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The Impact of Digital Economy on Total Factor Productivity of China's Service Industry

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ABSTRACT

As a kind of integrated economy, digital economy has an important impact on the economic growth and production and lifestyle of multiple countries and regions, and plays a significant role in promoting the reconstruction of the international economic pattern. As an important industry of China's national economy, the service industry is crucial to China's economic growth. This paper measures the development level of digital economy in provinces and cities through constructing digital economy index system, uses super efficiency SBM-Malmquist model to measure total factor productivity of service industry, and tests the influence effect of digital economy on total factor productivity of Chinese service industry. Finally, the optimization path of digital economy on China's service industry is proposed.

1. Introduction

In recent years, the digital economy has developed vigorously. At December 2018, at the G20 Summit held in Argentina, General Secretary Xi Jinping put forward the strategic goal of "promoting the deep integration of the digital economy and the real economy, while paying attention to the application of new technologies and risks and challenges, and strengthening the construction of the institutional system". As a kind of integrated economy, the digital economy has an important impact on the economic growth and production and living mode of many countries and regions, and has played a significant role in promoting the reconstruction of the international economic pattern, which has attracted widespread attention from all countries. As far as the domestic situation is concerned, China is in a strategic transition period of high-quality economic development. As the largest industry in China's national economy, the service industry is of great significance to high-quality economic development. The digital economy itself has the characteristics of innovation and high efficiency, which meets the requirements of high-quality development. Therefore, the development of digital economy provides a new way to improve the total factor productivity of the service industry and even the whole social operation mode, and contribute new economic growth points. Promoting the integration of digital economy and service industry is of great significance to the reconstruction of international trade

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rules, the adjustment of industrial structure under the domestic "new normal" and the continuous stability of economic order.

2. Literature Review

2.1 Relevant Literature on the Digital Economy

The concept of the digital economy first appeared in Don Tapscott (1996) [1]. On the Digital Economy: Hope and Risks in the Age of Intellectual Connectivity. In the early stage, scholars at home and abroad mixed "digital economy" with "Internet economy" and constructed a relevant system framework [2]; Some scholars also give corresponding level measures based on provincial research [3]. In general, the academic research on the level measurement of digital economy has undergone a theoretical transformation from "Internet economy" to "digital economy". At present, the academic research on digital economy is mainly focused on the economic benefits of digital economy, digital industrialization and industrial digitalization [4]. The convergence mechanism of inclusive finance on urban and rural income proves that digital inclusive finance can narrow the urban and rural income gap [5]. From the two levels of boosting the development of information industry and the deep integration of traditional industries and big data, we combed the development mode of industrial digitalization and digital industrialization in China, and analyzed the factors affecting the choice mode of enterprises, and put forward coping strategies from the two aspects of enterprise information application and information industry technology innovation [6]. From driving industry efficiency, promote industrial cross-border integration, reconstruction of industrial development competition mode, enabling industry upgrading four aspects, explains the value dimension of the industry digital, with "digital economy to promote industrial upgrading" as the starting point, from infrastructure construction, incentive mechanism and collaborative governance, system reform three aspects put forward the optimization path [7]. From the aspects of top-level design, overall planning, overall layout and digital governance, the successful experience of the digital economy development of the Yangtze River Delta is systematically summarized. It provides a model for digital economy development in other regions [8]. With "double cycle" as the strategic background, analyzes the challenges and opportunities facing Chinese industry digital transformation, and puts forward the "promotion mechanism", "collaborative mechanism", "sharing mechanism", "guarantee mechanism" four policies and digital infrastructure, governance level, mode innovation, technology system four dimensions, put forward the coping strategy and promote the digital transformation in China.

2.2 Relevant Documents on the Total Factor Productivity of the Service Industry

The research on total factor productivity in the service industry mainly focuses on three aspects: horizontal measurement, factors affecting total factor productivity and the impact of total factor in service industry productivity on other related industries. There are three main methods to measure total factor productivity in the service industry: non-parametric Malmquist index method [9-12]. Using gray correlation method to analyze the total factor productivity of qinhuangdao, shows that the total factor productivity of the service industry is not obvious, is still the market environment, output scale and industrial agglomeration, the local economic development level and residents prosperity play an auxiliary role [13]. Based on the inter-provincial panel data, with foreign investment and tax revenue as the two basic entry points, it is found that the overall efficiency improvement of the service industry can drive the efficiency growth of the manufacturing industry [14]. From the perspective of tourism innovation, we review the spatial effect of knowledge-intensive service industries in China's three urban clusters, compare the agglomeration effect and spatial spillover effect of relevant industries, and put forward corresponding strategies on the effect of radiation [15]. Based on the inter-provincial panel data, from the two dimensions of industrial digital and digital industrialization, the research has found that the development of digital economy has a spatial spillover effect, and has a certain role in promoting the total factor productivity.

To sum up, although the research on digital economy has achieved fruitful results, the effect of digital economy on service total factor productivity is relatively rare. Therefore, the advanced and unique of this article is: first, this article novel topic, digital economy is an important strategic guiding ideology and development direction in the difference plan and 2035 vision, and the service industry will gradually become the pillar of China's economic development, study the impact of digital economy on the total factor productivity of service industry is an innovative exploration. Second, in the research method, a variety of research methods cross application, mutual confirmation, through the application of entropy method of China digital economy development level, using super efficiency SBM-Malmquist model of provinces and cities, using measurement model for regression test, to explore the influence of digital economy on total factor productivity of Chinese service industry.

