The Impact of Informatization on the Agglomeration of Producer Services: Analysis Based on Quantile Regression in China's Heilongjiang Province

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Abstract. The The development of informatization is of great significance for promoting the agglomeration of producer services by promoting knowledge spillover, expanding the service radius and reducing agglomeration costs through convenient information transmission. The location quotient was constructed to measure the agglomeration level and regional differences of producer services in Heilongjiang Province. Based on the panel data from 2003 to 2019, the panel data model and quantile regression model were used to study the effect mechanism of informatization on the agglomeration of producer services. The study shows that there are significant differences in the agglomeration level of producer services among cities in Heilongjiang Province, and the panel data estimation results show that the overall impact of informatization on the agglomeration of producer services is positive. Quantile regression results show that the effect of informatization is not statistically significant at lower and higher concentration levels. At the medium level of agglomeration, informatization plays a significant role in promoting the agglomeration of producer services.

Keywords: Informatization · Panel Data · Quantile Regression · Producer Services · Location Quotient

1 Introduction

As an important part of modern service industry, producer services are knowledge-intensive and highly correlated with other industries, and the key factor to economic development [7]. To give full play to the positive externalities of producer services to related industries is an important driving force to promote the "transformation of development mode, optimization of economic structure and transformation of growth power" of China's economy. From the perspective of the overall development of China's service industry, producer services account for about 60% of the added value of the service industry and have become the industry sector with the greatest development potential [2]. Informatization is undoubtedly of great significance to the agglomeration of producer services, especially for the less developed areas. It can improve information transmission, reduce information asymmetry and promote the optimal allocation of resources. At

the same time, the popularization and application of information technology form powerful productivity and become an important source for the improvement of production efficiency and economic growth [1]. The improvement of the level of informatization reduces the transaction cost of geography and thus expands the boundaries of regions, and provides a broad space for the development of industries and enterprises with internal economies of scale (Karlsson, 2004). Information transmission cost has replaced transportation cost in manufacturing and become a spatial factor affecting the agglomeration of producer services [3].

Because of its high market value, high-tech content, low resource consumption and less environmental pollution, producer service industry has become the leading industry in China. Because of the non-materialization, non-storability, and the inseparability of production and consumption in time and space, producer services show stronger spatial agglomeration characteristics [11]. Informationization facilitates information transmission and reduces the agglomeration cost of producer services. Decentralized production areas tend to concentrate on fixed areas with lower costs, forming clusters of corresponding industries. In addition, when the industrial agglomeration reaches a certain degree, the high cost of crowding in the agglomeration area leads to the industrial diffusion [8]. According to a central idea of the economic geography, when the savings in transportation costs between regions are sufficient to compensate for the transaction costs between regions, as openness increases, dispersion diminishes faster than cohesion increases, at a certain critical point, the agglomeration force will exceed the dispersion force, causing a sudden agglomeration of industries in a certain region [10, 12]. At the same time, the diffusion of information technology has networked enterprises in the same cluster and enterprises in different clusters, facilitating the formation of "Virtual clusters" [13]. The development of information technology makes it unnecessary for enterprises to gather in a fixed area, which leads to the weakening of centripetal force and the tendency of industry to disperse.

Due to the influence of planned economy, the economic structure of Northeast China is dominated by heavy chemical industry and resource-based industry. Since the reform and opening up, service development has lagged behind. The revitalization of traditional industries in three provinces of northeast China needs the support of producer services. In the information age, the development of the productive service industry in Northeast China can not do without the promotion of the information level. Therefore, informationization is an important factor to promote the development of productive service and economic revitalization in the three northeast provinces. Does informatization affect producer services agglomeration? Is there any difference in the impact of informatization on producer services at different levels of agglomeration? This paper treats Heilongjiang province as the research object. Based on panel data of the 12 district cities, the location quotient index was constructed to measure the agglomeration level and regional differences of producer services, and the panel data model and quantile regression model were used to analyze the impact of information on the agglomeration of producer services.

