Empirical Research on the Influence of E-commerce on TFP of China’s Service Industry

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Abstract. Based on e-commerce development index system of alibaba, this paper adopts DEA method and uses non parameter Malmquist index model to empirically analyze the TFP, corresponding technical progress rate and technical efficiency, with further analysis of the relationship between e-commerce and TFP, technical progress rate and technical efficiency of China’s service industry. The result is the development of technical efficiency is due to e-commerce eliminates the decrease of scale efficiency caused by the decrease of marginal output elasticity of factors like capital. That’s why the average growth rate of TFP of China’s service industry from 1997 to 2013 remains high level of 6.29%. Therefore, technical progress is the main power to promote the growth of TFP of China’s service industry.

I. Research Background and Summary of Researches in and out of China

The latest IDC research shows that China’s e-commerce industry is becoming the world’s largest and the most leading strategic emerging industry, which serves as the foundation of China’s information economy. The e-commerce economy accelerates the conversion of traditional service industry to the modern one. E-commerce is promoting the conversion of traditional logistics to modern logistics featuring networking and informationization. Through the connection and cooperation with logistics enterprises, e-commerce platforms strengthens the monitoring to logistics distribution process, promotes the elevating of the service quality, and thus drives the transformation of business mode and management mode of logistics enterprises. Intelligent logistics depends on intelligence, while intelligence depends on big data, which means support and integrate social resources based on powerful e-commerce data, to build intelligent logistics network covering the whole country.

In recent years, many scholars conducted empirical researches on the relationship between e-commerce and the growth of service industry, and studied the role of the development of e-commerce on the productivity and returns to scale of the service industry from the quantitative perspective. Some scholars studied the development mechanism and index system of e-commerce from theory perspective, to discuss the influence mechanism between e-commerce and service industry, such as Ye and Nie [1]. At the same time, some other scholars studied the influence of e-commerce on enterprise economic growth from the perspective of economic efficiency. Meng [2] found that e-commerce has become the new factor to promote economic growth, with positive promotion to the growth of social economic efficiency. Yuan [3] found that the productivity of enterprises that adopt e-commerce is higher than those does not. That is to say, the introduction of e-commerce has positive influence on the productivity of enterprises.

Therefore, it has great academic significance and practical significance to study the contribution of e-commerce to China’s service industry, to discover the influence of e-commerce factor input on productivity and returns to scale of service industry, to analyze the factors that limit the development of e-commerce, and to provide policy recommendations to promote the development of e-commerce.
II. Research Methods and Data Processing

2.1 Method

Total factor productivity (TFP) is an important index to measure the quality of economic growth, and also an important reference index to measure the economic growth of a country or region. After decades of development, the theory of TFP is gradually maturing, with more detailed methods, from the original Solow residual method to later stochastic frontier production function, and Malmquist index method based on DEA.

What needs attention is that the higher the employment weight, the higher the TFP value, because employment growth is far less than the growth of the capital. Therefore, the weight value of capital is crucial to the evaluation of productivity growth on the economic aggregate level. According to international experience, it is generally believed that most development countries are capital-intensive economy, with high capital output elastic coefficient; while most developing countries are labor-intensive economy, with high labor output elastic coefficient.

Malmquist productivity index mainly has the following three advantages: (1) Low requirement for price information greatly reduces the difficulty of empirical analysis. This is because, unlike the data of input and output, the price of production factors is difficult to obtain, or even impossible for certain factors; (2) it can be used for sample analysis of cross countries and periods; (3) it can be further decomposed into technical efficiency change index and technical progress index [4].

