

International Comparison of Productivity Growth in China, Japan and South Korea

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Abstract

There are two opinions about China's productivity growth. The one is that economic growth is rapid but productivity growth is slow. The other is that not only economic growth but also productivity growth is rapid. We try to draw a conclusion about this question from statistical data. We will compare China's productivity growth in 1987-2007 to Japan's one in 1960-2005 (especially in 1960s of the high rapid growth period) and South Korea's one in 1975-2005 (especially from the late 1980s to the early 1990s of the high rapid growth period) by using input-output tables and analyze them. Our calculation results show the following. In China in 1987-1992, although economic growth was rapid, productivity growth was slow. But in 1992-1997, 1997-2002 and 2002-2005, not only economic growth but also productivity growth was rapid. It was by no means slower to those of Japan in 1960s and South Korea in 1985-1995, when those were the most rapid. We measured productivity growths of the three countries by using the indicator of total labor productivity (TLP, ratio of output to direct and indirect labor). Indirect labor means labor used for production of raw material, machine etc. We think that TLP is better indicator of productivity growth than traditional total factor productivity (TFP) in respects that TLP is productivity which includes fixed capital efficiency and that TLP can be measured regardless of competition condition etc. By bringing up TLP, we would like to contribute to improvement in method of measuring productivity.

Keywords: Total factor productivity, total labor productivity, input-output table, China's economic growth

1. Introduction

Japanese economy has realized high rapid growth of a little more than 10% annually from 1950s to the beginning of 1970s. South Korean economy has also achieved high rapid growth of nearly 10% annually from the second half of 1960s to the beginning of 1990s. These two countries' high rapid growths which lasted a quarter of century or 30 years are thought as unusual in the long history of

human-being and attracted the attention of many people in the world.

Chinese rapid economic growth from the end of 1970s to now is more worthy of notice in that it has continued in longer period than Japan's and South Korea's high rapid growth and also that it is the rapid economic growth of the largest population country and therefore it will have larger influence to the world economy.

We will compare China's productivity growth in 1987-2007 to Japan's one in 1960-2005 (especially in 1960s of the high rapid growth period) and South Korea's one in 1975-2005 (especially from the late 1980s to the early 1990s of the high rapid growth period) by using input-output tables and analyze them.

2. Total Factor Productivity (TFP) and Total Labor Productivity (TLP)

We have used not Total Factor Productivity (TFP) but Total Labor Productivity (TLP) to compare productivity growth among Japan, South Korea and China, because of the following reasons.

First, TFP presupposes perfect competition and cost minimization. But such conditions do not exist, to say nothing in China, also in Japan and South Korea.

Second, input factors of TFP are capital service, labor service, etc. But if we use capital service as input factor, we cannot measure improvement of fixed capital as rise of productivity. Because when fixed capitals are improved, capital services, that is, one of input factors increase, and therefore productivity, that is, ratio of output to input does not rise. We think that improvement of fixed capital, especially improvement of machine is important factor in rise of productivity.

TLP is ratio output to total of direct labor and indirect labor. Direct labor means labor quantity (not labor service) used in the industry where each product is produced. Indirect labor means labor quantity (not labor service) used for production of intermediate input and (depreciation portion of) fixed capital.

TLP does not need the assumption of perfect competition and cost minimization.

When fixed capitals are improved, if increase of labor quantity used for production of fixed capital is smaller than decrease of direct labor quantity etc, TLP rises.

3. Method for calculation of TLP growth

We will measure productivity growths of these three countries by using the two indicators of total labor productivity (TLP, ratio of output to direct and indirect labor). The one is **TLP growth of product** and the other is **TLP growth within industry**. In the former, intermediate input coefficient, fixed capital consumption coefficient, labor coefficient of all industries and share of export commodity are changed from the beginning of a period to the end of it. In the latter, it is assumed that intermediate input coefficient, fixed capital consumption coefficient, labor coefficient of the industry concerned are changed from the beginning of a period to the end, but those of all other

industries and share of export in the end of a period are the same as those in the beginning.

(1) Calculation of total labor per a unit price of domestic product, using national input-output table and employment table

- t : total labor per a unit price of domestic product, a row vector
- A : input coefficient of domestic intermediate, a matrix
- D : consumption coefficient of domestic fixed capital, a matrix
- e : share of export commodity, a column vector
- m : input coefficient of import material + consumption coefficient of import fixed capital, a row vector
- r : direct labor coefficient, a row vector

$$t = t(\mathbf{A} + \mathbf{D}) + t \cdot \mathbf{e} \cdot \mathbf{m} + \mathbf{r} \tag{1}$$

Substantial meanings of equation (1) are as follows.

