



The Impact of Digital Economy on the High-Quality Development of Service Industry in Beijing

Based on the Application of EViews Software in Multivariate Linear Regression

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Abstract. This paper makes use of econometrics software EViews to explore the impact of the digital economy on the high-quality development of the service industry by establishing a multivariate linear regression model, using ordinary least square (OLS) method for the parameter estimation. And to make recommendations for the future. Results show that the digital economy as a whole significantly contributes to the high-quality development of Beijing's service industry. Among them, the factors of digital information construction and digital innovation degree have significant positive impacts, while the number of mobile phone users has a negative impact to a certain extent. In the future, Beijing should further strengthen the development of the digital economy, improve the construction of digital infrastructures, attach importance to investment in scientific and technological research and development, improve the quality of mobile phone subscribers, and promote the process of high-quality development of the service industry.

Keywords: Multivariate Linear Regression · EViews Software · Digital Economy · Service Industry · High-quality Development · OLS Method

1 Introduction

With the development of economy and society, mobile internet technology has gradually penetrated into all aspects of people's lives. At present and for some time to come, the digital economy will further integrate with traditional economic development, both sides will promote each other, jointly foster new growth areas and drivers of growth for China's economic and social development. White Paper on the Development of China's Digital Economy (Year 2020) published by China Academy of Information and Communications Technology's (CAICT) shows the current quantitative development of the digital economy. The added value of China's digital economy was about 35.8 trillion yuan, accounting for 36.2% of the GDP in 2019; in the same year, the added value of China's digitalization of industry was about 28.8 trillion yuan, playing an important role in upgrading the industrial structure.

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D. Qiu et al. (Eds.): ICBEM 2022, AHIS 5, pp. 133–143, 2023.

https://doi.org/10.2991/978-94-6463-030-5_15

At the same time, the share of service industry continued to expand within three major industries, becoming the largest industry supporting the national economy. The added value of China's tertiary industry was 53423.3 billion yuan in 2019, accounting for 53.9% of the GDP in that year, which strongly drove the significant growth of the new economy and promoted the furthering of supply-side structural reform. However, at this stage, the service industry of China still has numerous problems alongside its excellent achievements. Therefore, it is important to solve the existing problems in the service industry and promote the improvement of productivity of the service industry in order to achieve high-quality development of the service industry.

China's economic has been transforming from a phase of rapid growth to a stage of high-quality development, the driving role played by the digital economy in achieving industry high-quality development is receiving widespread attention. Relevant scholars have paid attention to this issue, and the main research perspective is concentrating on several aspects such as the measurement of high-quality development of service industries, the impact mechanism of digital economy, the empirical methods, etc. A review of the existing literature reveals that, the research on high-quality development of the service industry rarely takes the digital economy as the main influencing factor on the one hand, on the other hand, the research on the impact of digital economy towards high-quality development of industry is mostly focused on theoretical analysis, while the empirical research is mostly focused on the analysis of overall economy or the upgrading of manufacturing structure.

As the key city of digital economy development, Beijing put "accelerate the opening up of public data in the digital economy and the Internet, and break the bottleneck between government data and social data", which reveals the concern about the impact of digital economy towards service industry high-quality development. This policy aims to shape the new paradigm in the Internet era, and new strategies is provided to achieve "new services, new retail and new consumption".

However, there are still some questions without clear answer. Whether the digital economy in Beijing positively contributed to the high-quality development of service industry? Which factors influenced the high-quality development of service industry? How to promote high-quality development of service industry better in the future?

In this paper, the service industry high-quality index is calculated, in order to analyze current situation of service industry high-quality development. An econometric model is used to explore the specific impact of the digital economy towards service industry development in Beijing. Furthermore, policy recommendations are raised for the future development of digital economy.

2 Materials and Methods

2.1 Theoretical Analysis

According to the White Paper on the Development of China's Digital Economy (Year 2020), digital economy covers a framework of "four-ization" governance paths, including digital industrialization, data valorization, governance digitization and industrial digitization. This paper argues that, in terms of the impact on service industry, digital industrialization and industrial digitization are the two main paths. Referring to the

study of Jing Wenjun, Sun Baowen (2019) [6], firstly, digital industrialization achieves a comprehensive technological innovation breakthrough. Secondly, industrial digitization accelerates the integration of digital economy with real economy. The technological innovation, brought about by the digital economy, enables service industry enterprises to achieve scale economy, meanwhile achieving the precise matching of supply and demand, accelerating industrial innovation and integration at industry level, which in turn improves the resource allocation efficiency at the macro level. As a result, the costs of service industry are reduced, the structure is promoted and the efficiency is enhanced, jointly contributing to high-quality development of service industry.

