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Provincial Gap in the Development of Information Service Industry in China

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Abstract: First, this paper compared the revenue scale and the business structure of information service industry in different provinces in China with the descriptive statistics method. Second, cluster analysis was adopted to classify 30 provinces into 4 groups according to 8 industrial development indicators. Third, a logistic model was established based on the grouped samples to analyze the impacts of regional GDP, human capital accumulation, R&D investment and geographical location on the development level of information service industry. Estimation results indicate that those 4 factors have significant impacts. In order to narrow the provincial gap, we suggest that the eastern regions in China should aim at the optimization of business structure and the technological innovation of the information industry itself, while the central and the western regions should focus on integrating the information industry deeper with the first and secondary industries.

1. Introduction

Information service industry provides services and products for society by using modern science and technology such as computer and communication network to produce, collect, process, store, transmit, retrieve information. According to the newly revised Industrial Classification for National Economic Activities issued by the National Bureau of Statistics of China, this industry is officially named Information Transmission, Software and Information Technology Service Industry, which includes three departments: Telecommunications, Radio and Television and Satellite Transmission Services, Internet and Related Services, and Software and Information Technology Services. According to the newly revised industrial classification rubrics, software and information technology services refer to services provided for the technical problems or technical needs arising in the process of information transmission, information production, information provision and information reception, and are broadly known as the Information Service Industry in a narrow conception sense. The scope of the information service industry that this paper defined is consistent with the narrow conception of information service industry mentioned above.

In the 14th five-year-plan formulated by the central government of China in March 2021, which pointed out that the development of the service industry should be oriented by serving the high-

quality development of manufacturing sector to promote the specialization of the industry and elevate it to the high range of the value chain. In November 2021, in order to implement the national 14th five-year plan, the Ministry of Industry and Information Technology (MIIT) of China issued The 14th Five-Year Plan for the Development Oof Deep Integration of Informatization and Industrialization, The 14th Five-Year-Plan for the Development of Software and Information Technology Service Industry and The 14th Five-Year Plan for the Development of Big Data Industry, so as to promote all departments of software and information service industry to move up to high-quality development.

Since then, all provinces, municipalities and autonomous regions in Chinese Mainland and all countries and cities under their jurisdiction have formulated their own information service industry development plans according to the central and provincial policies. It can be said that Chinese government at all levels have fully realized that the development of the information service industry is an important aspect of the national basic industrial capacity and an important support for China to build a modern economic system. Under the guidance and stimulation of those plans, China's information service industry is expected to usher in a climax of development and construction in infrastructure construction, ecological cultivation, and industrial chain value extension.

Due to the different historical processes of the rise and popularization of information technology in various countries and regions around the world, the academic circles in China and overseas that are interested in information service industry have experienced a transition from the perspective of information industry to the perspective of service industry [1]. Early researchers regarded the information service industry as a department of the information industry, analysed its development laws to guide the formulation of industrial development policies [2-6]. Around 2000, with the rise of the knowledge economy, the supply chain management, performance evaluation, quality management and property right reorganization in the information service industry became research hotspots [7-11]. Since 2006, scholars have applied theories and methods of industrial economics, regional economics, technical economics, growth economics and other disciplines to the research field of information service industry in a large number of ways, quantitative analyses have been made on the governance mode, industrial clusters, industrial competitiveness evaluation, industrial relations and industrial integration measurement [12-15]. In recent years, under the social development background of digital economy and carbon peaking and carbon neutrality goals, the role of information service industry in China's economic growth has also become a focus of the academic attention [16-19].

However, few study has focused on the provincial difference in the development of the information service industry in China. The Chinese Mainland has a vast territory, and the natural endowment, social and economic development levels of each region are different. It is extremely important to understand the current situation of the development of information service industry in each region if the local policy makers want to formulate industrial development policies in line with their own social and economic situation. Based on The Annual Statistical Data of Software and Information Technology Service Industry published by the Ministry of Industry and Information Technology of China, this paper will analyse the provincial gap of information service industry development in Chinese Mainland, and try to figure out the main factors that caused the differences from the macro-economy perspective. Under the definition of The Ministry of Industry and Information Technology of China, the information service industry is composed of four departments: software product industry, information technology service industry, information security industry and embedded system software industry. The research samples of this paper are all provinces, municipalities and autonomous regions in China except Tibet, which are 30 regions in total.

