilities	0.02	0.17	0.36	0.79
29	Gas utilities	0.04	0.31	-	1.11
30	Trade	0.02	0.18	0.24	0.46
31	Finance Insurance and Real Estate	0.08	0.25	0.52	1.00
32	Other private services	0.02	0.20	0.28	0.53
33	Public service				

Table 6: Relative Capital Price (JP=1.00)

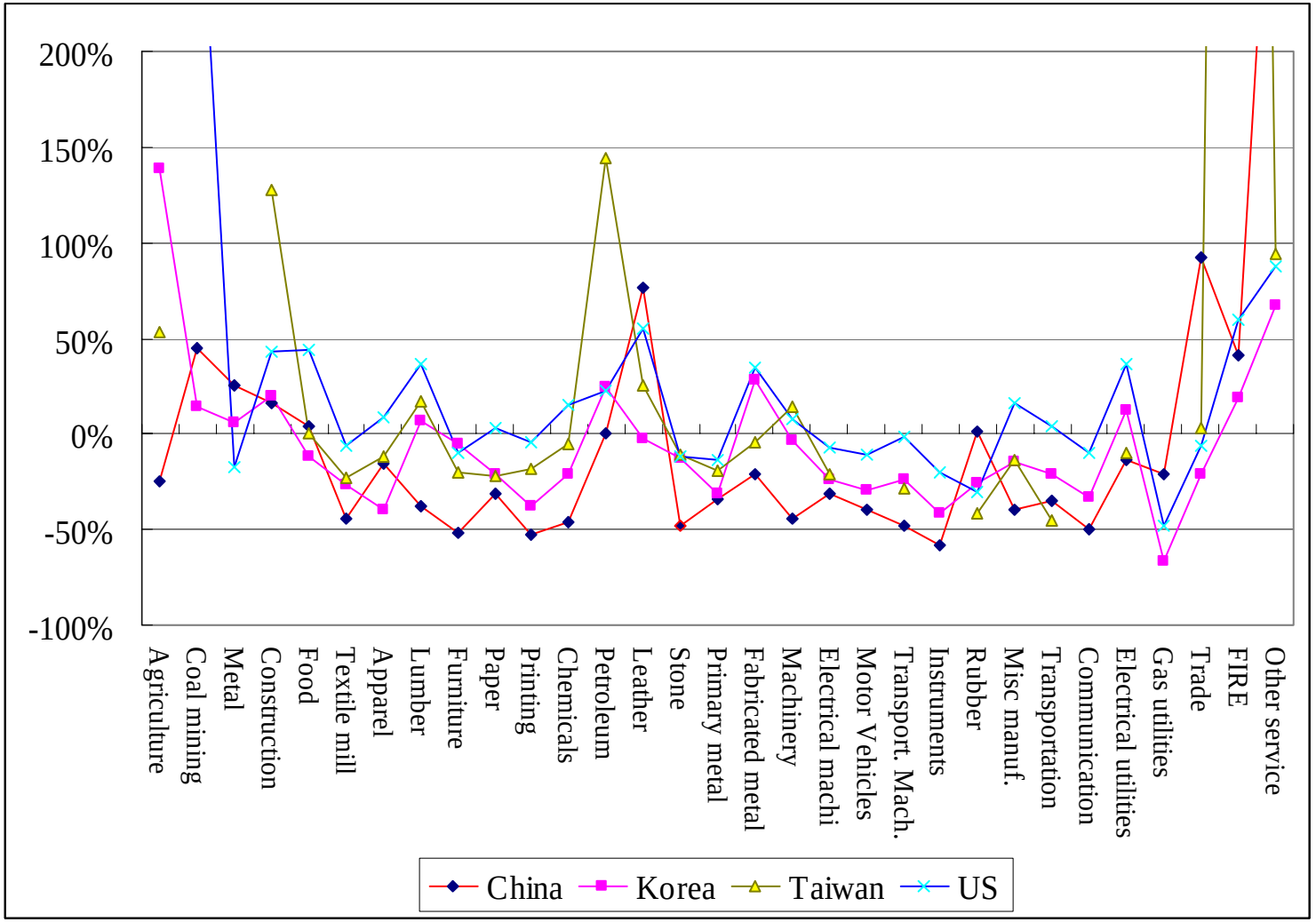
		China	Korea	Taiwan	US
1	Agriculture	0.91	4.64	0.86	0.78
2	Coal mining	1.49	2.12	-	2.50
3	Metal and nonmetallic mining	0.90	4.74	-	0.67
4	Oil and gas extraction	-	-	-	-
5	Construction	1.16	1.06	3.23	1.73
6	Food and kindred products	3.78	1.30	1.01	2.45
7	Textile mill products	4.34	1.07	0.74	1.02
8	Apparel	33.73	4.54	0.70	2.25
9	Lumber and wood	4.45	2.28	1.75	4.21
10	Furniture and fixtures	31.36	2.71	1.34	1.66
11	Paper and allied	1.74	1.04	0.23	1.36
12	Printing,publishing and allied	3.33	1.84	0.58	1.92
13	Chemicals	0.91	1.16	0.94	2.14
14	Petroleum and coal products	1.47	0.71	1.88	0.56
15	Leather	48.75	1.99	0.90	11.94
16	Stone, clay, glass	4.86	1.96	1.46	1.86
17	Primary metal	1.13	0.43	0.64	0.83
18	Fabricated metal	9.16	5.15	0.67	2.70
19	Machinery, non-elect	1.90	1.10	0.60	1.39
20	Electrical machinery	2.93	2.30	0.94	3.51
21	Motor Vehicles	4.16	1.28	-	2.36
22	Transportation equipment and ordnance	2.20	0.54	0.60	1.32
23	Instruments	3.31	3.58	-	1.75
24	Rubber and misc plastics	8.90	2.05	0.88	1.16
25	Misc manufacturing	2.53	2.77	0.81	4.55
26	Transportation	2.23	2.27	1.30	1.86
27	Communication	0.76	1.38	-	1.32
28	Electrical utilities	0.42	0.80	0.48	0.78
29	Gas utilities	0.25	0.28	-	0.47
30	Trade	4.65	3.39	2.29	2.28
31	Finance Insurance and Real Estate	1.07	1.14	17.73	1.28
32	Other private services	1.31	2.60	2.61	3.25
33	Public service				