$t \cdot A$ is a row vector indicating labor quantity inputted in the domestic raw materials necessary per a unit price of domestic product. $t \cdot D$ is a row vector indicating labor quantity inputted in the decrease of domestic fixed capitals necessary per a unit price of domestic product. $t \cdot e$ is a scalar indicating average total labor quantity per a unit price of domestic product calculated using products share in export as weight. $(t \cdot e) \cdot m$ is a row vector indicating labor quantity inputted in the import raw materials and the decrease of import fixed capitals necessary per a unit price of domestic product on the assumption that the labor quantity inputted in one dollar of import equals the average labor quantity inputted in one dollar of export. r is a row vector indicating direct labor quantity per a unit constant price of domestic product.

To sum up, equation(1) means that total labor quantity equals direct labor quantity plus labor quantity inputted in the domestic raw materials and the domestic fixed capitals plus labor quantity inputted in the import raw materials and the import fixed capitals.

If we solve (1) concerning t

$$t = \mathbf{r}(\mathbf{I} - \mathbf{A} - \mathbf{D} - \mathbf{e} \cdot \mathbf{m})^{-1} \tag{2}$$

(2) Calculation of domestic product quantity per a unit quantity of labor

- v : domestic product quantity per a unit quantity of labor, a row vector

$$v = [v_1, v_2, \dots, v_n] = \left[\frac{1}{t_1}, \frac{1}{t_2}, \dots, \frac{1}{t_n} \right] \tag{3}$$

(3) Calculation of TLP growth

$$\begin{aligned}
 G &= \left[\frac{v_1^1 - v_1^0}{v_1^0}, \frac{v_2^1 - v_2^0}{v_2^0}, \dots, \frac{v_n^1 - v_n^0}{v_n^0} \right] \\
 &= \left[\frac{t_1^0 - t_1^1}{t_1^1}, \frac{t_2^0 - t_2^1}{t_2^1}, \dots, \frac{t_n^0 - t_n^1}{t_n^1} \right] \quad (4)
 \end{aligned}$$

4. Data

We have used the following data to calculate TLP growth of Japan, South Korea and China.

Government of Japan: Management and Coordination Agency

“1960-1965-1970 Linked Input-Output Tables”, “1970-1975-1980 Linked Input-Output Tables”, “1980-1985-1990 Linked Input-Output Tables”, “1990-1995-2000 Linked Input-Output Tables”, “1995-2000-2005 Linked Input-Output Tables”, “1970 Fixed Capital Formation Matrix”, “1980 Fixed Capital Formation Matrix”, “1990 Fixed Capital Formation Matrix”, “2000 Fixed Capital Formation Matrix”, “2005 Fixed Capital Formation Matrix”

The Bank of Korea

“1975-1980-1985 Link Input-output Tables”, “1980-1985-1990 Link Input-output Tables”, “1985-1990-1995 Link Input-output Tables”
 “1990-1995-2000 Link Input-output Tables”, “1995-2000-2005 Link Input-output Tables”, “1990 Fixed Capital Formation Matrix”, “1995 Fixed Capital Formation Matrix”, “2000 Fixed Capital Formation Matrix”, “2005 Fixed Capital Formation Matrix”

National Bureau of Statistics of China

“1987 Input-Output Table of China”, “1992 Input-Output Table of China”, “1997 Input-Output Table of China”, “2002 Input-Output Table of China”, “2007 Input-Output Table of China”, “2005 China Statistical Yearbook”, “2009 China Statistical Yearbook”, “2000 Population Census”, “2005 Population Sample Survey”, “2010 Population Census”, “2004 Economic Census”, “2008 Economic Census”

5. Conclusions

In China in 1987-1992, although economic growth was rapid, productivity growth was slow. But in 1992-1997, 1997-2002 and 2002-2007, not only economic growth but also productivity growth was rapid. It was by no means much slower to those of Japan in 1960s and South Korea in 1985-1995, when those were the most rapid. Table of Calculation Results shows that TLP growth rates of product in average of all industries in China were 8.57% in 1992-1997, 8.91% in 1997-2002 and 7.82% in 2002-2007, while those in Japan were 9.68% in 1960s and those in South Korea were 9.34% in 1985-1990 and 8.74% in 1990-1995. Also this table shows that all TLP growth rates of product in 19 industries of China were large.