2. Analyses of the Current Status of Information Service Industry among Provinces

2.1. Industrial Scale and Regional Distribution

In 2020, the revenue of information service industry of 30 provinces, municipalities and autonomous regions in China totalled 8.16 trillion yuan, with an average value of 0.27 trillion yuan. Provinces that got above-average revenue include Beijing, Guangdong, Jiangsu, Zhejiang, Shanghai, Shandong, Sichuan and Shaanxi. Beijing got the highest information service industry revenue, reaching 1.57 trillion yuan, and Qinghai had the lowest of only 0.48 trillion. Compared with 2017, the average growth rate of revenue of information service industry in Chinese Mainland is as high as 123.0%. The growth rate of Anhui, Guangxi, Shanxi, Ningxia and Qinghai is higher than the average level, among which Ningxia Hui Autonomous Region reached a record of 1679.6% growth. The high growth of those regions may be mainly due to the small industry scale in the early stage. Because the scale of information service industry in Guangxi, Shanxi, Ningxia and Qinghai was very small in 2017. Fujian, Liaoning, Jilin, Hebei, Hunan, Heilongjiang and Inner Mongolia showed negative growth in 2020, compared to 2017.

Figure 1 shows the proportion of information service industry revenue of each province in the country in 2020. It can be seen from Figure 1 that the revenue of information service industry in Beijing, Guangdong and Jiangsu together accounted for nearly half of the national industry revenue. Zhejiang, Shanghai and Shandong each accounted for about 7-8 percentage points, Shaanxi and Sichuan each provided for about 4-5 percentage points, Chongqing, Fujian and Tianjin each took for about 2-3 percentage points, each of Anhui, Liaoning and Hubei made up for about 1-2 percentage points, while Guangxi, Jilin, Henan, Guizhou, Jiangxi, Hebei, Hainan, Yunnan, Hunan, Shanxi, Gansu, Xinjiang, Heilongjiang, Ningxia, Inner Mongolia and Qinghai occupied for less than 1 percentage point.

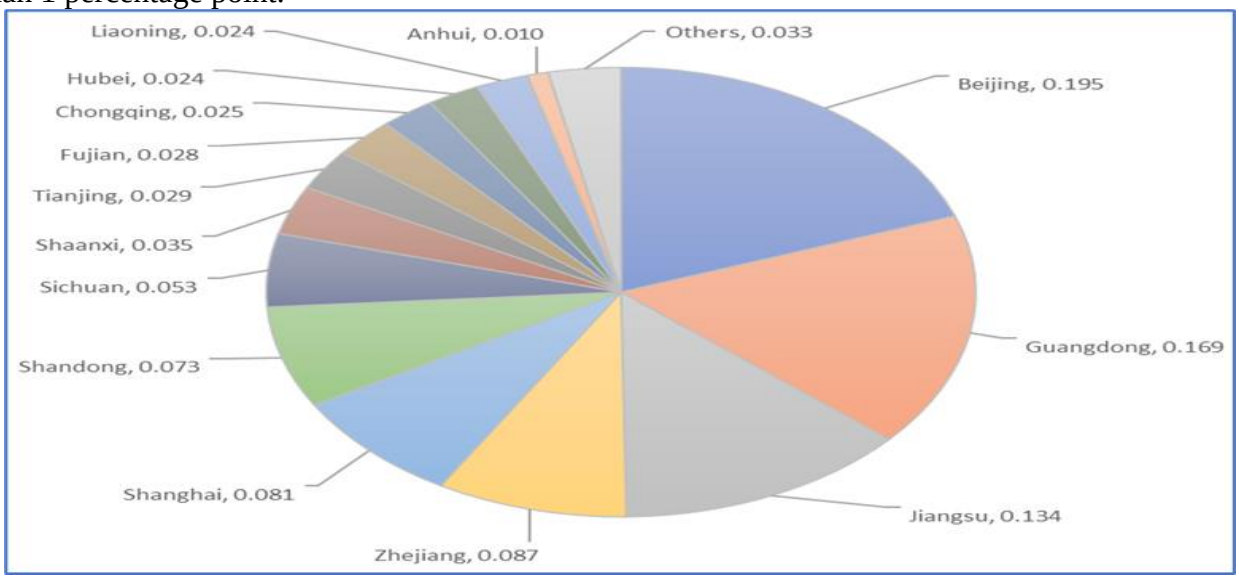

Figure 1: The revenue proportion of information service industry of each province in 2020.