2   Measurement on Agglomeration of Producer Services

2.1   Selection of Measurement Index

Producer services referred to in this paper include transportation, storage and postal services, information transmission, software and information technology services, wholesale and retail, financial industry, leasing and business services, scientific research and technology services. The development status of producer service industries is measured by the number of jobs created. Geographic agglomeration can well reflect the professional advantages of producer services in a certain region. Spatial Gini coefficient is the most widely used to measure the agglomeration of industry, which uses the square of the difference between the concentration rate of a single industry and the national mean to explain the fluctuation of deviation from the national mean. However, the index ignores the difference in the size of enterprises. If there is a large enterprise in a certain region, an industry may have a high Gini coefficient in a certain region, but the agglomeration characteristics do not appear. In view of this phenomenon, Ellison et al. proposed EG index by introducing Herfindahl index to consider the difference of enterprise size [4]. However, since the establishment of spatial Gini coefficient and EG index is mainly based on the research of manufacturing industry in the industrialization period, when applied to the study of agglomeration of modern service industry, the calculation results of regions in the cultivation period of modern service industry will be distorted, leading to the judgment of "pseudo agglomeration". Therefore, the location quotient is used in this paper, and the specific calculation formula is:

$$LQ_{ij} = \frac{L_{ij} / L_i}{L_j / L} \tag{1}$$

The LQ_{ij} is the location quotient of industry j in region i, which is calculated by the employment data of the industry. L_{ij} is the number of employment in industry j in region i. L_i is the total number of employment in region i. L_j is the total number of employment in j industry in China. L is the total number of people employed in all industries in China.

2.2   The Results of Measurement

According to the calculation formula of location quotient, the results of measurement on agglomeration of producer services in Heilongjiang Province are shown in Table1.

2.3   Regional Comparative Analysis of Agglomeration

Among all the 12 cities in Heilongjiang Province, only Harbin and Mudanjiang's location quotient of producer services is greater than 1. Harbin, as the capital city, has an obvious advantage of specialization, with a location quotient of 1.51, while Mudanjiang's location quotient is 1.14, showing a preliminary advantage of agglomeration. In addition, the location quotient of Daqing, Suihua and Jiamusi is relatively high, which has the potential of future development. The resource-based cities, such as Jixi, Hegang, Shuangyashan and Qitaihe, Yichun, have been slow to upgrade their industrial structures,

Table 1. The LQ of producer services among cities in 2019.

City	LQ	City	LQ
Haerbin	1.51	Shuangyashan	0.55
Qiqihar	0.61	Qitaihe	0.71
Mudanjiang	1.14	Heihe	0.81
Jiamusi	0.90	Yichun	0.36
Jixi	0.74	Daqing	0.88
Hegang	0.62	Suihua	0.83

the development of productive service is relatively backward, and the location quotient reflects the low level of agglomeration. Yichun has the lowest locational quotient at 0.36. Shuangyashan has a location quotient of 0.55 and Hegang has a location quotient of 0.55, second third to last respectively.

3   Econometric Model Construction

3.1   Panel Data Model

In order to verify the impact of informatization on the agglomeration of producer services in Heilongjiang Province, relevant influencing factors should be incorporated into the empirical analysis framework for testing. Therefore, this paper constructs the following econometric model:

$$lq_{it} = \alpha_i + \beta \inf_{it} + \sum\nolimits_{j=1} \gamma_j control_{ijt} + \varepsilon_{it} \tag{2}$$

wherein, the explained variable lq is the location quotient calculated in the previous paper and represents the agglomeration level of producer services. Informatization is the core explanatory variable and expressed as inf in model. Relevant studies mostly use post and telecommunications traffic as a proxy variable for informatization. This index can reflect the number of communication services provided by post and telecommunications enterprises for the society in the form of value in a certain period [5, 14]. Therefore, referring to the existing research, this paper adopts the volume of post and telecommunications as the representation of informatization. Regional economic development level measured by per capita GDP is expressed as *pgdp*. The government intervention in local economic development measured by fiscal expenditure as a percentage of GDP is expressed as *gov*. Foreign direct investment (*fdi*) represents the degree of opening to the outside world. Regional human capital is expressed as *hum* and measured by the number of university students per 10,000 people. The index of informatization, per capita GDP, foreign direct investment and human capital is logarithmic.

3.2   Quantile Regression Model

The ordinary panel estimation model mainly reflects the influence of explanatory variables on the conditional expectation of the explained variables by means of regression,

Table 2. The statistical description of relevant variables.