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3. Research and Design

3.1 Evaluation method of the digital economy

Model settings

In information theory, entropy is a mathematical method used to judge the degree of variation of some indicator. The greater the degree of variation, the greater the indicator in the level of the digital economy development, the greater the weight of the indicator; otherwise, the smaller the degree of variation, the less the weight of the index. The basic steps for implementing the entropy method are as follows:

Calculation formula for the 1) extremal method (for positive indicators):

$$X'_{ijk} = \frac{X_{ijk} - m_j}{M_j - m_j} \tag{1}$$

Among them, i means provinces and cities, j for indicators, k for year, M_j.For the X_{ijk}.Maximum value of, m_j.For the minimum value, then the X_{ijk}.j indicator of i Province in k.

2) dimensionthe raw data to determine the index weights:

$$P_{ijk} = \frac{X'_{ijk}}{\sum_{i=1}^{n} X_{ijk}} \tag{2}$$

3) entropy and the entropy of j index:

$$e_j = -\frac{1}{\ln n}\sum_{i=1}^{n} P_{ijk}\ln\left(P_{ijk}\right) \tag{3}$$

4) variance coefficient calculation:

$$g_j = 1 - e_j \tag{4}$$

The 5) determines the weight of the evaluation indicators:

$$w_j = \frac{g_j}{\sum_{i=1}^{n} g_j} \tag{5}$$

6) calculation of comprehensive score:

$$S = \sum_{i=1}^{n} w_j X'_{ijk} \tag{6}$$

The weight score of each digital economic inde x is calculated by entropy method and used by $x_{i1k.}$, $x_{\cdot i2k.}$… $x_{\cdot ink.}$ Each index is represented separately.

Selection of the 2. index system

According to the 2018 Global Digital Economy Development Index, there are 5 first-level indicators and 14 second-level indicators and the development of China's digital economy. Therefore, this paper follows the principle of scientific nature and accuracy of index data sources, selects the statistical data of 30 provinces and cities in China from 2007-2019, and constructs the following evaluation index system for digital economy development, as shown in Table 1.

Table 1. Evaluation System of Digital Economy Development Index

Primary indicators	Secondary indicators	Third-level indicators	Type
Level of digital economy development	Communication capability and service level (P1)	Internet Broadband Access port (X1)	Forward direction
		Long-distance optical cable line length (X2)	Forward direction
		Long Distance Telephone Switch Capacity (X3)	Forward direction
		Mobile phone switch capacity (X4)	Forward direction
	Creative abilities (P2)	Total R&D Personnel (X5)	Forward direction
		R&D Internal expenditure (X6)	Forward direction
		R&D topics (X7)	Forward direction
	Third Industries (P3)	Value value of tertiary industry (X8)	Forward direction
		Number of legal person units of the tertiary industry (X9)	Forward direction
		Third Industry Fixed Assets Investment (X10)	Forward direction

3.2 Measurement Method of Total Factor Productivity in the Service Industry

3.2.1 Model settings

(1) The SBM model build

Data envelope analysis (DEA) is a model method based on linear planning and distance function, including several models including CCR, BCC, SBM, etc. However, traditional CCR and BCC models cannot measure all relaxation variables and are defects in efficiency evaluation, hence the SBM model proposed by Tonek Kaoru:

$$min\rho = \frac{1 - \frac{1}{m}\sum_{i=1}^{m}\frac{s_i^-}{x_{ik}}}{1 + \frac{1}{q}\sum_{r=1}^{q}\frac{s_r^+}{y_{rk}}} \tag{7}$$

$$s.t.\begin{cases} x_k = X\lambda + S^- \\ Y_K = Y\lambda - S^+ \\ \lambda、\ s^+、\ s^- \geq 0 \end{cases} \tag{8}$$

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$t = 1/(1 + \frac{1}{q}\sum_{r=1}^{q} s_r^+ / y_{rk})$Order, its linear planning form is:

$$min\rho = t - \frac{1}{m}\sum_{i=1}^{m}\frac{ts_i^-}{x_{ik}} \#(9)$$

$$s.t. = \begin{cases} tx_k = Xt\lambda + ts^- \\ ty_k = Yt\lambda - ts^+ \\ t = \dfrac{1}{1 + \frac{1}{q}\sum_{r=1}^{q}\frac{s_r^+}{y_{rk}}} \\ \lambda、\ s^+、\ s^- \geq 0 \end{cases} \#(10)$$

$\rho^*\lambda s^- s^+$Among them, it indicates the efficiency value of the DMU being evaluated, m, q is the number of input and output variables and the vector variable; X, Y is the input and output variable matrix; x, y represents the input and output of DMU and the relaxati on var i able of input and output; i, r means i input and r output respectively. When the efficiency value =1 in the model, it is shown that the evaluated DMU is strongly effective ρ^*.

(2) The Malmquist index

The Malmquist index was originally proposed by Malmquist in 1953, and in 1994 Rolf Fare et al combined nonparametric linear planning with data envelope analysis (DEA) theory by which the index is possible to decompose the productivity changes into technical and technical efficiency changes, so the Malmquist index is defined as:

$$M(x^t, y^t, x^{t+1}, y^{t+1}) = (M^t \times M^{t+1})^{\frac{1}{2}} = \left[\frac{D_c^t(x^{t+1}, y^{t+1})}{D_c^t(x^t, y^t)} \times \frac{D_c^{t+1}(x^{t+1}, y^{t+1})}{D_c^{t+1}(x^t, y^t)}\right]^{\frac{1}{2}} \quad (11)$$

$$EC = \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \quad (12)$$

$$TC = \left(\frac{D^t(x^t, y^t)}{D^{t+1}(x^t, y^t)} \times \frac{D^t(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})}\right)^{\frac{1}{2}} \quad (12)$$

Among t hem, indicating the input and output of the t period, respectively, indicating the distance function of the period. When the technical efficiency change (EC) value is greater than 1, the relative technical efficiency is improved; when the technology progress change (TC) value, the technological innovation is greater than 1.