6. Tables of Calculation Results

(1) TLP Growth of Product in Japan

	annual rate					%
	60-70	70-80	80-90	90-00	00-05	
1 Agriculture, forestry and fishery	5.03	3.27	3.41	0.77	0.26	
2 Mining	12.92	5.55	3.41	1.66	-0.25	
3 Foods	7.56	5.27	1.88	2.23	-0.33	
4 Textiles, wearing apparel and leather	7.45	6.61	2.62	0.57	-0.65	
5 Pulp, paper and wooden products	10.39	5.01	3.66	0.91	0.03	
6 Chemicals	14.99	7.30	5.85	1.18	-1.12	
7 Petroleum and coal products	9.92	5.62	6.00	1.25	-8.69	
8 Ceramic, stone and clay products	10.44	4.44	3.37	0.31	0.03	
9 Iron and steel	12.45	7.25	4.31	1.22	-5.82	
10 Non-ferrous metals	9.24	6.33	2.25	1.19	-5.28	
11 Metal products	11.06	5.45	1.78	0.65	-1.80	
12 General machinery	11.90	6.23	3.82	-0.07	0.36	
13 Electric machinery	12.17	9.62	6.16	2.98	6.11	
14 Transportation equipment	10.41	8.34	3.65	0.26	0.10	
15 Precision instruments	9.33	8.89	5.17	0.22	1.65	
16 Miscellaneous manufacturing	11.84	3.04	4.07	-0.05	-0.10	
17 Constructio	9.53	2.97	2.81	-1.00	-1.08	
18 Electricity, gas, and heat supply	9.74	4.89	2.27	1.94	-2.68	
19 Water and waste	5.91	-2.81	1.42	-1.12	-0.86	
20 Commerce	10.90	3.94	0.33	1.27	2.80	
21 Finance and insurance	3.97	3.02	2.78	2.36	0.55	
22 Real estate	3.47	3.31	1.10	-2.18	0.48	
23 Transport	8.41	3.31	1.73	0.65	-0.61	
24 Communication and broadcasting	9.62	5.69	4.72	1.89	1.59	
25 Public administration	0.02	3.42	2.12	0.06	0.62	
26 Education and research	0.22	1.67	2.14	0.22	-0.85	
27 Medical service and social security	5.77	2.55	1.94	0.10	-0.92	
28 Other public services	0.19	7.08	0.54	0.54	2.32	
29 Business services	9.75	0.40	2.17	-0.04	1.06	
30 Personal services	6.14	0.36	2.86	-0.94	-1.49	
31 Office supplies	11.05	3.40	2.88	0.62	1.24	
32 Activity not elsewhere classified	10.18	2.56	3.87	-1.72	-7.53	
Average	9.68	3.49	3.81	1.14	0.21	

(2) TLP Growth of Product in South Korea

	annual rate					%
	75-80	80-85	85-90	90-95	95-00	
1 Agriculture, forestry and fishery	5.65	7.52	4.08	5.91	1.56	3.95
2 Mining	1.28	0.76	12.52	16.30	8.34	-0.68
3 Foods	6.11	6.08	6.34	10.11	3.59	4.94
4 Textiles, wearing apparel and leather	9.58	4.78	6.60	12.90	9.10	6.20
5 Pulp, paper and wooden products	5.06	6.45	9.06	16.36	4.61	3.69
6 Chemicals	8.52	6.38	7.85	11.34	8.90	2.93
7 Petroleum and coal products	-0.65	2.38	9.27	13.48	1.52	0.16
8 Ceramic, stone and clay products	4.45	5.03	8.60	12.70	8.01	3.51
9 Iron and steel	7.70	8.30	8.20	12.76	7.71	0.67
10 Non-ferrous metals	-0.55	5.36	6.19	13.34	8.63	1.04
11 Metal products	15.45	7.14	8.16	13.31	4.18	2.12
12 General machinery	6.37	5.67	7.56	12.64	7.03	5.55
13 Electric machinery	5.28	6.87	10.96	17.72	13.76	7.88
14 Transportation equipment	1.34	7.32	11.20	13.44	7.58	1.84
15 Precision instruments	9.01	3.28	5.74	9.72	7.93	14.70
16 Miscellaneous manufacturing	8.36	7.02	9.81	14.30	4.27	4.43
17 Constructio	2.79	4.10	5.70	12.61	5.68	0.82
18 Electricity, gas, and heat supply	7.23	5.86	7.76	5.02	0.77	5.94
19 Water and waste	0.85	8.23	11.13	9.64	5.86	-15.61
20 Commerce	5.36	8.67	6.23	3.59	0.54	5.22
21 Finance and insurance	3.83	4.10	10.93	7.10	5.24	4.70
22 Real estate	0.05	9.95	11.14	4.03	9.53	0.60
23 Transport	-8.12	-0.91	1.50	7.27	10.17	1.93
24 Communication and broadcasting	4.48	3.83	5.10	5.08	4.84	5.36
25 Public administration	7.56	-4.25	10.02	11.97	10.63	4.03
26 Education and research	4.95	-0.41	3.93	5.63	4.31	0.49
27 Medical service and social security	9.85	-0.06	-0.05	1.11	0.21	1.11
28 Other public services	-1.33	6.23	4.02	8.06	2.16	12.44
29 Business services	10.94	5.91	7.38	11.03	9.46	-1.27
30 Personal services	3.51	3.03	2.21	1.86	6.57	4.07
31 Office supplies	7.95	8.59	8.21	13.05	5.40	4.12
32 Activity not elsewhere classified	11.87	-9.31	13.03	6.25	21.23	4.48
Average	6.35	7.02	9.34	8.74	5.03	3.89