Table 7: Relative Total Factor Productivity (JP=1.00)

		China	Korea	Taiwan	US
1	Agriculture	0.75	2.39	1.53	4.03
2	Coal mining	1.45	1.14	-	4.24
3	Metal and nonmetallic mining	1.25	1.05	-	0.82
4	Oil and gas extraction	-	-	-	-
5	Construction	1.16	1.20	2.27	1.43
6	Food and kindred products	1.04	0.88	1.00	1.44
7	Textile mill products	0.56	0.73	0.77	0.94
8	Apparel	**0.84**	0.61	0.89	1.08
9	Lumber and wood	0.62	1.07	1.17	1.36
10	Furniture and fixtures	**0.48**	0.95	0.80	0.90
11	Paper and allied	0.68	0.79	0.78	1.03
12	Printing,publishing and allied	0.47	0.62	0.81	0.96
13	Chemicals	0.54	0.79	0.95	1.15
14	Petroleum and coal products	1.00	1.25	2.44	1.23
15	Leather	**1.76**	0.98	1.25	**1.56**
16	Stone, clay, glass	0.52	0.88	0.89	0.89
17	Primary metal	0.66	0.69	0.81	0.86
18	Fabricated metal	0.79	1.28	0.96	1.35
19	Machinery, non-elect	0.55	0.96	1.14	1.08
20	Electrical machinery	0.68	0.76	0.79	0.93
21	Motor Vehicles	0.60	0.70	-	0.89
22	Transportation equipment and ordnance	0.52	0.76	0.71	0.99
23	Instruments	0.42	0.58	-	0.80
24	Rubber and misc plastics	1.02	0.74	0.58	0.70
25	Misc manufacturing	0.61	0.85	0.87	1.16
26	Transportation	0.65	0.79	0.54	1.04
27	Communication	0.50	0.67	-	0.90
28	Electrical utilities	0.86	1.13	0.90	1.37
29	Gas utilities	0.79	0.34	-	0.52
30	Trade	1.92	0.79	1.03	0.94
31	Finance Insurance and Real Estate	1.41	1.18	**15.92**	1.60
32	Other private services	4.67	1.67	1.94	1.88
33	Public service	-	-	-	-

Note: Figures in bold font are derived by using capital prices over 10.

Figure 3: Relative TFP by Industry in 1995



Appendix : Sector Classification for ICPA Project

Table A Classification of Industry

1	Agriculture
2	Coal mining
3	Metal and non-metallic mining
4	Oil and gas extraction
5	Construction
6	Food and kindred products
7	Textile mill products
8	Apparel
9	Lumber and wood
10	Furniture and fixtures
11	Paper and allied
12	Printing, publishing and allied
13	Chemicals
14	Petroleum and coal products
15	Leather
16	Stone, clay, glass
17	Primary metal
18	Fabricated metal
19	Machinery, non-elect
20	Electrical machinery
21	Motor vehicles
22	Transportation equipment & ordnance
23	Instruments
24	Rubber and misc plastics
25	Misc. manufacturing
26	Transportation
27	.Communications
28	Electric utilities
29	Gas utilities
30	Trade
31	Finance Insurance and Real Estate
32	Other private service(*)
33	Public service(*)

* :The definition of 33 is government administration only and the rest of services should be put into 32

Table B Labor input
(cross classified as follows)

Industry	
	33 sectors in Table A
sex	
1	1.male
2	2.female
Age(*)	
1	16-34
2	35-54
3	55-
Education	
1	Junior high school or less
2	High school
3	College/University

*: A little modification can be made depending on data availability

Table C Capital input
(cross classified as follows)

Industry	
	33 sectors in Table A
asset type(*)	
1	structure
2	equipment
3	vehicles

*: Land and inventory should be estima as well, if possible