2.2. Business Structure and Regional Difference

By December 2020, there were 38661 information service enterprises in China, including 1254 foreign-invested enterprises and 925 Hong Kong, Macao and Taiwan invested enterprises, accounting for 23.2% of the total number of enterprises, and 36482 domestic funded enterprises, accounting for 76.7%. Large enterprises with an annual revenue of more than 100 million yuan and

micro enterprises with an annual revenue of less than 50 thousand yuan are of almost equal quantities, 3548 and 3714 respectively, accounting for only 1.9% of the total number of enterprises. There are 10205 medium-sized and 21194 small-sized enterprises, accounting for 54.8% and 26.4% respectively.

Like it demonstrated in Figure 2, in 2020, the revenue of information technology service business in Chinese Mainland reached 5.26 trillion, with an average of 0.175 trillion, accounting for 64.46% of the total industry revenue. It can be seen from Figure 2 that the business revenue of the information service industry in Tianjin, Shaanxi, Sichuan, Shandong, Jiangsu, Guangdong, Shanghai, Beijing and Zhejiang exceeded the national average level. In 2020, revenue of the software product business made up to 2.10 trillion yuan, with an average of 701.5 billion, accounting for 25.79% of the total industry revenue. The business revenue of software products in Liaoning, Sichuan, Shandong, Jiangsu, Guangdong, Shanghai, Beijing and Zhejiang exceeded the national average level. In 2020, the information security business revenue reached 0.129 trillion, with an average of 22.197 billion, accounting for 1.59% of the total industry revenue. The business revenue of software products from Liaoning, Sichuan, Shandong, Jiangsu, Guangdong, Shanghai and Beijing exceeded the national average. In 2020, the embedded software business revenue reach 0.67 trillion, with an average of 22.197 billion, accounting for 8.16% of the total industry revenue. The business revenue of the embedded software products in Chongqing, Fujian, Sichuan, Shandong, Jiangsu, Guangdong and Zhejiang exceeded the national average.