2.2 Measuring the BEIJING's Service Industry High-Quality Development

Total factor productivity (TFP) is supposed to reflect the efficiency of resource utilizing, i.e., the comprehensive impact of technological progress towards the economic development over a certain period of time. Based on the academic consensus of TFP as an important way to reflect the sustainability of economic growth, this paper chooses TFP of service industry as an indicator representing high-quality development of the service industry.

Establishing the Cobb-Douglas production function firstly.

$$Y_t = A_t \cdot K_t^\alpha \cdot L_t^\beta (\alpha + \beta = 1) \quad (1)$$

A_t is the Hicks neutral productivity term. Y_t is the real output of service industry in year t . K_t is the capital input of service industry in year t . L_t is the labor input of service industry in year t . α and β , respectively, are the average capital input share and the average labor input share. The output (Y_t) and labor input (L_t), respectively, were chosen to represent the added value of service industry and the number of employees in service industry at the end of the year in Beijing, referring to the study of Jiechang Xia, Xiao Yu and Shilin Li (2019) [8]. Finally, the capital input (K_t) was estimated according to the perpetual inventory method, according to Zhang Jun (2004) [9]. The formula is:

$$K_t = K_{t-1}(1 - \delta) + I_t = K_0(1 - \delta)^t + \sum_{n=1}^t I_n(1 - \delta)^{t-n} \quad (2)$$

$$K_0 = I_0/(g + \delta) \quad (3)$$

δ is the capital depreciation rate, set at 9.6% according to the default standard. I_t is the amount of fixed asset investment in service industry in year t . I_0 is the amount of fixed asset investment in service industry in the base year; and g is the average growth rate of output. Using the Solow residual method, the natural logarithm is taken simultaneously for both sides of the Eq. (1), i.e.,

$$\ln Y_t = \ln A_t + \alpha \ln K_t + \beta \ln L_t \quad (4)$$

$$d \ln Y / dt = (1/Y) \cdot (dY/dt) \quad (5)$$

$$\dot{Y} = dY/dt, \dot{A} = dA/dt, \dot{K} = dK/dt \quad (6)$$

$$\dot{Y}/Y = \dot{A}/A + \alpha \dot{K}/K + \beta \dot{L}/L \quad (7)$$

An OLS regression estimation of model (4) is performed to get α and β values. The regularized α and β values are brought into Eq. (7) to obtain \dot{A}/A , i.e., the TFP value.

2.3 Modelling the Relationship Between Quality Development in the Service Industry and the Digital Economy

This paper establishes a time series multiple linear regression benchmark model and an extended model as follows, where Eq. (8) and Eq. (9), respectively, are the benchmark model and the extended model with the addition of control variables.

$$TFP_t = \alpha_0 + \alpha_1 Income_t + \alpha_2 Mobile_t + \alpha_3 Innovate_t + \mu_t \quad (8)$$

$$TFP_t = \beta_0 + \beta_1 Income_t + \beta_2 Mobile_t + \beta_3 Innovate_t + \beta_4 Struct_t + \beta_5 GRP_t + \beta_6 Urban_t + \beta_7 DFT_t + \beta_8 Labor_t + \mu_t \quad (9)$$

The explained variable TFP_t is the indicator of Beijing's service industry high-quality development, which means the TFP of Beijing's service industry in year t is used to express Beijing's service industry high-quality development. Explanatory variables, such as $Income_t$, $Mobile_t$ and $Innovate_t$, respectively, represent the degree of digital information construction, digital mobile services and digital innovation, according to Shen Yunhong, Huang Jiao (2020) [7]. The digital information construction variable is reflected by the ratio of the output of information transmission, software and information technology service industry to the output of the tertiary industry. The digital mobile service variable is reflected by the number of mobile phone subscribers at the end of the year. Lastly, the digital innovation variable is reflected by constructing a composite variable that includes two secondary indicators: research investment and the proportion of research funding.

In this paper, five control variables are selected according to Zhao T, Zhang Z, Liang Shangkun (2020) [10], which are $Struct_t$, GRP_t , $Urban_t$, DFT_t and $Labor_t$, which represent industrial structure, economic development, urbanization level, foreign trade dependence and labor force structure of Beijing, respectively. The industrial structure is represented by the contribution rate of the tertiary industry. The economic development is represented by Beijing's gross regional product. The urbanization level is represented by the ratio of urban population to the total population. The foreign trade dependency is represented by the ratio of total imports and exports to GDP. Lastly, the labor force structure is represented by the ratio of employment in the tertiary industry to total employment.