(3) TLP Growth within industry and TLP Growth of product in China

	annual rate %					
	1987-1992			1992-1997		
	Domestic production growth	TLP growth within industry	TLP growth of product	Domestic production growth	TLP growth within industry	TLP growth of product
1 Agriculture, forestry and fishery	6.84	4.52	4.86	7.49	6.36	7.35
2 Mining	8.53	-2.55	1.35	5.80	-2.73	4.42
3 Foods	8.36	-0.02	4.55	13.61	1.36	8.53
4 Textiles, wearing apparel and leather	8.40	-0.82	3.51	12.25	7.52	14.16
5 Sawmills and furniture	10.16	3.63	7.08	27.49	7.75	15.94
6 Paper, printing and related products	10.60	-0.47	3.80	6.36	2.44	10.38
7 Petroleum processing and coking	6.03	-5.10	-2.23	6.47	-3.26	2.73
8 Chemicals	11.73	1.76	5.57	15.00	4.71	11.54
9 Nonmetallic mineral products	14.00	2.81	6.12	15.39	3.41	9.96
10 Metals	7.84	-3.16	0.78	10.42	0.95	7.97
11 General machinery	12.15	3.96	7.04	9.35	7.48	14.28
12 Transportation equipment	20.28	5.21	9.44	22.10	5.34	13.97
13 Electric machinery	11.37	2.61	6.44	22.74	5.15	13.58
14 Other manufacturing products	22.51	0.16	5.06	19.99	8.55	18.33
15 Construction	5.97	2.11	5.50	10.54	-2.06	4.99
16 Electricity, gas, and water	15.39	0.99	4.30	4.28	-5.71	1.13
17 Transport	6.06	-4.29	-1.01	14.81	8.09	13.31
18 Commerce and food services	22.88	6.55	8.86	5.22	-1.42	3.89
19 Services	11.91	-0.03	2.68	11.31	1.09	5.88
Average	10.35	2.02	4.60	11.75	3.57	8.57

	annual rate %					
	1997-2002			2002-2007		
	Domestic production growth	TLP growth within industry	TLP growth of product	Domestic production growth	TLP growth within industry	TLP growth of product
1 Agriculture, forestry and fishery	2.84	2.82	4.11	2.67	4.97	6.07
2 Mining	2.90	1.08	9.46	9.04	-5.85	2.07
3 Foods	2.80	4.73	9.95	20.83	3.92	10.13
4 Textiles, wearing apparel and leather	2.30	2.28	9.61	21.12	7.39	13.64
5 Sawmills and furniture	13.62	0.08	7.17	20.93	5.24	12.34
6 Paper, printing and related products	12.65	5.05	13.36	15.73	4.59	12.64
7 Petroleum processing and coking	7.70	-4.89	4.59	12.89	-3.56	3.85
8 Chemicals	10.56	6.16	13.83	19.86	5.48	12.48
9 Nonmetallic mineral products	-6.25	2.94	11.34	29.84	12.90	19.71
10 Metals	13.57	5.60	13.94	19.57	0.80	8.71
11 General machinery	13.12	2.74	12.50	23.41	6.89	15.11
12 Transportation equipment	14.25	3.92	13.91	29.27	6.50	16.26
13 Electric machinery	18.79	3.28	13.92	28.18	6.08	15.14
14 Other manufacturing products	4.54	4.65	13.78	22.86	3.73	12.98
15 Construction	9.18	-4.12	3.46	5.00	-2.74	6.88
16 Electricity, gas, and water	10.85	-0.37	8.36	25.72	2.33	9.77
17 Transport	20.54	5.72	11.94	5.05	-1.53	4.03
18 Commerce and food services	12.55	5.63	10.95	2.48	-2.42	1.48
19 Services	16.93	6.01	11.02	3.77	-2.78	3.03
Average	10.00	3.37	8.91	14.64	2.29	7.82

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