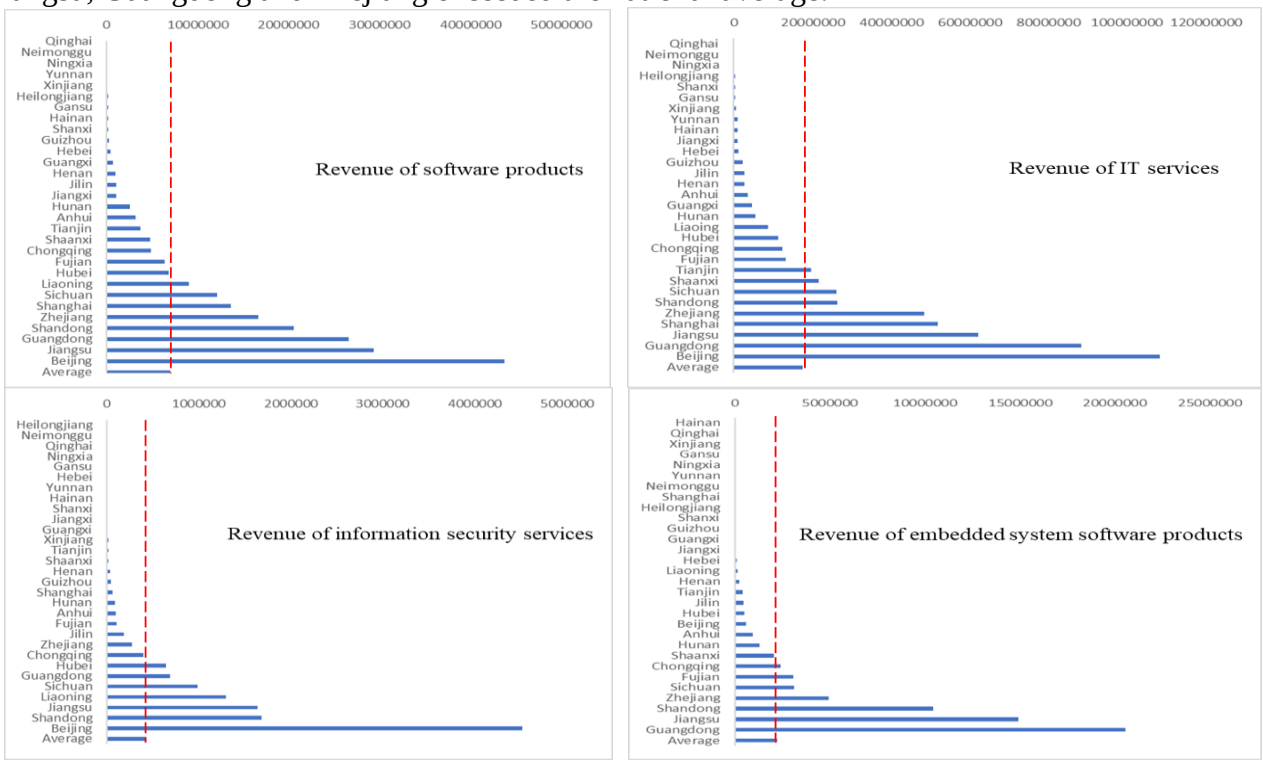

Figure 2: Business structure of information service industry among provinces.

We can see it in Figure 3 that from the perspective of the internal composition of the information service industry of each province, Qinghai has the largest proportion of information technology service business revenue, reaching 89.01%, and Shandong has the lowest proportion, reaching 44.60%. Region that had the largest proportion of software product business revenue is Jiangxi, accounting for 48.96%, and the lowest is in Qinghai, accounting for only 4.24%. The regions with the largest and lowest proportion of embedded software system business revenue are Shandong and Hainan, with a difference of 17.63 percentage points. Liaoning has the largest proportion of

information security business revenue, accounting for 6.76%, 6.68 percentage points higher than Tianjin, which has the lowest proportion.

