An Empirical Research on the Influence of E-Commerce on Productivity and Returns to Scale of China’s Service Industry

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Abstract — The increasing development of user scale leads to quadratic growth of income and rapid drop of average cost, which forms the unique ascending returns to scale of network economy, and reflects the value-added potential of network economy. Adopting trans-log production function model, this paper studies the influence of factors, including e-commerce index, capital, and labor on the added value of service industry. Politic suggestions on the adjustment of service industry development structure are raised to promote the development and efficiency of China’s service industry.

Keywords - E-commerce; service industry; returns to scale

I. BACKGROUND AND PURPOSE

As the representative of the information economy, e-commerce can promote the transformation of traditional service industry to modern service industry, and help to reduce trade links and save consumption cost. With breaking the limitation of time and space to consumption, it raises consumption ability, promotes long tail effect, and enriches the supply of consumer goods, to promote domestic growth. What's more, it reduces service cost by reducing costs including transaction, distribution, inventory, and purchasing [1]. Thus, e-commerce has significant effect to improve productivity and returns to scale of China’s industry. In recent years, many scholars analyzed the mechanism of e-commerce in promoting the growth of service industry, based on the application of e-commerce. They used econometrics to quantitatively analyze the effect of e-commerce on the promotion of service industry, which showed that e-commerce had significant influence on productivity and returns to scale of service industry.

Based on e-commerce and industry economy theories, Zheng Qiongjie and Li Chenghua (2011) took a series of indicators and data that evaluate the development level of domestic e-commerce from 1997 to 2011 as samples, analyzed the mechanism and strength of e-commerce on the tertiary industry, with regression analysis of econometrics [2]. Nie Quyun (2013) developed a set of indicator system to measure the development level of e-commerce, measured e-commerce indicators with threshold metod and linear weighted model, established empirical model of e-commerce and various indicators of service industry with Cobb-Douglas production function, and explained the result of the model [3]. Peng Xinmin (2001) analyzed and studied the effect to develop e-commerce with empirical research from microcosmic point of view, and established a research framework that integrates value chain theory, transaction cost theory, and business process. In order to accurately estimate the change of productivity, returns to scale, and factor substitution elasticity of China’s service industry, variable substitute elastic function was used as the production function model. In the production theory, substitute elasticity means the change of input percentage with the change of marginal technical substitution rate when the technical level and input price remain unchanged. In this case, Christensen, Jorsenson, and Lau developed trans production function to evaluate the variable substitute elasticity [4, 5].

II. MODEL SELECTION AND DATA DESCRIPTION

This paper studies the influence of e-commerce on productivity of service industry with production function model which adopts service industry added value as dependent variable and add e-commerce indicator, capital, and labor into the production function as input factors [6-8]. In most production functions that studies e-commerce, it is considered as an input factor while technology improvement is considered as neutral, in which, C-D production function, CES production function are widely used. In actual economic system, the influence of various input factors not only related to its own change, but also some other input factors; At the same time, the technical progress of various input factors cannot be the same, and the C-D and CES production functions with neutral technical progress may not reflect the interaction of input factors and the interaction between technical progress and input factors, therefore, this paper uses trans-log function model [9].

Trans-log production function is a variable elastic production function model that is easy to evaluate. It belongs to square reflecting surface model, which can effectively research the interaction between input factors and the difference of various technical progresses. By trans-log production model, we can analyze the output elasticity of input factors and substitution elasticity of the factors [11, 12]. See below:
According to formula (1), set the marginal output elasticity of capital and labor as \( \frac{\partial Y}{\partial K} \) and \( \frac{\partial Y}{\partial L} \), then:

\[
\frac{\partial Y}{\partial K} = \beta_0 + \beta_1 \ln K + \beta_2 \ln L + \beta_3 t + \frac{1}{2} \beta_4 (\ln K)^2 + \frac{1}{2} \beta_5 (\ln L)^2 + \beta_6 t
\]

(1)

Set scale elasticity as RTS, then:

\[
RTS = \left( \frac{\partial Y}{\partial K} + \frac{\partial Y}{\partial L} \right) = \frac{\beta_0}{\beta_0 + \beta_1 \ln K + \beta_2 \ln L + \beta_3 t + \frac{1}{2} \beta_4 (\ln K)^2 + \frac{1}{2} \beta_5 (\ln L)^2 + \beta_6 t}
\]