3.2.2 Index system construction

(1) Selection of the study subjects

Service industry is the general term of industry in the electronic information era, which is divided into service industries and service undertakings. Using the data of the fourth national economic census provided by the National Bureau of Statistics in 2018, we can obtain 141-digit service industries, 452-digit, 1743-digit, and 3254-digit service industries. Considering the availability and scientific nature of data, the input and output factor data of provinces and cities from 2007-2019.

(2) Selection of capital investment indicators

For capital investment, refer to [16]. The capital stock estimation theory is formulated as follows:

$$K_{ik} = K_{ik}(1 - \delta_{ik}) + I_{ik} \quad (14)$$

$K_{ik}I_{ik}\delta_{ik}$ Among them, i ndicating the service capital stoc k of i area in the k period, indicates the constant price investment of i area in each period, indicating the depreciation rate, the depreciation rate is 4%. For the estimation of the base period capital stock, refer to [17]. The formula is as follows:

$$K_{i,k-1} = \frac{I_{ik}}{g_{ik} + \delta_{ik}} \quad (15)$$

g_{ik} Among them, the geometric average growth rate of output over a period of time, that is, the geometric average value of the added value of the service industry in various provinces and cities from 2007 to 2019.

(3) Selection of labor input indicators

Labor input should be considered in various factors, such as the quality of labor, labor quantity and other factors. Considering the availability of data, the number of year employed as the labor input index.

(4) Selection of service industry output indicators

This paper selects the added value of the service industry in various provinces and cities as the output variable, taking 2007 as the base year. Considering the data loss of some provinces and cities, the arithmetic average method complements the missing data.

3.3 Construction of the Measurement Model

3.3.1 Benchmark model setting

This article establishes the following benchmark model:

$$\ln TFP_{ij} = \lambda_0 + \lambda_1 \ln INT_{ij} + \lambda_2 control_{ij} + \delta_{ij} \quad (16)$$

TFP_{ij} Among them, i represents the province, j represents the year, the total factor productivity of the service industry, the indicators of digital economy development, the control variables, and the random error items.$INT_{ij}control_{ij}\delta_{ij}$

3.3.2 Index system construction

(1) Variinterpreted variable

Service total factor productivity (TFP) is selected as

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the interpreted variable.

(2) Explain the variable

The core interpretation variable of this paper is the Data Economy Development Level (INT), and the Internet broadband access port in the province and city where the sample is the proxy variable.

(3) Control variable

Control variables include the level of scientific and technological development, fiscal expenditure, urbanization level, and foreign investment. Among them, the development level of science and technology adopts the technology market turnover, recorded as TMT; financial expenditure by the general budget expenditure of the provinces and cities, the GBE; urbanization level as the proportion of urban population at the end of the year, and PUP; foreign investment by the number of foreign invested enterprises in various provinces and cities, recorded as NFIE.

4. Positive Results and Analysis

4.1 Calculation Results of the Level of Digital Economy Development

From the development level of regional digital economy from 2007-2019, see Table 2 and Appendix 1 for specific values.

Table 2. Development level of digital economy in all regions of China

	Average level	Annual growth rate
Beijing	0.685	-1.11%
Tianjin City	0.096	-0.46%
Hebei Province	0.219	0.11%
Shanxi Province	0.125	-0.65%
Inner Mongolia	0.126	-0.81%
Liaoning Province	0.213	-4.46%
Jilin Province	0.112	-0.88%
Heilongjiang Province	0.156	0.00%
Shanghai	0.320	-0.04%
Jiangsu Province	0.436	-0.30%
Zhejiang Province	0.329	1.51%
Anhui Province	0.178	-0.17%
Fujian Province	0.176	-0.66%
Jiangxi Province	0.120	1.67%
Shandong Province	0.354	0.00%
Henan Province	0.265	1.36%
Hubei Province	0.223	-0.86%
Hunan Province	0.205	2.84%
Guangdong Province	0.501	-1.61%
Guangxi Province	0.156	1.61%
Hainan Province	0.024	4.23%
Chongqing	0.106	3.83%
Sichuan Province	0.354	1.65%
Guizhou Province	0.098	2.19%
Yunnan Province	0.154	2.88%
Shaanxi Province	0.232	-1.04%
Gansu Province	0.092	-0.14%
Qinghai Province	0.038	4.44%
Ningxia Province	0.019	5.17%
Xinjiang Province	0.102	1.61%

Data in Table 2 show that the development level of China's digital economy shows an overall upward trend, but the phenomenon of unbalanced and uncoordinated development among regions still cannot be ignored. Among them, the top three levels of digital economy development are Beijing 0.69, Guangdong, 0.50 and Jiangsu 0,0.44; the last three are Ningxia 0.02, Hainan 0.02, and Qinghai 0.04. It can be seen that due to differences in policies, economic level and human resources, the digital economy development level of the three urban clusters is high and strong radiation force, while the development index of the eastern coastal areas is significantly faster than that of the central and western regions; and the development index of Hainan and the five northwest provinces are lower than the average level and the development level is low.

However, in terms of annual growth rate, the top three annual growth rate of digital economy is Ningxia 5.17%, Qinghai 4.44% and 4.23% in Hainan; the latter three are Liaoning-4.46%, Guangdong-1.61% and Beijing-1.11% respectively. With the advancement of the strategy of "western development", the growth rate of digital economy in central and western China is greater than that of relatively developed eastern regions. Since 2013, the northwest region has led Ningxia to promote the building of the western cloud base, actively combining digital technology with government affairs, transportation, parks and other industries, and making its digital economy grow rapidly through the construction of a new smart city. Among them, Qinghai Province thoroughly implemented the "Broadband China" strategy, earnestly implemented the "Broadband Qinghai · Digital Qinghai" strategic plan (2014-2020) ", with the" three network integration "as the starting point, promoted the construction of" Qinghai on the cloud ", making its growth rate firmly in the top three. Based on the strategy of the "One Belt And One Road" digital economy channel, Southwest China strengthens the connectivity of infrastructure and promotes the construction of the digital economy, making its growth

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rate in the top 10. For developed areas along the eastern coast, the economy has entered a new normal, so the growth rate has slowed down and gradually turned into a stage of high-quality development.