Variable	Mean	Sd	Mix	Max
lq	0.813	0.295	0.311	1.608
inf	9.844	0.626	8.630	11.650
pgdp	0.210	0.120	0.031	0.591
gov	5.122	1.205	2.807	8.239
fdi	8.339	2.043	2.485	12.809
hum	5.458	0.708	4.344	6.903

and cannot examine objective results at different levels, so the reflected information is limited. Moreover, the objective function minimized by "mean regression" is the sum of squares of residials, and its estimation results are easily affected by extreme values. The quantile regression proposed by Koenker and Basett(1978)[9] uses the weighted average of the absolute value of residuals as the minimized objective function, which is not susceptible to the influence of extreme values, and thus the regression results are more reliable. In addition, quantile regression can provide comprehensive information of conditional distribution, so as to more truly reflect the relationship between explanatory variables and explained variables, and make regression estimation results more accurate and detailed [6, 15]. This paper introduces the idea of quantile regression into the analysis of traditional panel data, and its model is expressed as follows:

$$Q_{it}(\tau_k|x_{it}, \alpha_i) = x_{it}^T \beta(\tau_k) + \alpha_i \tag{3}$$

Wherein, $Q_{it}(\tau_k|x_{it}, \alpha_i)$ represents the τ_k conditional quantile of the explained variable, and $\beta(\tau_k)$ is the regression coefficient under the quantile of τ_k. To estimate the regression coefficients under different quantiles, the following Eq. (4) should be solved:

$$\min_{\alpha, \beta} \sum_{k=1}^{K} \sum_{t=1}^{T} \sum_{i=1}^{N} w_k \rho_{\tau k}(y_{it} - \alpha_i - x_{it}^T \beta(\tau_k)) + \lambda \sum_{i}^{N} |\alpha_i| \tag{4}$$

Wherein, w_k is the weight of each corresponding quantile, and λ is the adjusting coefficient. To empirically test the influence of informatization on producer services agglomeration, the conditional quantile regression model is constructed as follows:

$$Q_{lq_{it}}(\tau_k|\alpha_i, x_{it}) = \alpha_i + \beta_\tau \inf_{it} + \sum_j \gamma_{j\tau} control_{ijt} + \varepsilon_{it} \tag{5}$$

3.3 Data Description

The statistical description of relevant variables is shown in Table 2.

The geographical scope of this study is 12 cities under the jurisdiction of Heilongjiang Province, and the sample data interval is set from 2003 to 2019.

Table 3. The results of panel data Regression.

Var	Coefficient	SE	T	P > |T|
inf	0.0427**	0.0199	2.1504	0.0328
pgdp	0.1275***	0.0249	5.1169	0.0000
gov	−0.1864*	0.0993	−1.8772	0.0620
fdi	−0.0188**	0.0084	−2.2214	0.0275
hum	0.3136***	0.0248	12.6557	0.0000
_cons	−2.0695***	0.2802	−7.3861	0.0000

Note:***, ** and * respectively indicate that the estimated coefficient value is significant at the level of 1%, 5% and 10%

4   Results of Regression Model

4.1   Results of Panel Data Regression

The regression results of common panel data are reported in Table 3 The fitting degree R^2 of the panel data regression model was 0.752, indicating that the part of explained variables explained by all explanatory variables was very high. Regression analysis results show that the coefficient of informatization is positive, that is, informatization has a positive effect on improving the agglomeration of producer services. The improvement of the development of informatization makes the information exchange channels between regions more convenient, expands the service radius of producer services, reduces the agglomeration cost of producer services, and promotes the agglomeration of industries in a certain region.

While the coefficient of per capita GDP is positive and it passes the statistical significance test at the level of 5%, indicating that the higher the regional economic development level measured by per capita GDP, the more obvious the agglomeration of producer services will be. The coefficient of fiscal expenditure to GDP is negative and passes the statistical significance test at the level of 10%, that is, the government's economic intervention is not conducive to the agglomeration of producer services, because the government tends to invest financial resources in manufacturing and other traditional advantageous industries, which is not conducive to the agglomeration of producer services. The coefficient of FDI is negative and passes the statistical significance test at the level of 5%, that is, attracting FDI is also not conducive to the agglomeration of producer services, because FDI mainly flows to manufacturing and other sectors, which has a negative impact on the development of producer services. The coefficient of human capital is positive and passes the significance statistical test at 1%, it indicates that the improvement of human capital level is conducive to the agglomeration of producer services. The reason is that the information computing, scientific research, technical services and other industries in producer services need the support of high-quality human capital, so the improvement of human capital level is conducive to the agglomeration of producer services.

Table 4. The Results of Quantile Regression.