From t to t + 1 period, the Malmquist index to measure the growth of TFP can be represented as:

$$M_0(x_{t+1}, y_{t+1}, x_t, y_t) = \left[ \frac{d_0^i(x_{t+1}, y_{t+1})}{d_0^i(x_t, y_t)} \times \frac{d_{t+1}^i(x_{t+1}, y_{t+1})}{d_0^i(x_t, y_t)} \right]^{1/2}$$  \hspace{1cm} (1)

In formula (1), \((x_{t+1}, y_{t+1})\) and \((x_t, y_t)\) respectively represent the input and output vector of \((t + 1)\) and \(t\) period; \(d_0^i\) and \(d_{t+1}^i\) respectively represent the distance functions of \(t\) and \((t+1)\) period based on the technology \(T_t\) in \(t\) period.

Take technology \(T_t\) of \(t\) period as reference, the Malmquist index based on output perspective can be represented as:

$$M_0^t(x_{t+1}, y_{t+1}, x_t, y_t) = \frac{d_0^i(x_{t+1}, y_{t+1})}{d_0^i(x_t, y_t)}$$  \hspace{1cm} (2)

Similarly, take technology \(T_{t+1}\) of \(t+1\) period as reference, the Malmquist index based on output perspective can be represented as:

$$M_0^{t+1}(x_{t+1}, y_{t+1}, x_t, y_t) = \frac{d_{t+1}^i(x_{t+1}, y_{t+1})}{d_0^i(x_t, y_t)}$$  \hspace{1cm} (3)

To avoid the difference that may be caused by the randomness of period selection, this paper modeled the structure of Fisher index and take the geometric average of formula (2) and formula (3), namely formula (1) to measure the Malmquist index that measures the productivity change from period \(t\) to \(t+1\). When the index is greater than 1, the TFP from period \(t\) to \(t+1\) increases.

The Malmquist index obtained from the above method has good properties, which can be decomposed into EC and TP under the unchanged returns to scale, the decomposition process is as follows:

$$M_0(y_{t+1}, x_{t+1}, y_t, x_t) = \left[ \frac{d_{t+1}^i(x_{t+1}, y_{t+1})}{d_0^i(x_t, y_t)} \times \frac{d_0^i(x_{t+1}, y_{t+1})}{d_0^{t+1}(x_{t+1}, y_{t+1})} \times \frac{d_0^i(x_t, y_t)}{d_0^{t+1}(x_t, y_t)} \right]^{1/2} \times \text{EC} \times \text{TP}$$  \hspace{1cm} (4)

The TP index can be further decomposed into PC and SC. The measurement of Malmquist productivity index needs linear programming method to calculate the various distance functions on input and output. For the change of TFP from period \(t\) to \(t+1\), the following four distance functions based on DEA need to be calculated:
### 2.2 Data Sources and Processing

This paper studies the influence of e-commerce on productivity of service industry based on productivity function model. The added value of service industry is taken as the dependent variable, while e-commerce index, capital and labor are taken as input factors of the production function. China’s e-commerce developed from 1997, so the data in this paper for empirical analysis is from 1997 to 2013.

This paper takes added value as output, substrate the data of each year with the data of 1997 as basis. The added value of service industry is from “Statistical Yearbook of China’s Tertiary industry”. This yearbook provides the national growth of tertiary industry and growth speed on the basis of last year. In this way, we can get the growth speed on the basis of 1997 and the added value of each year.

E-commerce index use Alibaba e-commerce development index system, with data coming from the institute of Ali. First level indexes of e-commerce include electronic retailing and online index, with weight of 0.5. Electronic retailing index consists of two secondary indexes, which are density index and average network trade index [6], with weight of 0.5.

Electronic retailing density index = 0.5 * (number of B2B electronic retailing/population + retail electronic retailing number/population),

Average trade volume = electronic retailing trade amount/retailing number.

Online shopping index consists of two secondary indexes, which are online shopping consumer density index, and average consumption index, with weight of 0.5.

Online shopping consumer density = number of online consumers/population,

Average consumption = online consumption/number of online consumers.

### III. Empirical Results

Through the Malmquist index analysis based on EDA, and software such as Stata and DEA, we can get the Malmquist productivity index and its decomposition result of China’s service industry from 1997 to 2013, as shown in table 2. The change trend of average growth rate of each index is as shown in figure 1 to figure 4.