4.2 Calculation Results of Total Factor Productivity in the Service Industry

By calculating the total factor productivity of the service industry in 2007-2019, the following results are shown in Table 3.

Table 3. Total factor Production Index of Regional Service Industry in 2007-2019

Province	TFPC.	EC.	TC.	PEC.	SEC.
Beijing	1.073	0.995	1.078	0.997	0.998
Tianjin City	1.084	1.006	1.077	1.007	0.999
Hebei Province	1.040	0.974	1.068	0.981	0.993
Shanxi Province	1.007	0.955	1.054	0.961	0.994
Inner Mongolia	1.068	0.997	1.072	0.992	1.005
Liaoning Province	1.073	0.996	1.077	0.996	1.000
Jilin Province	1.064	0.992	1.073	0.991	1.000
Heilongjiang Province	1.054	0.992	1.062	0.995	0.998
Shanghai	1.070	1.000	1.070	1.000	1.000
Jiangsu Province	1.095	1.019	1.074	1.024	0.996
Zhejiang Province	1.075	0.998	1.077	1.002	0.997
Anhui Province	1.043	0.986	1.058	0.986	1.000
Fujian Province	1.048	0.979	1.070	0.981	0.999
Jiangxi Province	1.049	0.992	1.058	0.994	0.999
Shandong Province	1.059	0.994	1.065	1.009	0.985
Henan Province	1.043	0.983	1.062	0.987	0.995
Hubei Province	1.042	0.983	1.060	0.985	0.998
Hunan Province	1.049	0.990	1.059	0.990	1.000
Guangdong Province	1.057	0.991	1.067	1.000	0.991
Guangxi Province	1.036	0.976	1.061	0.976	1.000
Hainan Province	1.027	0.966	1.063	0.969	0.997
Chongqing	1.093	1.016	1.075	1.014	1.002
Sichuan Province	1.037	0.979	1.058	0.980	0.999
Guizhou Province	1.108	0.957	1.063	0.958	0.999
Yunnan Province	1.033	0.972	1.063	0.971	1.002
Shaanxi Province	1.087	1.023	1.063	1.025	0.998
Gansu Province	1.024	0.966	1.060	0.971	0.994
Qinghai Province	1.015	0.959	1.058	1.000	0.959
Ningxia Province	1.028	0.968	1.062	0.999	0.970
Xinjiang Province	1.014	0.955	1.062	0.957	0.998
Nationwide	1.053	0.985	1.066	0.990	0.996
Eastern Region	1.064	0.993	1.072	0.997	0.996
Central Region	1.047	0.986	1.062	0.987	0.999
Western Region	1.048	0.977	1.063	0.985	0.992

According to the data in Table 3, that the total factor production index of each province and urban region is greater than 1, and the total factor growth rate of service industry in eastern region is 6.37%, central region is 4.66% and 4.75%, which shows that the total factor growth rate of service industry is significantly different in different regions. With its excellent geographical location and reasonable industrial structure, the total factor growth rate of the service industry has been maintained at a high level. Among them, since 2007, the introduction of foreign investment has entered the golden period of rapid development, gradually forming a new situation of "secondary industry and service industry", making the total factor growth rate of service industry to 9.5%. With the total factor productivity of western development. Among them, Guizhou established the first national big data center in 2015, realizing the synchronous data transmission and remote backup of the national and disaster preparedness center in Guizhou, so the total factor growth rate of Guizhou ranked first; the central industrial structure adjustment entered the deep water zone, the service industry development lags behind, and the industrial structure needs to be optimized, resulting in the growth rate behind other regions. Among them, the total factor growth rate of the service industry in Shanxi Province is only 0.7%, due to the proportion of Shanxi Province that is a resource-based industry in higher provinces, investment in the service industry lags behind and the total investment is low, making their growth rate ranked last.

Figures 1, 2 and 3 show that the technology progress index in each region is greater than 1, but the technology efficiency change index, pure technology efficiency change index and scale efficiency index do not exceed 1, which shows that the improvement of total factor efficiency in the eastern region and western regions mainly depends on the improvement of technological progress, and ignores the technical efficiency. If they want to break the bottleneck period and maintain the continuous growth of total factor productivity in the service industry, we must pay attention to improving technology efficiency and scale efficiency. The technical efficiency change index in the central region and the efficiency change index of pure technology efficiency are also less than 1, among which the scale and efficiency change index of 5 provinces is greater than or equal to 1, indicating that a large number of production factors are outflow and the degree of opening up to the outside world is low, making the economic structure unreasonable and the industrial adjustment seriously lags behind. The shortage of funds leads to the lack of market vitality, the weak independent growth of enterprises, and the total factor growth rate