τ	Var	Coef	SE	T	P > |T|
0.1	inf	0.0231	0.0196	1.1792	0.2398
	pgdp	0.1638***	0.0245	6.6763	0.0000
	gov	−0.2200**	0.0978	−2.2490	0.0257
	fdi	−0.0018	0.0083	−0.2178	0.8278
	hum	0.2819***	0.0244	11.5530	0.0000
	_cons	−2.5012***	0.2759	−9.0650	0.0000
0.25	inf	0.0466*	0.0238	1.9581	0.0517
	pgdp	0.1406***	0.0299	4.7085	0.0000
	gov	−0.3782***	0.1190	−3.1772	0.0017
	fdi	−0.0213**	0.0101	−2.1082	0.0363
	hum	0.3025***	0.0297	10.1860	0.0000
	_cons	−2.1823***	0.3358	−6.4982	0.0000
0.5	inf	0.0520**	0.0224	2.3235	0.0212
	pgdp	0.1227***	0.0281	4.3690	0.0000
	gov	−0.2640**	0.1120	−2.3579	0.0194
	fdi	−0.0122	0.0095	−1.2820	0.2014
	hum	0.3013***	0.0279	10.7859	0.0000
	_cons	−2.0394***	0.3159	−6.4561	0.0000
0.75	inf	0.0666*	0.0360	1.8498	0.0659
	pgdp	0.0617	0.0452	1.3666	0.1733
	gov	0.2349	0.1801	1.3047	0.1936
	fdi	−0.0216	0.0153	−1.4111	0.1598
	hum	0.3375***	0.0449	7.5141	0.0000
	_cons	−1.5140***	0.5080	−2.9805	0.0033
0.9	inf	0.0095	0.0298	0.3184	0.7506
	pgdp	0.1289***	0.0374	3.4459	0.0007
	gov	0.1476	0.1492	0.9896	0.3236
	fdi	−0.0116	0.0127	−0.9169	0.3603
	hum	0.3662***	0.0372	9.8421	0.0000
	_cons	−2.3334***	0.4208	−5.5450	0.0000

4.2   Results of Quantile Regression

The regression results of the general panel estimation model reflect limited information. So, it is necessary to know whether the influence of informatization on the agglomeration of producer services will change under different quantile conditions. The conditional quantile $\tau = 0.1$–0.9 was selected for regression estimation and the analysis results are shown in Table 4. Under different agglomeration levels, informatization has different

impacts on agglomeration of producer services. When $\tau = 0.1$, the effect of informatization on the agglomeration of producer services is not statistically significan. Because the agglomeration level of producer services is low, the scale effect of industrial development has not been formed, and informatization fails to effectively promote the agglomeration. When the value of τ is between 0.25 and 0.75, the coefficient of informatization is positive and passes the statistical significance test, indicating that informatization plays an obvious role in promoting the agglomeration of producer services. When $\tau = 0.9$, the effect of informatization on the agglomeration of producer services is not statistically significant too. Because the agglomeration of producer services is at a relatively high level, informatization drives the producer services from agglomeration to diffusion.

In addition, the estimation results of control variables are not significantly different from panel data model. At the same time, under different agglomeration levels, the influence of control variables on agglomeration of producer services shows obvious differences too.

5   Conclusions

Based on the clustering characteristics of producer services in Heilongjiang Province and the analysis results of quantile regression of panel data, the conclusion of this paper are as follows:

First, there is an obvious regional gap on the agglomeration level of producer services among cities in Heilongjiang Province. Harbin has an outstanding advantage in the agglomeration of producer services. The agglomeration of producer services in Mudanjiang, Daqing, Suihua and Jiamusi is relatively high, which has the potential of future development. The agglomeration of producer services in Yichun, Hegang, Shuangyashan and other cities is low.

Secondly, the regression results of panel data show that informatization has a positive effect on the agglomeration of producer services, that is, the improvement of informatization can promote the agglomeration of producer services in Heilongjiang. The coefficients of per capita GDP and human capital are positive and statistically significant. At the same time, the coefficient of fiscal expenditure in GDP and foreign direct investment is negative and statistically significant.

Thirdly, the results of quantile regression model support the conclusion of panel data model that informatization has a positive role in promoting producer services. At the same time, under different levels of agglomeration, the effect of informatization shows obvious differences. At lower and higher levels of agglomeration, the effect of informatization on agglomeration of producer services is not statistically significant. At the medium level of agglomeration, informatization plays a significant role in promoting the agglomeration of producer services.

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