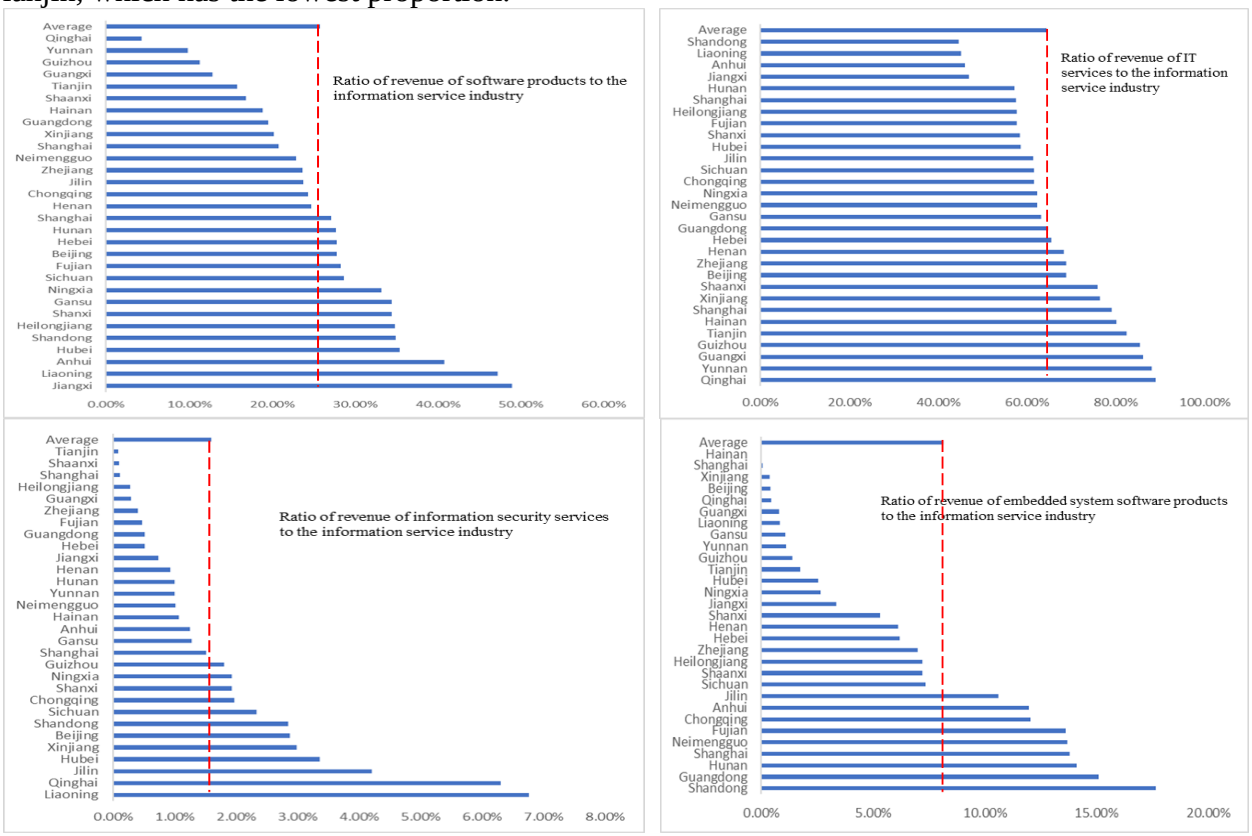

Figure 3: Proportion of business revenue in each province.

From the above analysis, we can see that there are great differences in the development of information service industry in various regions of Chinese Mainland. From the perspective of industrial scale, the Yangtze River Delta region, Pearl River Delta region, Beijing-Tianjin-Hebei region and Sichuan-Chongqing area contributed more than 87.4% of the industry output. From the perspective of business structure, Beijing-Tianjin-Hebei region and Yangtze River Delta region have obvious advantages in information technology service and software product business, while Pearl River Delta region and Sichuan-Chongqing area have certain strength in embedded software system business. In addition, the development of the information service industry in Anhui, Fujian, Hubei and Shaanxi has also emerged, possibly due to the advantages of the gathering of well-known universities, research institutions and industry university research communities in the provincial capital cities. However, for most of China's inland areas, the scale of its information service industry is still relatively small.

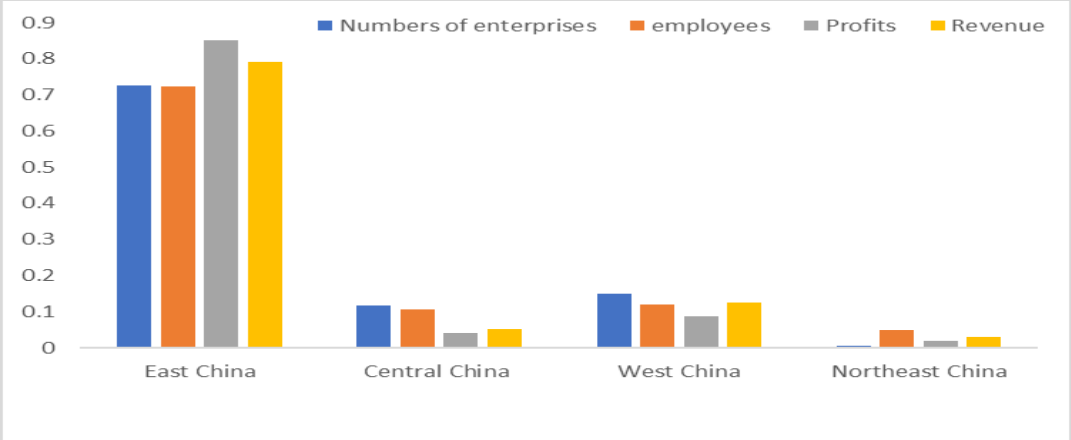

Figure 4: The development of information service industry among 4 regions.

Actually, if we divide China into four regions: the East, the Central, the West and the Northeast, as is shown in Figure 4, we can see that the development of information service industry in the eastern region is far better than that in the central, the western and the northeast region in terms of scales of revenue, profit, number of enterprises and number of labour input.

3. Macro Factors Caused the Provincial Differences

3.1. Cluster Analysis

In this section, we hope to explore the reasons caused provincial differences in the development of information service industry in Chinese Mainland from a macro perspective based on logistic regression method. For that reason, we first use the statistical data published in the 2020 Statistical Data of Software and Information Technology Service Industry published by the Ministry of Industry and Information Technology of China, to classify 30 sample regions into different groups through cluster analysis. The eight indicators used in the clustering process are regional revenue, number of employees, number of enterprises, total profit, total assets, staff wages and R&D investments. In the clustering process, all index values are first standardized using the method shown in formula (1). The similarity between samples was calculated by the Euclidean distance algorithm shown in formula (2), and the similarity between groups was calculated with the method of the nearest neighbour shown in formula (3).

