Research on the Impact of Information Industry Agglomeration on Technological Innovation

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Abstract. In order to better promote the development of China's information industry and technological innovation, this paper takes 29 provinces in China as the research area, and uses stata16.0 software as the research tool to study the impact of information industry agglomeration on technological innovation. This paper first measures the degree of agglomeration of the information industry by calculating its "location entropy", and then constructs a panel data econometric model for empirical analysis to explore the impact of the degree of agglomeration of the information industry on technological innovation. The research conclusion shows that the agglomeration level of China's information-based manufacturing industry has a significant inhibitory effect on technological innovation, while the agglomeration level of information-based service industry has a positive effect on technological innovation. Finally, based on the research conclusion, this paper puts forward suggestions on the development of China's information industry from the perspective of government support and talent training.

Keywords: information industry · industrial agglomeration · technological innovation · location entropy

1 Introduction

Driven by a new round of scientific and technological revolution, the information industry has been developing rapidly, and has also had a wide and profound impact on economy, culture, society and other aspects. In this context, many scholars at home and abroad have studied the information industry. For example, foreign scholars Oliner [1], Chowdary [2] and Hofmann [3] found that information industry technology plays a positive role in improving the production efficiency, reducing costs, and improving income of manufacturing industry by studying the application of information industry technology in manufacturing industry. Domestic scholars Huang Yongming and Chen Xiaofei [4] studied the growth and industrial integration of China's information industry based on the input-output method and the construction of an econometric model; Vanke and Liu Yaobin [5] studied the provincial comparative advantages of China's information industry from the perspective of value chain; Yu Meng and Guo Shiming [6] studied many problems and challenges faced by China's information industry upgrading, and put forward development suggestions.

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In recent years, scholars have increasingly studied industrial agglomeration [7]. The study found that industrial agglomeration, as a major development state of industry, not only promotes economic growth, but also has a positive impact on technological innovation [8–10]. Therefore, this paper decides to take the information industry as the research object to explore the impact of information industry agglomeration on technological innovation.

2 Methods and Materials

This paper mainly adopts two methods: location entropy and empirical research. The location entropy is mainly used to measure the degree of agglomeration of information industry. The empirical research method is mainly to build an econometric model, look for data, and then use the econometric software for causal analysis to explore whether the level of information industry agglomeration has a significant impact on technological innovation.

For the need of data availability and integrity, this paper selects the data of 29 provinces except Hong Kong, Macao, Taiwan, Tibet and Ningxia from 2013 to 2019 to calculate the location entropy. The data collation, the calculation of location entropy and the regression of the econometric model are all run through the code compiled by stata16.0 software.

3 Measurement of Industrial Agglomeration

First, we need to define the scope of the information industry. Based on the research of Zhang Zehua [11], this paper decides to divide the information industry into information manufacturing and information service industries, and divide the manufacturing of communication equipment, computers and other electronic equipment into information manufacturing industries, and divide the information transmission, computer services and software industries into information service industries. Then, according to the research of Zhang Hu [12], this paper uses the index of location entropy as the agglomeration level of information industry. The calculation formula is shown in formula (1):

$$\mathrm{agg} = \frac{e_{ij}}{e_j} \Big/ \frac{e_i}{e} \tag{1}$$

Where "e_{ij}" refers to the number of employees in j industry in region i, and "e_j" refers to the number of employees in j industry in the country; "e_i" refers to the total number of people employed in i region, and e refers to the sum of the number of people employed in the country. The calculation results and corresponding codes are shown in Table 1 and Fig. 1. Among them, "agg_manu" represents the degree of agglomeration of information manufacturing industry, and "agg_serv" represents the degree of agglomeration of information service industry.

According to the calculation results in Table 1, it can be seen that the degree of agglomeration of China's information manufacturing industry is generally weak. In

