Analysis on the Changes of TFP in Manufacturing Industry among Different Regions

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Abstract. Based on China Industry Business Performance Data from 1998-2013, this paper calculates and decomposes the TFP of China's manufacturing industry, and then analyzes the changes of TFP from a regional perspective. It finds that the average TFP levels of the eastern, northeast, central and western regions decrease successively, and the top ten provinces in the TFP average level come from the eastern regions.

1. Introduction

Over the past 40 years of reform and opening up, China's economy has maintained rapid growth and created the "Chinese miracle" of world economic development. However, with the acceleration of China's aging population, slowing down of large-scale government investment and increasing export resistance, China's economy is facing increasing downward pressure. Then how to successfully overcome the "middle-income trap" and achieve a sustained high-quality economic development is an important issue to China at this stage. Therefore, this paper will calculate and decompose the TFP of China's manufacturing industry at the enterprise level, analyze the changes of TFP from regional perspectives.

2. Data Description and Processing

This paper is based on China Industry Business Performance Data from 1998-2013, in which the industrial output, capital stock, investment, intermediate input and the number of employees are selected. Among them, the original data of the number of employees and the intermediate input index data are directly adopted. For industry output, the proxy variable of industrial added value is used. The capital stock and investment indicators are processed by the perpetual inventory method.

3. Calculation, decomposition and result analysis of TFP

3.1 Calculation and analysis of TFP

First of all, according to the statistical caliber of the 2018 National Statistical Yearbook, this paper...
divides the corresponding provinces and cities into four areas for statistics, namely, the eastern region [the eastern region refers to 10 provinces (cities) in Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan], the central region [the central region refers to Shanxi, Anhui, Henan, Hubei and Hunan provinces], the western region [the western region refers to 12 provinces (autonomous regions and municipalities) in Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang], and Northeast China [Northeast China refers to Liaoning, Jilin and Heilongjiang provinces]. Then it calculates the TFP level and its average annual growth rate by provinces and the average TFP level by regions respectively as shown in Table 1.

**Table 1**: TFP in manufacturing industry and its average annual growth rate (by provinces, districts and cities)

| Regions         | Provinces       | Average level of TFP | Annual growth rate of TFP | Regional average level of TFP |
|-----------------|-----------------|-----------------------|---------------------------|------------------------------|
| eastern regions | Beijing         | 4.893                 | 8.223                     |                              |
|                 | Fujian          | 4.49                  | 4.542                     |                              |
|                 | Guangdong       | 4.481                 | 7.183                     |                              |
|                 | Hainan          | 4.782                 | 7.875                     | 4.673                       |
|                 | Hebei           | 4.891                 | 5.752                     |                              |
|                 | Jiangsu         | 4.469                 | 4.112                     |                              |
|                 | Shandong        | 4.517                 | 2.507                     |                              |
|                 | Shanghai        | 5.023                 | 8.938                     |                              |
|                 | Tianjin         | 4.765                 | 5.859                     |                              |
|                 | Zhejiang        | 4.423                 | 6.485                     |                              |
| central regions | Anhui           | 4.458                 | 4.363                     |                              |
|                 | Henan           | 4.629                 | 4.079                     |                              |
|                 | Hubei           | 4.675                 | 5.985                     | 4.583                       |
|                 | Hunan           | 4.335                 | 4.298                     |                              |
|                 | Jiangxi         | 4.514                 | 4.788                     |                              |
|                 | Shanxi          | 4.885                 | 8.777                     |                              |
| western regions | Gansu           | 4.556                 | 3.889                     |                              |
|                 | Guangxi         | 4.414                 | 6.178                     |                              |
|                 | Guizhou         | 4.601                 | 2.765                     |                              |
|                 | Inner Mongolia  | 4.454                 | 4.757                     |                              |
|                 | Ningxia         | 4.106                 | 12.62                     |                              |
|                 | Qinghai         | 4.541                 | 9.397                     | 4.374                       |
|                 | Shaanxi         | 4.342                 | 6.4                       |                              |
|                 | Sichuan         | 4.398                 | 4.995                     |                              |
|                 | Tibet           | 2.942                 | 6.364                     |                              |
|                 | Xinjiang        | 4.648                 | 5.74                      |                              |
|                 | Yunnan          | 4.304                 | 3.849                     |                              |
|                 | Chongqing       | 5.182                 | 5.096                     |                              |
| Northeast regions | Heilongjiang    | 4.584                 | 4.778                     | 4.594                       |
|                 | Jilin           | 4.537                 | 4.671                     |                              |
|                 | Liaoning        | 4.661                 | 5.913                     |                              |
From Table 1, it can be found that, firstly, the TFP average level of the eastern region is the highest, 4.673, and the lowest is that of the western region, 4.374. Second, half of the top ten provinces of the national TFP average level are from the eastern region, as shown in Figure 1. Seven of the ten provinces and cities at the bottom are from the western region, as shown in Figure 2. This shows that China's regional development is imbalanced. There is still a certain gap between the central and western regions and the eastern regions, therefore more support at national and local levels is needed to improve their TFP.