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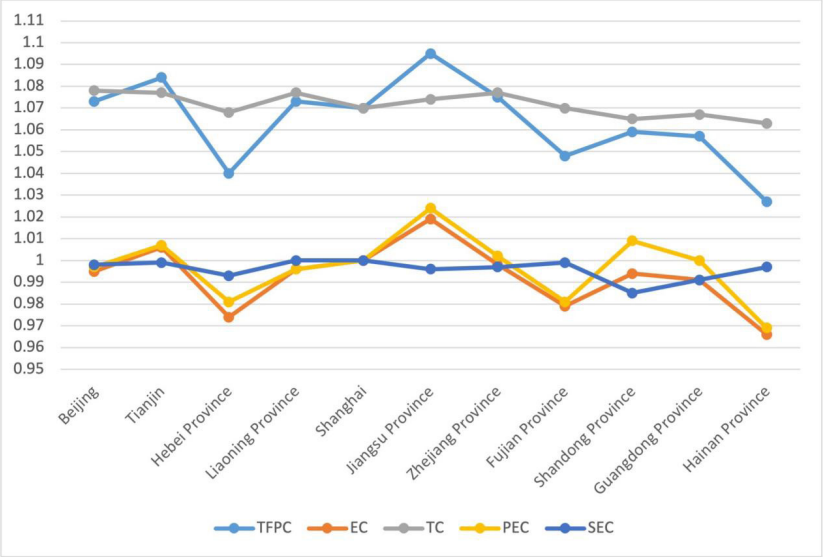

Figure 1. Eastern region TFP and its decomposition index

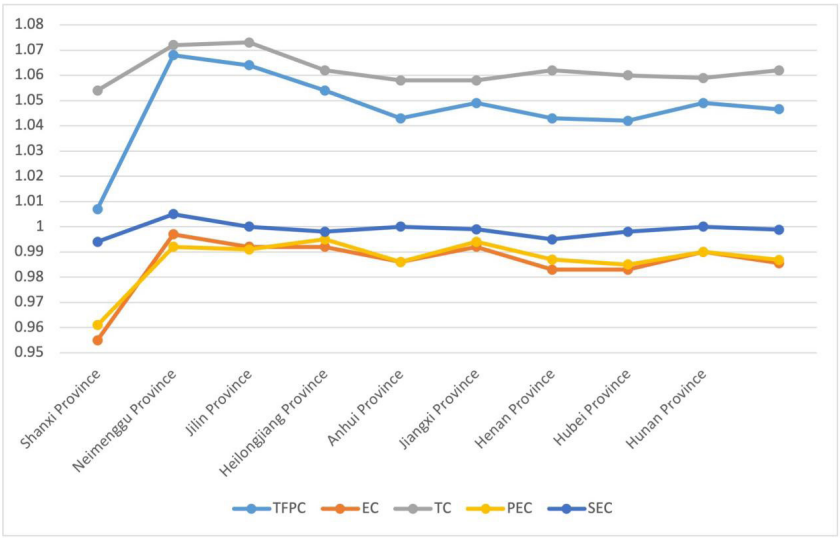

Figure 2. Central region TFP and its decomposition indicators

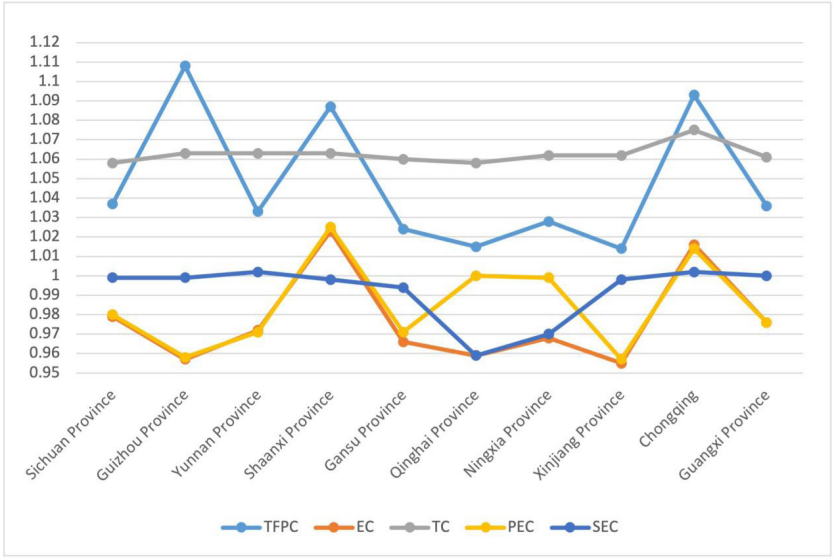

Figure 3. TFP and its decomposition index in the western region

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of the service industry lags behind the east and western regions. Therefore, as the "hollow zone" of high-end producer services, the Central Plains Economic Zone needs to accelerate the spatial agglomeration effect of the service industry, and balance the proportion of high, middle and low-end services, so as to achieve catch-up.

4.3 Inspection of the Impact of the Digital Economy on the Total Factor Productivity of China's Service Industry

First, this paper uses the overall sample data for the impact of the digital economy on the total factor productivity of the service industry

In empirical analysis, through Hausman test, the fixed effect model is selected for regression. Model 1-model 4 is to consider the regression of time fixed effect and provincial fixed effect based on the addition of control variables. See Table 4 for specific results.

Table 4. Base regression results

	（1）	（2）	（3）	（4）
Variables	InTFP.	InTFP.	InTFP.	InTFP.
InINT.	0.609*** (4.87)	0.597*** (4.68)	0.588*** （4.57）	0.576** (4.50)
InTMT.	0.466*** (3.84)	0.457*** (3.79)	0.509*** （4.15）	0.443*** (3.68)
InGBE.	0.444*** (3.70)	0.442*** (3.66)	0.441*** （3.64）	0.440*** (3.62)
InPUP.	-0.278 （0.448）	-0.1408** （0.560）	-0.1374** （0.561）	-0.1416** （0.564）
InNFIE.	0.211*** (1.86)	0.170*** (1.21)	0.184*** （1.57）	0.0814* (0.34)
Constant item	1.903*** （77.53）	2.108*** （66.07）	2.153*** （58.74）	2.134*** （61.45）
Time effect	Not controlled	Not controlled	Control	Control
Provincial effect	Not controlled	Control	Not controlled	Control
N.	390	390	390	390
$R.^2$	0.465	0.474	0.445	0.487

Note: *, * *, * * * tables represent significant at 10%, 5%, 1%, and values in parent heses represent the corresponding t value.