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gen agg_com=(com_employee/com_conemployee)/(pro_employee1/
con_employee1)
gen agg_data=(data_employee/data_conemployee)/(pro_employee2/
con_employee2)
```

Fig. 1. Operation code for calculating location entropy

2013, only six provinces were highly concentrated. However, the degree of agglomeration of some provinces still showed an upward trend. By 2019, eight provinces reached a highly concentrated level. The degree of agglomeration of information service industries is also relatively weak on the whole. In 2019, only six provinces reached a high level of agglomeration, but there are still some provinces with an upward trend of agglomeration, such as Tianjin and Shanghai.

4 Model Construction and Empirical Analysis

4.1 Model Construction

Based on previous studies and data availability, this paper constructs a panel regression model as shown in formula (2). The meaning of each variable in the model is shown in Table 2.

$$pat\_apply = \beta_0 + \beta_1 agg_{it} + \beta_2 lngov_{it} + \beta_3 lnpgdp_{it} + \beta_4 lnedu_{it} + \beta_5 lnlabor + \beta_6 lninfra + \mu_{it} \tag{2}$$

Except pat_apply and agg, other variables are in logarithmic form. The data in this paper are mainly from China Statistical Yearbook and China Industrial Statistical Yearbook.

4.2 Empirical Analysis

Since this paper uses panel data, a series of tests are needed to determine the best model. The inspection results and corresponding running codes are shown in Fig. 2 and Table 3.

Through the test of the model in Table 3, the fixed effect model is finally selected in this paper. The panel model regression results and corresponding running codes are shown in Fig. 3 and Table 4.

Model (1) and model (2) are mixed OLS regression, and the variance expansion factor is less than 5, indicating that there is no serious multicollinearity problem. Model 3 and model (4) are the regression results of the fixed effect model. Through observing model (3), we can find that the level of industrial agglomeration in the manufacturing industry of communication equipment, computer and other electronic equipment has a significant inhibitory effect on technological innovation. This is mainly because China's manufacturing industry is already a mature industry, and the scale of industrial agglomeration is relatively large, which to some extent exceeds the local economic affordability, Therefore, it inhibits technological innovation. The result of model (4) shows that the level of industrial agglomeration of information transmission, computer services and

Table 1. Industrial agglomeration degree

province	agg_manu			agg_serv		
	2013	2016	2019	2013	2016	2019
Beijing	1.0390	0.7637	0.6227	4.3409	4.2957	4.0928
Tianjin	1.9838	1.2847	0.9711	0.6534	0.8246	0.9199
Hebei	0.1715	0.1738	0.1361	0.7306	0.6453	0.6623
Shanxi	0.4774	0.4710	0.4756	0.7175	0.5705	0.4474
Inner Mongolia	0.0217	0.0302	0.0534	1.0660	0.8044	0.6306
Liaoning	0.2870	0.2277	0.2162	1.0207	1.1047	1.0323
Jilin	0.0605	0.0557	0.0421	1.1012	0.9763	0.7619
Heilongjiang	0.0170	0.0155	0.0123	0.8402	0.8441	0.9506
Shanghai	2.9269	2.2392	1.9439	1.9356	2.0975	2.1989
Jiangsu	3.3788	3.1092	2.7152	1.1210	0.8959	0.9174
Zhejiang	0.9113	0.9266	1.0739	0.7926	0.8614	0.9300
Anhui	0.2304	0.3509	0.4312	0.6608	0.7601	0.6005
Fujian	0.9971	0.8764	1.0136	0.5979	0.6685	0.6355
Jiangxi	0.4995	0.7029	1.1144	0.7891	0.5836	0.4562
Shandong	0.4542	0.4612	0.3333	0.7521	0.7357	0.6087
Henan	0.5137	0.5667	0.5449	0.4865	0.5235	0.6476
Hubei	0.3258	0.3904	0.4429	0.7226	0.8402	1.0427
Hunan	0.4141	0.4309	0.5950	0.6738	0.6397	0.5143
Guangdong	4.5766	4.3581	4.1011	0.9354	1.0918	1.2094
Guangxi	0.2366	0.3127	0.2704	0.7188	0.5141	0.4220
Hainan	0.0544	0.0141	0.0090	0.7280	0.7768	0.8051
Chongqing	0.7556	1.0871	1.3102	0.6732	0.5474	0.4768
Sichuan	0.5615	0.5110	0.6309	1.0213	1.1480	0.9561
Guizhou	0.0151	0.1753	0.2015	0.6248	0.5697	0.4689
Yunnan	0.0153	0.0296	0.0657	0.8588	0.5863	0.5469
Shaanxi	0.2158	0.3007	0.3709	1.0368	1.0761	1.0064
Gansu	0.0604	0.0591	0.0685	0.6598	0.5083	0.5574
Qinghai	0.0028	0.0054	0.0717	0.8619	0.7008	0.5333
Xinjiang	0.0007	0.0165	0.0104	0.5147	0.4446	0.4282

software industries is significant to technological innovation at the level of 1%, and the estimated coefficient is 13.646, indicating that the higher the level of industrial agglomeration, the more it can promote technological innovation. In addition, the results of

Table 2. Variable interpretation

Variables	Meaning	Quantitative indicators
pat_apply	Technological innovation	Number of patent applications per 10000 people
agg	Degree of Industry agglomeration	Location entropy
gov	Government expenditure	Government financial expenditure
pgdp	Economic growth	Per capital GDP
edu	Human capital stock	Number of college students per 10000 people
labor	Labor level	Number of employees in urban units
infra	Infrastructure level	Road area