3 Results and Discussion

3.1 Total Factor Productivity Measurement Results

The regression results for α and β , respectively, are 0.26027 and 0.183766. After regularization, the final values of α and β , respectively, are 0.585538 and 0.414462. According

Table 1. Total factor productivity in Beijing's service industry

Time	2002	2003	2004	2005	2006	2007	2008	2009	2010
TFP (%)	12.69	8.16	0.09	11.64	10.02	20.57	12.67	-1.72	9.14
Time	2011	2012	2013	2014	2015	2016	2017	2018	2019
TFP (%)	13.48	5.01	6.32	4.13	5.01	5.46	8.03	13.96	6.46

to the calculation model, the final measured TFP of service industry in Beijing, with the base year of 2000, is shown in the Table 1. The data source is the Beijing Statistical Yearbook from the year 2001 to 2020.

3.2 Regression Results of the Model

3.2.1 Data Sources and Descriptive Statistics of Indicators

Considering the availability of data, the time data for the study in this paper spans from 2005 to 2019. Data, from 2006 to 2020, were obtained from Beijing Statistical Yearbook, the annual statistical report on telecommunication business on the website of the Ministry of Industry and Information Technology, etc. The explanatory and control variables in the empirical evidence were analyzed econometrically using growth rate data, with no serial autocorrelation tested. The descriptive statistical analysis of the indicators is shown in Table 2.

As is shown in part II, this paper chooses TFP_t of service industry as an indicator representing “High Quality Development Index”, which means the TFP of Beijing's service industry in year t is used to express Beijing's service industry high-quality development. The data were measured in Table 1.

3.2.2 Regression Results

The results of the baseline and extended regressions of the time series using OLS method for the prediction model, using stepwise addition of control variables, are shown in the Table 3.

3.3 Discussion of Regression Results

According to the analysis of the regression coefficient results of the model (5) with all the control variables introduced, among the explanatory variables, there is a significant positive correlation between two indicators, which are the digital information construction and the degree of digital innovation, and the service quality development indicators. They are at the 5% and 1% significance levels respectively with correlation coefficients of 0.1893 and 0.3615 respectively. This shows that at this stage, the construction of digital information infrastructure and the degree of digital innovation have a positive effect on the high-quality development of service industry.

Meanwhile there is a negative correlation between digital mobile services and service quality development indicators, which passes the test at the 5% significance level

Table 2. Descriptive statistics for indicators (from 2006 to 2019)

Variables	Variable Description	Overall average	Standard deviation	Maximum value	Minimum value
TFP _t	High Quality Development Index	8.4684	5.4547	20.5741	-1.7164
Income _t	Digital Information Construction	2.7622	5.0559	12.4055	-3.7729
Mobile _t	Digital Mobile Services	7.8226	9.3921	22.986	-4.5143
Innovate _t	Degree of digital innovation	7.4801	4.5446	15.5708	1.34480
Struct _t	Industrial structure	1.6098	11.9961	26.4368	-23.0303
GRP _t	Level of economic development	12.1855	4.6554	24.3055	6.84257
Urban _t	Level of urbanization	0.2508	0.3452	1.1201	-0.0584
DFT _t	Foreign trade dependence	-1.4553	16.6739	24.2366	-28.8799
Labor _t	Workforce structure	1.6007	1.2494	4.4733	-0.5376

with the correlation coefficient of -0.0815 . It means that the development of digital mobile services inhibits the process of high-quality development of service industry. The negative impact of the number of mobile phone subscribers is analyzed as follows.

Beijing Statistical Yearbook explains that mobile phone subscribers refer to “all telephone subscribers who entered the mobile phone network through mobile phone exchanges at the end of the reporting period. This includes all types of contracted users, smart network prepaid users, wireless Internet card users, etc.” When the same individual is connected to the mobile phone network several times through different means and channels, the total number of subscribers shows an increase, but the actual number of users does not change. In recent years, the number of “multiple users per person” has been increasing. The graph below shows how the mobile phone penetration rate (total number of mobile phone users compared to the number of people living in the administrative area) has changed in recent years in Beijing. As is shown in the graph, from 2003 to 2019, the mobile phone penetration rate in Beijing shows a rapid upward trend, rising from 76.1 households per 100 people to 186.7 households per 100 people in the same year, which means the total number of mobile phones in Beijing is now close to twice the resident population. This indicates that the growth rate of the number of mobile phone