It can be seen from Table 4 that the digital economy promotes the total factor productivity in the service industry. The fixed effect is found that there are time and provincial differences in the influence of digital economy on total factor productivity in the service industry. In addition, other control variables also have some impact on the total factor productivity in the service industry. As can be found from model 4, the coefficient of the technology market turnover (TMT) is positive and significant, indicating that the greater the transaction volume of the technology market, the higher the total factor productivity of the service industry. The greater the turnover increase of the technology market indicates that the higher the transformation efficiency of scientific and technological achievements, so it is easy to improve the total factor productivity of the service industry; the coefficient of the general budget expenditure (GBE) of all provinces and cities is positive and significant, indicating that the more the government general budget expenditure, the higher the total factor productivity of the service industry. The increase in general budget expenditure shows that the increase in government input and basic research factors can improve the infrastructure level of enterprises and promote the vitality of enterprises, thus having a positive impact on the improvement of total factor productivity in the service industry.

The coefficient of urbanization level (PUP) is negative and significant, indicating that the rapid urbanization process is not conducive to the improvement of total factor productivity of the service industry. In recent years, the steady influx of rural labor into cities has led to a sharp expansion of the urban population, causing not only serious unemployment problems, but also increased urban poverty. Therefore, the urbanization process is significantly faster than that of the industrial structure transformation process is not conducive to the improvement of total factor productivity in the service industry; the factor of foreign investment (NFIE) is positive and significant, indicating that the increase of foreign investment is conducive to the improvement of total factor productivity in the service industry. The increase of foreign investment is conducive to enterprises attracting investment and technology and wisdom, and promoting the improvement of total factor productivity of the service industry on the basis of optimizing the business environment and adhering to open development.

4.4 Test of Robustness

The above tests show that the development of digital economy can significantly promote the improvement of total factor productivity. For stability seriously, this paper selects the tool variable method to handle the endogenous problem. Taking the Internet broadband access port of various provinces and cities as the premise, tool variables construct the development level of digital economy, and use the second stage least squares method to return. See Table 5 for specific results.

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Table 5. Robustness Inspection

	(5)	(6)	(7)
InINT.	0.138*** (2.18)	0.142*** (2.63)	0.144*** (2.85)
InTMT.	0.1085** (0.052)	0.3711*** (0.127)	0.0237 (0.045)
InGBE.	0.427 (0.357)	0.230 (0.610)	0.187 (0.639)
InPUP.	-0.1440** (0.0573)	-0.0883 (0.144)	-0.0813* (0.0453)
InNFIE.	0.113 (1.53)	0.168 (1.72)	0.177 (1.86)
Constant item	0.548*** (0.775)	0.301*** (0.222)	0.312*** (0.324)
Time effect	Control	Control	Control
Provincial effect	Control	Control	Control
N.	390	390	390
$R.^2$	0.0182	0.3206	0.1164

Note: The values in parentheses indicate standard deviations, and the *, * *, * * * scores are significant at 10%, 5%, 1% levels.

According to the results of model 5 - model 7, the overall digital economic indicators are exogenous and are significantly effective in the total factor productivity of the service industry.

5. Conclusions and Policy Suggestions

5.1 Conclusions

Through the construction of digital economy index system, we measure the development level of provinces and cities in 2007-2019. At the same time, the influence of digital economy development on the service industry total factor productivity is analyzed because of the empirical economic linkage between regions, and obtains the following conclusions:

First, the overall development level of digital economy is on the rise, but the regional development is unbalanced. The development index of the eastern coastal regions is significantly higher than that of the central and western regions, and the digital economy growth rate of the central and western regions is greater than that of the relatively developed eastern regions.

Second, the development of digital economy has a positive impact on the total factor productivity of the service industry and helps to improve the total factor productivity in the regional service industry.

Third, the level of scientific and technological development, fiscal expenditure and foreign investment will promote the improvement of total factor productivity of the service industry. However, the level of urbanization has a negative impact on total factor productivity of the service industry. The rapid urbanization process is not conducive to the improvement of total factor productivity of the service industry.

5.2 Policy Suggestions

Through the construction of digital economy index system, we measure the development level of provinces and cities in 2007-2019. At the same time, the influence of digital economy development on the service industry total factor productivity is analyzed because of the empirical economic linkage between regions, and obtains the following conclusions:

Improves the policy system and jointly promotes the development of the digital economy

(1) Increase the industrialization of basic research and development in basic software, high-end chips and core components. We will fully strengthen cooperation with universities and research institutes, and promote the in-depth integration of production, education and research. Use government procurement and financial incentives to solve the problem of core technology "bottleneck": strengthen basic research in cutting-edge industries such as artificial intelligence, big data, cloud computing and quantum computing. We will encourage market participation and balance industrial, innovation and competition policies.

(2) Establish a timely artificial intelligence safety ethics prevention system, attach great importance to the risks brought by the application of artificial intelligence technology, and strive to promote the application of artificial intelligence technology in the field of security. On the other hand, the risk of artificial intelligence products may delay technical research and industrial development in related fields, and AI enterprises in related industries may withdraw from research and development under the pressure of public opinion. According to the ethical risks of AI, the relevant regulatory institutions should formulate the corresponding identification mechanism and tracking mechanism to eliminate the hidden dangers in time [18].

(3) Promote the application of 5G in the industrial field, and clarify the 5G application of requirements and application scenarios. In view of the groups that have significantly reduced employment opportunities and knowledge and skills cannot adapt to the digital service industry due to intelligence, the relevant departments should make plans as early as possible, make predictions and plans, resolve the pressure through skills training, increase the effective supply of public welfare posts, and comprehensively plan the social security system to play the role of social security [19].