<table>
<thead>
<tr>
<th>Year</th>
<th>Malmquist productivity index</th>
<th>PC</th>
<th>EC</th>
<th>PC</th>
<th>SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>1.085</td>
<td>0.997</td>
<td>0.976</td>
<td>0.969</td>
<td>0.991</td>
</tr>
<tr>
<td>1998</td>
<td>1.060</td>
<td>1.012</td>
<td>0.982</td>
<td>0.997</td>
<td>0.985</td>
</tr>
<tr>
<td>1999</td>
<td>1.026</td>
<td>1.042</td>
<td>1.012</td>
<td>1.077</td>
<td>1.033</td>
</tr>
<tr>
<td>2000</td>
<td>0.984</td>
<td>1.054</td>
<td>1.042</td>
<td>1.009</td>
<td>1.012</td>
</tr>
<tr>
<td>2001</td>
<td>1.015</td>
<td>1.099</td>
<td>1.044</td>
<td>0.972</td>
<td>0.989</td>
</tr>
<tr>
<td>2002</td>
<td>1.047</td>
<td>1.072</td>
<td>1.057</td>
<td>1.005</td>
<td>0.972</td>
</tr>
<tr>
<td>2003</td>
<td>1.038</td>
<td>1.144</td>
<td>1.094</td>
<td>0.994</td>
<td>1.001</td>
</tr>
<tr>
<td>2004</td>
<td>1.059</td>
<td>1.088</td>
<td>1.112</td>
<td>1.014</td>
<td>0.998</td>
</tr>
<tr>
<td>2005</td>
<td>1.091</td>
<td>1.170</td>
<td>1.113</td>
<td>0.970</td>
<td>0.962</td>
</tr>
<tr>
<td>Year</td>
<td>PC</td>
<td>EC</td>
<td>SC</td>
<td>PC</td>
<td>EC</td>
</tr>
<tr>
<td>------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>2006</td>
<td>0.994</td>
<td>1.089</td>
<td>1.115</td>
<td>0.997</td>
<td>1.008</td>
</tr>
<tr>
<td>2007</td>
<td>1.024</td>
<td>1.072</td>
<td>1.109</td>
<td>1.005</td>
<td>0.972</td>
</tr>
<tr>
<td>2008</td>
<td>1.033</td>
<td>1.087</td>
<td>1.118</td>
<td>0.989</td>
<td>0.991</td>
</tr>
<tr>
<td>2009</td>
<td>0.998</td>
<td>1.072</td>
<td>1.121</td>
<td>1.011</td>
<td>0.998</td>
</tr>
<tr>
<td>2010</td>
<td>1.045</td>
<td>1.079</td>
<td>1.132</td>
<td>0.997</td>
<td>0.985</td>
</tr>
<tr>
<td>2011</td>
<td>1.029</td>
<td>1.075</td>
<td>1.132</td>
<td>1.009</td>
<td>1.012</td>
</tr>
<tr>
<td>2012</td>
<td>1.018</td>
<td>1.054</td>
<td>1.230</td>
<td>0.989</td>
<td>0.991</td>
</tr>
<tr>
<td>2013</td>
<td>0.989</td>
<td>1.175</td>
<td>1.239</td>
<td>1.011</td>
<td>0.998</td>
</tr>
<tr>
<td>Average</td>
<td>1.0629</td>
<td>1.0758</td>
<td>1.0958</td>
<td>1.0858</td>
<td>0.9942</td>
</tr>
</tbody>
</table>