$$x = \frac{X - \mu}{\sigma} \tag{1}$$

$$d_{ij} = \left(\sum_{k=1}^{p} \left| x_{ik} - x_{jk} \right|^2 \right)^{\frac{1}{2}} \tag{2}$$

$$D_{kr} = \min_{x_i \in G_k, x_j \in G_r} d_{ij} \tag{3}$$

Take the number of clusters as the horizontal axis and the Euclidean distance coefficient as the vertical axis to draw the elbow line, as shown in Figure 5. It can be seen that the Euclidean distance coefficient changed slightly when the number of clusters went bigger than 4, which means that increasing the number of clusters can no longer optimize the clustering results. According to this, 30 regions was divided into four groups: high development level, upper-middle level, mediate and low development level.

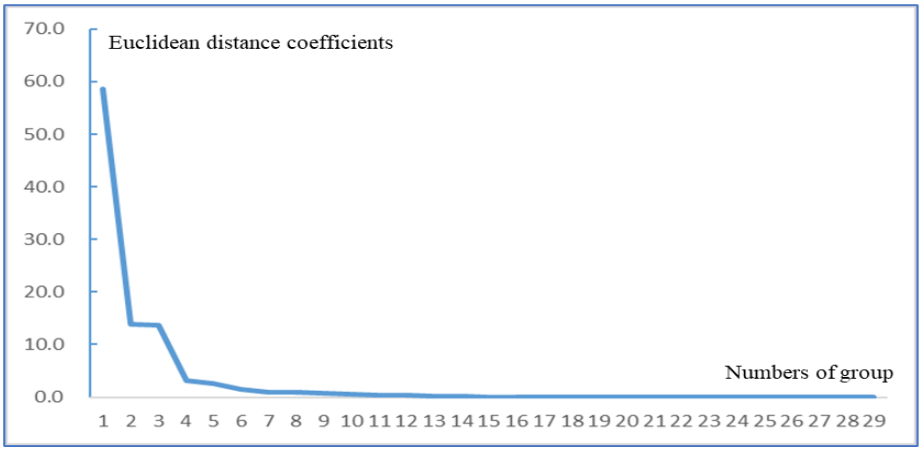

Figure 5: Selecting K with the elbow method.

Table 1 shows member details in each cluster. Regions in the high-level development group account for 13.4% to 19.5% of revenue of the country total. Regions in the upper-middle level group accounts for 7.3 to 8.7% of the country total revenue. Each of the 6 regions in the intermediate level group accounts for about 2.4% to 5.3% of the country total. Each of the rest 18 regions in the low development level group accounts for l1% or less of the country total.

Table 1: Members of each cluster.

Cluster	Cluster Members
group 1: High development level	Beijing Jiangsu Guangdong
group 2: upper-middle-income development level	Shanghai Shandong Zhejiang Tianjin
group 3: intermediate development level	Liaoning Chongqing Fujian Hubei Sichuan
group 4: low development level	Hebei Hunan Xinjiang Qinghai Ningxia Yunnan
	Henan Jiangxi Guizhou Guangxi Shaanxi Shanxi
	Heilongjiang Jilin Anhui Gansu Hainan Neimenggu

3.2. Logistic Regression Analysis

Logistic regression is a multiple regression analysis method that often used to study the relationship between the binary variable or multivalued qualitative variable and their influencing factors. The logistic model can generally be expressed as formula (4):

$$P(y=m)=\frac{\exp(\beta_0+\beta_1 x_1+\cdots+\beta_i x_i)}{1+\exp(\beta_0+\beta_1 x_1+\cdots+\beta_i x_i)} \tag{4}$$

Where y is a multivalued explained variable. In this paper, y = 1,2,3,4, respectively, representing the regions that are in the low, intermediate, upper-middle and high development level of information service industry. The value of y in each region is determined by the above clustering analysis results. $x_1 \cdots x_i$ are the explanatory variable, which in this paper refers to various macro factors that contribute to the development gap of information service industry in various regions. In identifying these influencing factors, we mainly took into account the following aspects.

The information service industry is a knowledge intensive and technology intensive industry that provides specialized services such as information production, processing, storage and transmission only under the support of the modern science and technology such as computers and the internet. Therefore, whether a region has a high degree of knowledge intensity, that is, whether there are a

large number of professionals gathered in the region, plays a vital role in the production of the innovation of information products and services. In addition, sufficient R&D investment can often lead the growth direction of knowledge intensive industries. The level of regional economic development usually determines the development level of local information infrastructure, and geographical location may affect the position and production cost of enterprises in the industrial chain. Therefore, from a macro perspective, the level of regional economic development, the accumulation of human capital, the scale of R&D investment and geographical location are the most important factors affecting the development of information service industry.