![Figure 1: The top ten provinces and cities in TFP ranking list of manufacturing industry.](image1)

![Figure 2: The bottom ten provinces and cities in TFP ranking list of manufacturing industry.](image2)

3.2 Decomposition and analysis of TFP

This paper adopts MP method to decompose and calculate TFP and obtains the contribution rate of incumbent firms, entry firms and exit firms to TFP.
According to the results shown in Table 2, from 1998 to 2013, the optimal allocation efficiency of resources among firms is not high, which does not effectively promote the TFP improvement of firms, and even hinders their improvement. The TFP of entry firms are lower than the TFP average level in the same year, the possible reason is that entry firms have not yet realize mass production and the cost is relatively high, thus inhibiting the TFP improvement. Or due to the high technical barriers and low efficient management and operation, the firms cannot unleash their

| Year  | t=1    | t=2    | Year  | t=1    | t=2   | Year  | t=1   | t=2   | Year  | t=1    | t=2   | Year  | t=1    | t=2   | Year  | t=1   | t=2   |
|-------|--------|--------|-------|--------|------|-------|--------|------|-------|--------|------|-------|--------|------|-------|--------|------|
| 1998  | 2.503  | 1.391  | 0.038 | 0.875  | 2.306 | 0.125 | 2.449  | 1.374 | 0.042 | 0.848  | 2.400 | 0.15  | 2.637  | 0.14  | 2.800 | 0.18  |
| 1999  | 2.461  | 1.412  | 0.039 | 0.847  | 2.331 | 0.153 | 2.558  | 1.450 | 0.040 | 0.854  | 2.637 | 0.14  | 2.800  | 0.18  | 2.899 | 0.13  |
| 2000  | 2.580  | 1.511  | 0.033 | 0.816  | 2.525 | 0.184 | 2.668  | 1.548 | 0.035 | 0.815  | 2.646 | 0.12  | 2.780  | 0.13  | 3.434 | 0.12  |
| 2001  | 2.727  | 1.603  | 0.034 | 0.896  | 2.392 | 0.104 | 2.876  | 1.690 | 0.036 | 0.873  | 2.899 | 0.13  | 3.090  | 0.14  | 4.499 | 0.16  |
| 2002  | 2.869  | 1.730  | 0.034 | 0.892  | 2.664 | 0.108 | 3.067  | 1.839 | 0.034 | 0.864  | 2.899 | 0.13  | 3.434  | 0.12  | 4.499 | 0.16  |
| 2003  | 3.107  | 1.882  | 0.029 | 0.778  | 2.818 | 0.222 | 3.392  | 1.905 | 0.035 | 0.828  | 3.062 | 0.17  | 3.499  | 0.15  | 4.499 | 0.16  |
| 2004  | 3.357  | 1.901  | 0.042 | 0.906  | 3.134 | 0.100 | 3.160  | 1.965 | 0.038 | 0.814  | 3.017 | 0.18  | 3.499  | 0.16  | 4.499 | 0.16  |
| 2005  | 3.131  | 1.960  | 0.042 | 0.891  | 3.155 | 0.109 | 3.215  | 2.082 | 0.041 | 0.873  | 3.192 | 0.12  | 3.434  | 0.12  | 4.499 | 0.16  |
| 2006  | 3.207  | 2.067  | 0.044 | 0.888  | 3.254 | 0.112 | 3.316  | 2.222 | 0.042 | 0.871  | 3.434 | 0.12  | 3.499  | 0.16  | 4.499 | 0.16  |
| 2007  | 3.359  | 2.202  | 0.043 | 0.841  | 3.187 | 0.159 | 4.681  | 3.637 | 0.114 | 0.837  | 4.499 | 0.16  | 4.644  | 0.32  | 6.644 | 0.32  |
| 2008  | 4.610  | 3.654  | 0.086 | 0.882  | 4.690 | 0.118 | 4.618  | 3.689 | 0.070 | 0.672  | 4.644 | 0.32  | 6.644  | 0.32  | 6.644 | 0.32  |
| 2009  | 4.853  | 3.811  | 0.010 | 0.832  | 4.614 | 0.168 | 4.278  | 3.426 | 0.002 | 0.688  | 4.615 | 0.31  | 4.883  | 0.24  | 6.883 | 0.24  |