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Takes measures according to local conditions to promote coordinated competition in the service industry

(1) With the urban circle and urban agglomeration as the basic carrier, promote the regional integration strategic arrangement of market integration, convenient connectivity, industrial integration, innovation cooperation, governance coordination, and achievement sharing. Free trade zone linkage mechanism as the starting point, in the first three batches in 2018 on the basis of free trade zone collaborative open development initiative, according to the role of 18 free trade zone, and regional urban area and urban agglomeration market unified construction, break the administrative barriers, break the barriers of all factors of production mechanism, to "area" construction "introduction" and "go out", with more inclusive and open attitude, build a free trade zone open network system. Establish related collaborative open new platform and BBS mechanism, improve the level of connectivity, build collaborative mechanism, guide the national development zone, high-tech development zone to participate in the free trade zone reform, establish industry-university combination mechanism, digital as a means, close contact with universities and research institutes, speed up the transformation of high and tech scientific and technological achievements, improve the upstream and downstream industrial chain.

(2) Actively promote the relevant free trade zone, high-tech industrial development zone, city integration demonstration zone, economic and technological development zone, digital transformation, using technical discount, loan discount, industrial guidance, fund equity investment, with finance, tax as leverage, through the government purchase guide small and medium-sized enterprises, small micro enterprises and service platform cooperation, through pilot demonstration, cultivate emerging service Internet platform.

(3) Improve the organization and coordination mechanism, coordinate and coordinate at the various levels, make use of the joint meeting policies of the pilot reform of free trade zones, and give timely guidance. At the same time, the typical practices are promoted and publicized. Use the regional linkage mechanism and collaborative development and collaborative governance mechanism to form industrial agglomeration for exchanges in industrial migration and flow of factors, and form a scale effect.

System is open, deepen industrial integration

(1) Further improve the negative list management system, the negative list and stabilize foreign capital, expand domestic demand, promote structural transformation, classification relax restrictions, guide foreign investment, steadily handle the relationship between industrial attributes, business attributes and ideology, sensitive industries such as the Internet, culture, education, should not only to keep the bottom line, but also to prevent safety generalization. We will improve the dynamic formulation and adjustment mechanism for the negative lists, Enhance the authority and seriousness, Only reduce but not increase, Really make government departments "cannot be done without law", Improve the management system for the negative list of cross-border trade, With a "negative list" as the traction, We will steadily advance the reform of separating licenses and licenses, Optimize the approval services, Using data sharing, Closely promote the construction of a digital government, Innovative service platform, To realize the interaction mechanism of industry and commerce, taxation, and other public security, Special agencies have been set up (such as Chongqing Big Data Application Administration) to manage artificial intelligence, big data, information, social public information management, and promote the reform of "separation of licenses" in an orderly manner.

(2) Improve the ongoing and post-event supervision system matching with the negative list. According to the characteristics of the industry, improve the service dynamic policy system, do "remedy to the case", improve the supervision system construction, put an end to regulation, while detailed administrative discretion adhering to the basic principle of prudent tolerance, will maintain the market order in place, the e-government and wisdom governance as a means and foothold, establish and improve the credit-based enterprise credit system, improve service efficiency.

(3) Based on the reform of telecommunications industry, select businesses not related to national security; gradually relax the restrictions of foreign shareholding ratio to mobilize more international resources for our use, thus improve the underlying conditions of China's network infrastructure and promote the deep integration of digital economy and service industry.

(4) Improve the protection mechanism for foreign investment, clean up the unreasonable mechanism for foreign investment, revise industrial guidance and country guidance in the service industry and personnel entry and exit flow, enhance the supply of effective public services in foreign investment, build an overseas risk monitoring and early warning system, and guide enterprises to prevent and defuse risks.

(5) Establish a mechanism for promoting international

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exchanges in the service industry and learn from international experience. Close cooperation with relevant international organizations, the benchmarking countries in the international service industry, deep understanding of OECD countries, especially the benchmarking countries promote service opening and reform, use the existing regional free trade zone agreement (such as "area", China, Japan and South Korea free trade zone) to optimize the layout of international resources, promote the service industry realize industrial chain integration. At the same time, we will increase the publicity of China's policy of opening up the service industry, and encourage the international community to timely understand the latest developments in China's service industry.

Improves the development conditions and optimizes the business environment

(1) Promote the construction and application of service data standards, guide industry organizations and enterprises to research and formulate industry data industry standards, group standards, clear public data collection, exclusive, sharing, at the same time clear "rights —— obligations" relationship between government and enterprise, build data sharing mechanism between government and enterprise, guarantee legal compliance of data collection and data, and prevent enterprises to use public data monopoly, for personal gain.

(2) Speed up the combination of digital economy and traditional service industry, establish a special fund for digital service industry, the use of short video platform, electricity platform, with big data insight service demand, communication, Internet of Things, big data, blockchain and other new technologies into the traditional service industry, give full play to the demonstration effect of leading enterprises, promote the enterprise technology iteration. We will promote cooperation with telecom operators, China UnionPay and other large enterprises to optimize the underlying conditions for product innovation and technological innovation. At the same time, the leading enterprises to the industrial chain to improve the collaborative innovation system, improve the industrial policy to encourage small and medium-sized enterprises, establish a unified technology market trading system and supporting scientific and technological achievements transformation incentive policy, to promote industrial structure upgrading: at the same time actively promote foreign advanced management mode, blade inward, stimulate enterprise endogenous power.