(5)

The substitution elasticity of capital and labor is:

\[
E_s = \frac{\partial Y}{\partial K} \cdot \frac{\partial Y}{\partial L} = \frac{\beta_0}{\beta_0 + \beta_1 \ln K + \beta_2 \ln L + \beta_3 t + \frac{1}{2} \beta_4 (\ln K)^2 + \frac{1}{2} \beta_5 (\ln L)^2 + \beta_6 t}
\]

(6)

Set marginal productivity of capital and labor as \( MPK \) and \( MPL \), then:

\[
MPK = \frac{\partial Y}{\partial K} \quad \text{and} \quad MPL = \frac{\partial Y}{\partial L}
\]

(7)

(8)

where, \( Y \) is the added value of service industry; \( K \) and \( L \) are capital and labor inputs respectively; \( t \) is e-commerce indicator; \( \beta \) is the parameter to be estimated; \( \epsilon_u = v_u - u_u \) and \( \epsilon_u = v_u - u_u \); \( v_u \) is random variables (white noise), conforming with normal distribution (N(0,(V2))); \( u_u \) is nonnegative random variable.

The development of China’s e-commerce starts from about 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. Fixed asset investment is substitute by infrastructure investment and construction and upgrading investment, while labor input is expressed by the number of staff in service industry and department [13].

E-commerce index use alibaba e-commerce development index system, with data coming from the institute of ali [14]. First level indexes of e-commerce includes 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, 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 index, 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. Influence of E-commerce to Productivity of China’s Service Industry

As the continuous expansion of service industry with more application of industrialization management and large-scale use of information technology in service industry, plus the uniqueness of service compared with tangible products, theory and method research on the operation and management of service has got great attention. The research contents mainly include service operation strategy, service value chain and service process design, service demand management, service quality and service productivity, application of new technology in service industry, and e-commerce in service industry.

What makes e-commerce so important is not that it creates a new industry, but that it provides a powerful operation method for the manufacturing industry and service industry, enabling enterprises to improve their operation mode, efficiency and customer service with this method. Because of this, e-commerce is closely related with operation and management. E-commerce refers to informationization of substance and transaction, which means a revolutionary change of the content, method, and process of transaction handling. Therefore, this evolution will inevitably cause a large industry restructuring. Some industries and enterprises will gradually disappear, while other industries and enterprises will be created, and some other industries, enterprises, and units will be expanded. We must be aware that, the external environment of enterprise operation tends to be standardized, the competition among enterprises will be eventually embodied in the products and services enterprises provide to the market.

A. Influence of E-commerce on Returns to Scale of China’s Service Industry

The supply capability of the society depends on the supply capability of an individual manufacture, namely the operation scale of a individual manufacture. Returns to scale must be taken into consideration for manufacturers who want to expand their production capacity. It is the basic requirement for making a production plan that a manufacture should determine a reasonable operation scale. When other conditions remain unchanged, with the change of production factors, the network economic changes in the feature of increasing of returns to scale. At the same time, the average cost decreases, income increases in quadratic, which reflects the unique growth of network economy. One of the important factors in increasing returns is the cost down of external factors. When other conditions remain unchanged, with the change of production factors, the network economic changes in the feature of increasing of returns to scale. At the same time, the average cost decreases, income increases in quadratic, which reflects the unique growth of network economy. One of the important factors in increasing returns is the cost down of external factors. When other conditions remain unchanged, with the change of production factors, the network economic changes in the feature of increasing of returns to scale. At the same time, the average cost decreases, income increases in quadratic, which reflects the unique growth of network economy. One of the important factors in increasing returns is the cost down of external factors. When other conditions remain unchanged, with the change of production factors, the network economic changes in the feature of increasing of returns to scale. At the same time, the average cost decreases, income increases in quadratic, which reflects the unique growth of network economy.
greatly reduces the subjective uncertainty and thus the cost due to wrong decisions. The economic behavior in information network has strong increasing returns, which is originated from the "noncompetition" of information consumption. That is to say, compared with material products in the traditional economy, information, as the main product of network economy, can be replicated and spread with zero marginal cost, and the value that each information contains won't be decreased. Thus the cost of network economy means periodic fixed cost and unlimited output, which makes the average cost rapidly drops with the increasing of total output, i.e. strong returns increasing.