Table 3. Time series stepwise regression results (OLS)

Variable name	Return to baseline Models	Extended Return Models (1)	Extended Return Models (2)	Extended Return Models (3)	Extended Return Models (4)	Extended Return Models (5)
Income _t	<i>TFP_t</i>	<i>TFP_t</i>	<i>TFP_t</i>	<i>TFP_t</i>	<i>TFP_t</i>	<i>TFP_t</i>
	0.3253 (0.2995)	0.2711 (0.1789)	0.3043* (0.1553)	0.2399** (0.0981)	0.2113** (0.0815)	0.1893** (0.0481)
Mobile _t	-0.0409 (0.1610)	-0.0758 (0.0963)	-0.0439 (0.0846)	-0.0266 (0.0528)	-0.0673 (0.0474)	-0.0815** (0.0280)
	0.5609 (0.3189)	0.3688 (0.1950)	0.4911** (0.1789)	0.4664*** (0.1113)	0.4675*** (0.0912)	0.3615*** (0.0613)
GRP _t		0.8336 (0.1904)	1.0021*** (0.1843)	0.9712*** (0.1148)	0.9101*** (0.0985)	0.8577*** (0.0596)
	Urban _t		-5.4229* (2.6841)	-5.5701** (1.6684)	-4.4092** (1.4744)	-5.4128*** (0.9092)
Struct _t				0.1474*** (0.0398)	0.1626*** (0.0334)	0.1243*** (0.0224)
	Labor _t				-0.7574* (0.3601)	-0.6997** (0.2116)
Struct _t						0.0763** (0.0216)
	Constant	3.6943 (3.2487)	-4.6042 (2.7092)	-6.5528** (2.5294)	-6.1491*** (1.5756)	-4.1200 (1.6169)
AR ²	0.2999	0.7763	0.8519	0.9500	0.9712	0.9918

Note: *, ** and ***, respectively, indicate passing the test at the 10%, 5% and 1% significance levels. Figures in brackets are standard errors after adjusting by heteroskedasticity and correlation

subscribers has exceeded the growth rate of the number of mobile phone users. As the phenomenon of multiple households per person increases, the frequency and activity of user units of mobile phone subscribers decreases, the contribution to output decreases, thus decreases the productivity. The higher the growth rate of mobile phone subscribers, the lower the TFP of the service industry, ultimately leading to a dampening outcome (Fig. 1).

In addition, with reference to relevant studies [4, 5], this paper argues that diminishing marginal utility still exists in the modern network economy. As a result, when the number of smart mobile devices increases to a certain level, it has an Inhibition effect on the output of service industry. The digital transformation of service industry may create “creative destruction”, with the digital economy showing an inverted “U” shape. At this stage, the digital economy has a negative impact on the real economy in general, as it

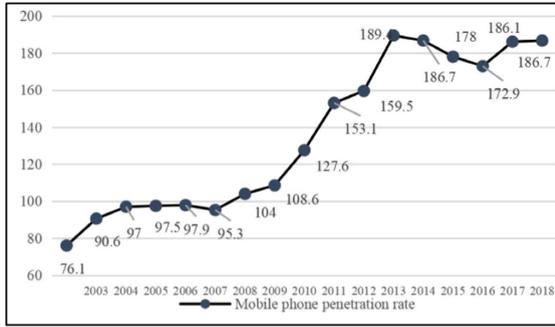


Fig. 1. Changes in mobile phone penetration in Beijing

has already crossed the threshold of the inverted “U” outcome, resulting in a so-called “crowding-out effect”. The crowding-out effect of the mobile devices growth on the real economy will outweigh the positive impact of the online economy and eventually lead to an Inhibition effect.

In general, the promotion effect is significantly stronger than the inhibition effect, indicating that the digital economy, through digital industrialization and industrial digitization channels, has a positive impact on the service industry in terms of basic industrial construction and industrial innovation, etc. This indicates that the digital economy has a clear positive impact on the quality development of the service industry through digital industrialization and industrial digitization paths, in terms of infrastructure construction and industrial innovation.