As it is shown in table 1, the average growth rate of TFP of China’s service industry is 6.29%. With the popularization of e-commerce, technologies in service industry develop significantly, with continuously improving technical progress, which promotes the growth of TFP. According to the above theoretical analysis, we can divide Malmquist productivity index into PC and EC. From 1997 to 2013, the PC index and EC index of China’s service industry remain normal growth rate, with the trend of rising, while SC index shows a volatility trend. Average annual growth rate of PC is 7.58%; during the same period, the average growth rate of EC is 9.58%, in which the growth rate of PC is 8.58% while the growth rate of SC is -0.58%. It indicates that, compared with the technology progress, technical efficiency plays a more important role on TFP, while average SC growth rate is negative. The technical efficiency increase brought by e-commerce eliminates the decrease of scale efficiency caused by the decrease of marginal output elasticity of factors like capital. That’s why the average growth rate of TFP of China’s service industry from 1997 to 2013 remains high level of 6.29%, which is consistent with the theory that technical progress is the main power to promote TFP of China’s service industry.
Based on the above empirical analysis, we can see that e-commerce has both positive and negative effect on the TFP productivity of China’s service industry.

Among them, positive effects are: The development of e-commerce brings the improvement of technological progress; China’s retail e-commerce development model should integrate e-commerce with the development of core enterprises, and reform of logistics enterprises. Unite the core enterprises solutions with the improvement of enterprise competitive strategy: E-commerce solutions can be integrated with the business goal of enterprises to make e-commerce platform an important part of enterprise competitiveness. The construction of various platforms and application of solutions is a technical project and innovation of technology. The wide application needs to be integrated with policy innovation, and the construction of technical service system of the industry. The practice of the e-commerce mode will play a fundamental, global, and demonstrative role for the informationization of retail industry and the development of e-commerce, and promotion role for structure adjustment of retail industry. Also, it can promote the structure adjustment and technical innovation of the retail industry. Implementing e-commerce and joining WTO means deeper structure adjustment for China’s service industry, and that traditional retail industry must transfer to the new track that improves industry competitiveness by technical innovation.

Negative effects are: The development of e-commerce reduces the average growth rate of scale efficiency; Network economy takes knowledge as the main production factor, which means it uses unique business model and technology to possess knowledge as the main factor; while traditional industry is different. Its business model and technology is relatively mature and fixed, which means the key factor is capital. The new economy features that the gain rises with the scale. For the same network or information service, the more users, the lower the unit cost and marginal cost. Therefore, the expansion is limitless. But for traditional industry, it is common that returns to scale decreases. Based on Internet and other information and technology, network economy main is implemented on the Internet, with enjoying the external positive effect brought by the Internet. But an enterprise needs constant and comprehensive innovation to be good. Innovation is the essence of market economy, and the fundamental requirement for entrepreneurs. Any enterprise has three systems: operation system, management system, and technical system, which corresponds to three kinds of innovation respectively. Enterprise is a system engineering, with operation as the lead, technology and product as the tool and carrier. Only if the innovation of three systems is completed, can the production ability improve. The change of production or returns caused by two kinds of production resources is periodic. Under the same technology level, the change of production scale may cause increasing returns of scale in the same production process. With the change of resource input, the returns of scale may remain unchanged or decreased. Thus, the technology level of China’s e-commerce is still low.

IV. Conclusion and Policy Suggestion

Based on DEA-based Malmquist index method, this paper conducts empirical analysis of the influence of e-commerce on TFP of China’s service industry, with finding that the development of e-commerce can promote technology efficiency, and thus promote the growth of TFP of China’s service industry. Therefore, to improve the technology efficiency by developing e-commerce has great practical significance to China’s service industry.

Based on the empirical research, this paper puts forward the following suggestions: (1) Establish a national standard for e-commerce system to provide reference for the development of e-commerce in our country, and constantly improve the e-commerce industry standardization of consciousness and the importance and popularity to e-commerce from all walks of society, to realize the application and coverage of e-commerce in social production and business activities; (2) strengthen the cooperation of enterprises and scientific research institutions, to establish standards and specifications related to e-commerce, improve the technical efficiency and technical progress growth rate of e-commerce, to realize higher TFP productivity of the service industry; (3) speed up online payment system of e-commerce. Establish related principal for online payment and strengthen risk prevention awareness to reduce payment risk.
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Reference