| 2010  | 4.627  | 3.540  | 0.019 | 0.850  | 4.578 | 0.150 | 4.976  | 3.929 | 0.043 | 0.751  | 4.883 | 0.24  | 5.180  | 0.30  | 6.883 | 0.24  |
| 2011  | 4.920  | 3.890  | 0.333 | 0.871  | 4.743 | 0.129 | 5.034  | 4.006 | 0.269 | 0.899  | 4.866 | 0.10  | 4.964  | 0.18  | 6.883 | 0.24  |
| 2012  | 5.017  | 3.966  | 0.375 | 0.858  | 5.014 | 0.142 | 5.030  | 3.921 | 0.310 | 0.812  | 4.964 | 0.18  | 6.883  | 0.24  | 6.883 | 0.24  |
| 2013  | 5.160  | 4.013  | 0.403 | 0.871  | 5.014 | 0.142 | 5.030  | 3.921 | 0.310 | 0.812  | 4.964 | 0.18  | 6.883  | 0.24  | 6.883 | 0.24  |
maximum advantage, which ultimately leads to the entry firms not being able to well improve their TFP. Therefore, the corresponding measures and suggestions should be given from the perspective of further optimizing the allocation of resources and helping entry firms to improve management and operation efficiency.

4. Policy suggestions

To further improve the TFP of the manufacturing industry and its contribution to economic growth, this paper proposes suggestions from the following:

(1) Optimize industrial structure and promote rational industrial layout. To optimize industrial structure and improve the share of service industry in the economic aggregate, allow efficient enterprises to enter the market and increase their market share and force low efficient enterprises out of the market, first, it is essential to focus on the strategic deployment of "Made in China 2025" and adhere to the basic policy of innovation-driven, quality-oriented, green development, structural optimization, and talent-based. Besides, it is also important to intensify efforts to advance the technological upgrading and reform of the traditional industry, promote the deep integration between informatization and industrialization and improve the smart manufacturing level of traditional advantageous industries. Second, different measures should be taken according to the levels of economic development. For the relatively developed eastern coastal areas, it’s necessary to fully unleash its driving role in promoting the optimization and upgrading of industrial structure to improve the utilization rate of production factors. For less-developed central and western regions, the undertaking of industrial transfer of developed areas in the east region should be taken as the priority, and in the meantime, emphasis should be given to the optimization and upgrading of industrial structure to gradually eliminate industries featuring low TFP and low efficient resource utilization. Besides, industries that cause heavy environment pollution should be eliminated resolutely. Third, great efforts should be made to develop a new generation of strategical emerging industries, build a high-tech modern industrial cluster and advance the integrated development of thrice industries. Fourth, the modern service industry should be energized to improve its share in the industrial structure.