(3) We will gradually promote the orderly opening up of government public data, promote the institutional supply-side reform of "big data + public services", and build a national platform for the unified opening up of public data. The government digitalization will be gradually extended to towns, streets and grass-roots level, publicizing the credit information of all market entities in operation timely and accurately, and using the data network to gradually achieve "released by one party and shared by the three parties".

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Appendix:

Measurement results of China from 2007-2019

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Beijing	0.6933	0.6725	0.6858	0.6963	0.6817	0.6774	0.7243	0.7121	0.7193	0.6850	0.6811	0.6721	0.6064
Tianjin City	0.0806	0.0958	0.0884	0.0916	0.0949	0.0965	0.0998	0.1001	0.1066	0.1091	0.1110	0.0910	0.0763
Hebei Province	0.1972	0.2127	0.2054	0.2147	0.2081	0.2179	0.2307	0.2228	0.2340	0.2338	0.2514	0.2211	0.1999
Shanxi Province	0.1175	0.1214	0.1216	0.1271	0.1258	0.1244	0.1413	0.1277	0.1437	0.1317	0.1261	0.1131	0.1087
Inner Mongolia	0．1080	0.1191	0.1126	0.1275	0.1354	0.1348	0.1464	0.1427	0.1391	0.1385	0.1261	0.1101	0.0980
Liaoning Province	0.2243	0.2323	0.2160	0.2296	0.2285	0.2354	0.2426	0.2391	0.2614	0.1897	0.1873	0.1527	0.1298
Jilin Province	0.1121	0.1216	0.1175	0.1193	0.1134	0.1151	0.1189	0.1073	0.1074	0.1056	0.1072	0.1096	0.1008
Heilongjiang Province	0.1414	0.1556	0.1519	0.1608	0.1531	0.1496	0.1658	0.1609	0.1685	0.1607	0.1632	0.1517	0.1414
Shanghai	0.3268	0.3278	0.3111	0.3036	0.2976	0.3184	0.3102	0.3304	0.3516	0.3146	0.3245	0.3131	0.3252
Jiangsu Province	0.4226	0.4285	0.3971	0.4401	0.4349	0.4428	0.4258	0.4441	0.4624	0.4669	0.4602	0.4319	0.4074
Zhejiang Province	0.3193	0.3040	0.2662	0.2813	0.2752	0.2901	0.3096	0.3212	0.3762	0.3668	0.3979	0.3831	0.3821
Anhui Province	0.1702	0.1714	0.1659	0.1749	0.1748	0.1860	0.1814	0.1781	0.1962	0.1827	0.1870	0.1760	0.1667
Fujian Province	0.1786	0.1743	0.1622	0.1795	0.1784	0.1856	0.1889	0.1720	0.1841	0.1801	0.1768	0.1669	0.1649
Jiangxi Province	0.1125	0.1153	0.1089	0.1154	0.1124	0.1187	0.1165	0.1123	0.1284	0.1254	0.1377	0.1188	0.1372
Shandong Province	0.3246	0.3510	0.3411	0.3598	0.3561	0.3538	0.363	0.3592	0.3747	0.3693	0.3745	0.3435	0.3245
Henan Province	0.2304	0.2587	0.2400	0.2663	0.2527	0.2553	0.2855	0.3052	0.2725	0.2629	0.2644	0.2735	0.2709
Hubei Province	0.2257	0.2259	0.2178	0.2209	0.2191	0.2245	0.2363	0.2249	0.2405	0.2316	0.2208	0.2106	0.2034
Hunan Province	0.1728	0.1824	0.1702	0.1783	0.1843	0.1882	0.2062	0.2047	0.2233	0.2202	0.2487	0.2457	0.2417
Guangdong Province	0.5401	0.5346	0.5095	0.5069	0.5171	0.5215	0.4846	0.4612	0.4914	0.4994	0.5005	0.4977	0.4446
Guangxi Province	0.1357	0.1368	0.1372	0.1524	0.1504	0.1519	0.1619	0.1490	0.1602	0.1586	0.1814	0.1851	0.1643
Hainan Province	0.0163	0.0178	0.0190	0.0243	0.0239	0.0247	0.0245	0.0218	0.0252	0.0278	0.0265	0.0265	0.0268
Chongqing	0.0885	0.0911	0.0873	0.0951	0.0947	0.1025	0.1082	0.0993	0.1130	0.1129	0.1154	0.1255	0.1389
Sichuan Province	0.3120	0.3226	0.3296	0.3285	0.3219	0.3317	0.3615	0.3639	0.3890	0.3904	0.4004	0.3670	0.3798
Guizhou Province	0.0844	0.0835	0.0753	0.0862	0.0970	0.1014	0.1107	0.1061	0.1043	0.0991	0.1063	0.1092	0.1095
Yunnan Province	0.1346	0.1315	0.1222	0.1366	0.1412	0.1432	0.151	0.1466	0.1689	0.1735	0.1826	0.1849	0.1892
Shaanxi Province	0.2384	0.2398	0.2299	0.2328	0.2300	0.2330	0.2514	0.2320	0.2387	0.2342	0.2261	0.0261	0.0279
Gansu Province	0.0826	0.0863	0.819	0.0929	0.0944	0.0945	0.1071	0.0931	0.1005	0.0957	0.0949	0.2215	0.2102
Qinghai Province	0.0219	0.0255	0.0223	0.0343	0.0342	0.0398	0.0449	0.0444	0.0473	0.0486	0.0504	0.0869	0.0812
Ningxia Province	0.0125	0.0141	0.0138	0.0174	0.0175	0.0178	0.0202	0.0197	0.0213	0.0199	0.0208	0.0418	0.0369
Xinjiang Province	0.0912	0.0964	0.0821	0.0974	0.0978	0.1032	0.117	0.1124	0.1033	0.1009	0.1044	0.0223	0.0229

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