B. Model Establishment and Validation

We use EVIEWS to process the data in service industry, and adopt OLS to evaluate the model coefficient, and obtain the model coefficient as shown in table 1:

![Table 1: Model Results](image)

Sources: Eviews

R² = 71.49%, nR² = 70.23%, which are close to 1, meaning the model fitness basically meet the requirements. However, it doesn’t reach the level of 90%, meaning the model fitness precision meets the requirement. F statistic is, which is larger than the critical value of 3.03 in the condition of 5% significance level, which means the significance of the whole model is high.

Then, we conducted multicollinearity test for main explanatory variables and obtained the correlation coefficient as shown in table 4 after related analysis to various variables:

![Table 4: Correlation Coefficient](image)

From the correlation analysis between the above variables, there is no collinearity among the above explanatory variables. Therefore, the validity of the model meets the requirements.

C. Analysis of Productivity and Returns to Scale of China’s Service Industry

The evaluation result of productivity and returns to scale of China’s service industry (1997-2013) is shown in table 5, based on DEA calculation. In the table, Ek, El, and Et respectively refer to capital, labor, and marginal output elasticity of e-commerce index, and RTS refers to measure of returns to scale.

![Table 5: Productivity and Returns to Scale of China’s Service Industry](image)
According to the measurement results, from 1997 to 2013, the marginal output elasticity of capital $E_k$ gradually declines while remain stable, from 1.1143 to 1.0789; the unit output elasticity of capital input decreased by 0.0356, which shows that the contribution of capital input to the growth of China’s service industry is decreasing. From 1997 to 2013, marginal output elasticity of labor $E_l$ is slowly rising, from 0.9987 to 1.0505; the unit output elasticity of capital input increased by 0.0518, which shows that the contribution of labor to the growth of China’s service industry remains stable and slightly increases. From 1997 to 2013, marginal output elasticity of e-commerce index $E_t$ is rapidly rising, from 0.6150 to 2.7280; the unit output elasticity of e-commerce index increased by 0.4433, which shows that the contribution of e-commerce to the growth of China’s service industry is significant and in steady rising.

Returns to scale measures the output change when labor, capital and e-commerce input all increases by 1%. According to the analysis result, from 1997 to 2013, the returns to scale of China’s service industry remains stable and slightly increases. Despite the relative small change, it is still in steady increasing. This also proves the rationality of the function selection in this paper. Returns to scale is the combination of marginal output elasticity, capital marginal output elasticity, and e-commerce marginal output elasticity. With the rapid growth of e-commerce marginal output elasticity, the returns to scale of service industry keeps increasing.

### D. Summary and Follow-up Research

This paper analyzed the contribution of e-commerce to the growth of China’s service industry. Adopting the mathematical model established in the theoretical study, DEA method, Stata and DEA software, this paper empirically analyzed the whole factor productivity, related technological progress and technical efficiency of China’s service industry, and further analyze their relationships, and get the conclusion. The mechanism of e-commerce to promote the growth of service industry is studied from promoting consumption, reducing costs, and increasing employment. Take service industry growth as dependent variable, and capital, labor, and e-commerce index as input factors in the Cobb-Douglas production function to develop a Cobb-Douglas production function model with e-commerce index. Through an empirical analysis on the impact of e-commerce on services, this paper adopts model explanation to analyze the contribution of e-commerce to the growth of service industry from virtual space commerce, process reconstructing, and cost. What's more, this paper also analyzed the bottleneck factor of e-commerce and provided policy suggestions to promote the development of e-commerce. Based on the above empirical research result, this paper put forward policy suggestions to promote the growth and efficiency of China’s service industry from the perspective of promoting and standardizing China’s e-commerce development, and adjust development structure of China’s service industry, to provide reference to the policy making of macroeconomy that promote the development of service industry.

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### REFERENCES