Based on the above considerations, this paper selects the regional gross domestic product (GDP), the average number of employees with college or university education experience in information service industry (EDU), R&D expenditure (EXP) and geographical location (GEO) as explanatory variables. The data were selected from the 2020 Statistical Data of Software and Information Technology Service Industry published by the Ministry of Industry and Information Technology of China and The 2021 China Statistical Yearbook. In order to eliminate heteroscedasticity, three quantitative explanatory variables were treated with natural logarithms and expressed by LGDP, LEDU and LEXP respectively. The variable GEO is a dummy variable representing industrial agglomeration and location. The region located in Beijing-Tianjin-Hebei Region, Yangtze River Delta Region, Pearl River Delta Region and Chengdu-Chongqing area were assigned with 1 on variable GEO, and the value of GEO of other provinces, municipalities and autonomous regions were assigned with 0.

We adapted bootstrap parameter estimation strategy using spss20.0 while processing the Logistic regression. The estimation results obtained from the logistic regression are shown in formula (5). The statistical properties of parameter estimation are shown in Table 2.

$$Y = -36.54 + 3.19LGDP + 1.60LEDU + 1.50LEXP + 0.85GEO \quad (5)$$

Table 2: Results of the Logistic regression.

Variable	β_i	Sig.	Exp (β_i)
LGDP	3.194714	0.055169	24.40319
LEDU	1.60432	0.095292	4.97447581
LEXP	1.50088	0.095906	4.48563469
GEO	0.8537	0.096428	2.34831958
C	-36.5435	0.047846	1.35E-16

As it showed in Table 2, at the significance level of 10%, all explanatory variables have significant effects on the explained variables. The most important factor that affects the regional development of information service industry is the economic development level of the region. For every 1% increase in regional GDP, the Logistic model predicted probability of becoming a high development information service industry area will increase by 23.403 times. The impacts of human capital accumulation level and R&D investment are almost equivalent. For every 1 percentage point increase in both, the probability of becoming a high development area of information service industry will increase by 4.97 times and 4.49 times. The influence of location factors is in the last place. However, we believe that regions around the well-developed areas we mentioned above are very likely to use the spillover effect of industrial agglomeration from their neighbors to improve the development level of their own information service industry.

4. Conclusion and Discussion

In recent years, countries all over the world have attached great importance to the development of their own information service industry and formulated relevant policies and guidelines conducive

to the development of their own information service industry. For example, for one hand, the United States implements the policy of financial support, policy guidance and talent introduction; on the other hand, it adopts technology containment against other countries such as China. Europe has also increased its investment in innovation and research and development of information and communication technologies to promote the development of the information service industry. Japan puts the information service industry at the center of its economy to promote the digitization of the public service sector. South Korea made a national plan to guide information service industrial development, implement the green IT strategy, to create high-quality local information service enterprises. India has invested vast of funds to continuously develop the infrastructure construction of the information service industry for many years. In the past 20 years, China's information service industry has developed rapidly and achieved remarkable success. However, through the provincial comparison of the information service industry in Chinese Mainland, we can find that there are obvious development gaps among various regions.

In the future, restricted by the regional economic development, the development of information service industry in provinces in the central and western regions may still be facing difficulties to achieve substantial increase in scale and structural optimization. Therefore, it is expected that the inter provincial gap in the development of China's information service industry will exist for a long time. We believe that only by formulating industrial development goals and policies according to their conditions can each region achieve the maximum benefit in economic and social development. For the central and western regions, the ideal information service industrial policy should be to continue to deepen the integration of the information service industry with the primary and secondary industries, so as to realize the expansion of the industrial scale in the process of deepening the integration. For the eastern provinces such as Beijing, Shanghai, Jiangsu, Zhejiang and Guangdong, they should aim at the goal of optimizing the business structure and improving the innovation ability, to promote the optimal allocation and sharing of resource among scientific research institutes, colleges and universities and enterprises, and encourage the first edition software, industrial basic databases, intelligent manufacturing systems and other productive services to move up to the specialization and high-end extension of the value chain.

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