Among the control variables, the level of economic development, industrial structure and foreign trade dependence have a positive correlation with the indicators of high-quality development of the service industry, passing the significance test at 1%, 1% and 5% levels respectively, with correlation coefficients of 0.8577, 0.1243 and 0.0763, indicating that the increasing of economic development, upgrading of industrial structure, foreign trade dependence may accelerate service industry high-quality development. The variables of urbanization level and labor force structure are negatively correlated with the indicators of service industry high-quality development, with the correlation coefficients of -5.4128 and -0.6997 respectively, which passed the significance test at the 1% and 5% levels respectively, indicating that the continued increase of urbanization level and the proportion of service industry labor force have an inverse effect on service industry high-quality development.

As to the inhibition effect, it has been suggested that an inverted U-shaped curve occurred between population size and productivity in cities above the prefecture level in China at this stage [2]. In particular, the mega-cities, represented by Beijing, have already exceeded the optimal population size for a long time, entering the stage of diseconomies of scale. The continued increase of urban population rises the cost of commuting, creating negative externalities and further aggravating the diseconomies of scale. In addition, based on the TFP perspective, Cui Min and Zhao Zeng Yao (2020) [3] argue that productive service industries such as accommodation and catering, information transmission,

computer services and software, real estate, and transportation, storage and postal services are underdeveloped service industry, with the TFP growth rate always lower than the average level of service industry. In recent years, the lagging effect of the concentration of labor in these productive service industries in Beijing will also have a negative impact on the TFP of service industry.

4 Conclusions

4.1 Conclusion

This paper explores the impact of the digital economy on Beijing's service industry high-quality development, analyzes the specific factors that influence it. The empirical results show that the digital economy as a whole may significantly contribute to Beijing's service industry high-quality development. Among them, the factors of digital information construction and digital innovation degree have a significant positive impact. The development of digital information infrastructure industry and digital innovation research accelerate the process of digital industrialization and industry digitization, thereby reducing the production cost of enterprises, promoting industrial structure and the efficiency of resource allocation, finally promoting the improvement of TFP in the service industry. The number of mobile phone users has a negative impact on TFP of the service industry. As the carrier of internet digital information, the number of mobile phone devices has increased along with the phenomenon of "multiple households per person", and the increasing in the number of households has led to the decreasing in their contribution to unit output.

The level of economic development, industrial structure and foreign trade dependency are positively correlated with the indicators of service industry high-quality development, while the urbanization level and the structure of labor force are negatively correlated with the indicators of service industry high-quality development. However, as Beijing is a typical mega-city, the urban population density and labor force have already reached a peak, with the diminishing marginal effects obvious, thus more increases of both indicators lead to more negative externalities and diseconomies of scale, which means a negative relationship with the TFP of service industry.

4.2 Policy Recommendations and Solutions

Firstly, the policy approach of vigorously developing the digital economy should be maintained, thereby promoting the integration of digital economy industrial development and the service industry digitalization. On the one hand, the construction of digital infrastructure should be implemented, perfecting digital information service channel services, creating a high-quality digital service platform [1]. Only when digital economy infrastructure services are abundant, may we give full play to the information cost advantages of network platforms, achieving efficient matching of information and developing new economic models such as the sharing economy. On the other hand, supporting should be made on scientific research and the transformation of research, especially co-adaptive digital technologies such as AI, big data, cloud computing, industrial internet,

etc. should be focused, enhancing their transformation and practical application, further developing new digital devices.

Secondly, the quality of mobile phone users should be improved. Identifying and classifying the behavior of mobile phone users, users involved in the production process of service industry should be guided and regulated, for example cleaning up “zombie numbers” used infrequently by government and state-owned enterprises and institutions, or developing industry regulations to facilitate the cancellation and conversion of long-term inactive users.

Thirdly, the recruiting of digital talents and digital transformation of the workforce should be strengthened. On the one hand, the introduction of high-quality talents is important, and on the other hand, the professional quality of the workforce should also be enhanced, by implementing worker skills training by industry and position, also by upgrading worker skills of service industry in operating digital equipment. Employment pressure in Beijing may be reduced by guiding highly-qualified workers to skilled and professional positions, achieving the upgrading of service industry internal structure, thereby alleviating the current situation of diseconomies of scale.

In addition, attention should be paid to a reasonable balance between the development of digital network economy and the development of the real economy of service industry. On the one hand, it is necessary to further the supply-side structural reform, adopt reasonable methods and means to strengthen the layout of development path of service industry, enhance the adaptability of the real economy of service industry in dealing with the impact of new business models and industries. On the other hand, it is necessary to strengthen the application of digital technology in real economy, achieve digital reform in all areas of real economy of service industry, ultimately achieve the integration of digital economy and real economy of service industry.

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