(2) Lower regional barriers and promote the free movement of factors of production among regions. First, it is necessary to increase investment in transportation and communication infrastructure in various regions, western regions, in particular, to reduce transportation and communication costs among regions. Second, the local protection barriers of governments at various levels should be eliminated to promote the free flow of production factors among provinces and cities and advance the process of regional integration. Third, efforts should be made to strengthen inter-regional cooperation, improve the construction of the regional business environment and carry forward the industry-university-research cooperation and innovation and entrepreneurship, develop and expand urban agglomeration and extra attention should be given to the technical exchanges and cooperation at provincial and prefecture-level. Fourth, coordinate regional development planning, formulate differentiated policies to promote regional innovation and guide the flow of capital, technology, and talents to backward areas like the central and western regions.

References
[1] Dong Zhiqing, Xu Xiaoli. Is There a "Ownership Trap" in TFP?— Empirical Evidence from the Perspective of Factor Mismatch[J]. Study & Exploration, 2015(8):78-85
[2] Shizhen. How to Understand and Calculate the Growth of "TFP"--An Econometric Analysis of a Specific Technical Economy problem[J]. Journal of Quantitative & Technical Economics, 1988(12):68-71.
[3] Yu Miaojie. Trade Liberalization and Productivity: Evidence from Chinese Firms[J]. Economic Research Journal, 2010(12):97-110.
[4] Yi Gang, Fan Gang, Li Yan. A Theoretical Analysis on Economic Growth in China and Total Factor Productivity[J]. Economic Research Journal, 2003(8):13-20
[5] Zhang Peigang, Zhang Jianhua. Development Economics[M]. PEKING UNIVERSITY PRESS, 2009.
[6] Zhou Xinmiao, Qian Huanhuan. A Study of Misallocation and Economic Sustainable Growth
Based on TFP Estimation: Evidence from Manufacturing Industry in China[J]. China Soft Science, 2017(1):183-192.

[7] Zhang Jun. Productivity Change and Factor Allocation Effect in China's Industrial Sector:1993-2006[J]. Dong Yue Tribune, 2010(10):70-82.

[8] Aigner D,Lovell C,Schmidt P. Formulation and Estimation of Stochastic Frontier Production Function Models[J]. Journal of Econometrics, 1977, 6(1): 21-37.

[9] Brandt Loren,Biesebroek Johannes-Van,Zhang Yifan. Creative accounting or creative destruction? Firm-level productivity growth in Chinese manufacturing[J]. Journal of Development Economics, 2012, 97(2): 339-351.

[10] Chow G, Lin A. Accounting for Economic Growth in Taiwan and Mainland China: a Comparative Analysis[J]. Journal of Comparative Economics, 2002, 30(3): 507-530.

[11] Caves D W, Diewert L R C E. The Economic Theory of Index Numbers and the Measurement of Input, Output, and Productivity[J]. Econometrica, 1982, 50(6):1393-1414.

[12] Comin D. Total Factor Productivity[M]// The New Palgrave Dictionary of Economics. Palgrave Macmillan UK, 2008.

[13] Gang Y, Amp F G. A Theoretical Analysis on Economic Growth in China and Total Factor Productivity[J]. Economic Research Journal, 2003.

[14] Jefferson Gary-H., Rawski Thomas-G., Zhang Yifan. Productivity growth and convergence across China's industrial economy[J]. Journal of Chinese Economic and Business Studies, 2008, 6(2): 121-140.

[15] Wu Y. Is China's economic growth sustainable? A productivity analysis[J]. China Economic Review, 2002, 11(3):278-296.

[17] Curtis C C. Economic reforms and the evolution of China's total factor productivity[J]. Review of Economic Dynamics, 2016, 21:225-245.