```
gen lnpgdp=log(pgdp)
gen lngov=log(gov)
gen lnedu=log(edu)
gen lnlabor=log(labor)
gen lninfra=log(infra)
xtset province year
xtreg pat_apply agg_com lngov lnpgdp lnedu lnlabor lninfra,fe
xtreg pat_apply agg_data lngov lnpgdp lnedu  lnlabor lninfra,fe
xtreg pat_apply agg_com lngov lnpgdp lnedu lnlabor lninfra,fe
est store fe
xtreg pat_apply agg_com lngov lnpgdp lnedu lnlabor lninfra,re
est store re
hausman fe re,constant sigmamore
xtreg pat_apply agg_data lngov lnpgdp lnedu lnlabor lninfra,fe
est store fe
xtreg pat_apply agg_data lngov lnpgdp lnedu lnlabor lninfra,re
est store re
hausman fe re,constant sigmamore
```

Fig. 2. Running code of model inspection

Table 3. Inspection Results

Model	Inspection method	p-value	Result	Conclusion
agg_manu to pat_apply	Fixed effect model test	0.000	$p < 0.05$	Select fixed effect model
agg_serv to pat_apply	Fixed effect model test	0.000	$p < 0.05$	Select fixed effect model
agg_manu to pat_apply	Hausman test	0.000	$p < 0.05$	Select fixed effect model
agg_serv to pat_apply	Hausman test	0.001	$p < 0.05$	Select fixed effect model

```
gen t=year-2012
reg pat_apply agg_com lngov lnpgdp lnedu lnlabor lninfra
estat vif
reg pat_apply agg_data lngov lnpgdp lnedu lnlabor lninfra
estat vif
xtreg pat_apply agg_com lngov lnpgdp lnedu lnlabor lninfra, fe
estat vif
xtreg pat_apply agg_data lngov lnpgdp lnedu lnlabor lninfra t, fe
estat vif
```

Fig. 3. Running code of regression results

Table 4 show that government expenditure, economic development level and labor force level also have a positive impact on technological innovation.

Table 4. Impact of industrial agglomeration on economic growth

	pat_apply			
	(1)	(2)	(3)	(4)
agg_manu	2.568**		-13.162***	
	(1.088)		(2.442)	
agg_serv		5.167***		13.646***
		(1.557)		(3.904)
lngov	-2.522	-3.934	20.951***	21.965***
	(3.736)	(3.661)	(4.417)	(4.620)
lnpgdp	39.637***	38.716***	27.799***	34.664***
	(2.828)	(2.748)	(6.399)	(6.655)
lnedu	1.411	-3.023	-34.928***	-33.686***
	(3.991)	(3.926)	(6.272)	(6.732)
lnlabor	11.359***	9.635***	15.304**	14.604**
	(2.839)	(2.895)	(6.003)	(6.275)
lninfra	-6.843***	-2.380	-8.351*	-15.225***
	(2.271)	(2.657)	(4.789)	(4.792)
_cons	-398.553***	-389.658***	-276.230***	-315.175***
	(27.375)	(26.907)	(50.479)	(55.416)
N	203.000	203.000	203.000	203.000
VIF	4.09	4.53		
F	111.907	115.809	71.592	63.087
r^2	0.774	0.780	0.719	0.693

5 Conclusion

This paper calculates the agglomeration degree of information industry by calculating the location entropy. The results show that the overall level of agglomeration of China's information industry is low, and the agglomeration of information manufacturing industry is higher than that of information service industry. Through empirical analysis, it is found that the agglomeration level of information manufacturing industry has a restraining effect on technological innovation, while the agglomeration level of information service industry has a promoting effect on technological innovation. In addition, government expenditure, economic development level and labor level also have a positive impact on technological innovation. Based on the above research conclusions, this paper puts forward the following suggestions:

First, increase government support for information service industries. By increasing the government's policy support and financial support, on the one hand, it will promote the development and expansion of the information service industry, on the other hand, it will achieve the penetration and integration between the information manufacturing industry and the information manufacturing industry, inject new development impetus into the information manufacturing industry, and thus realize the promotion role of the two industries in technological innovation.

Secondly, increase investment in education and cultivate high-quality talents. The information industry is an industry with high technology content and high demand for talents. Therefore, it is necessary to increase investment in education, especially in higher education, so as to provide strong human capital for the development of the information industry and realize knowledge spillover to the information industry.

References

1. OLINER S, SICHEL D. The resurgence of growth in the late 1990s:is information technology the story?[J]. the Journal of Economic Perspectives, 2000,14(4): 3–22.
2. CHOWDARY B V.Information technology in the Caribbean manufacturing firms: an industrial survey[J]. Global Journal of Flexible Systems Management, 2005, 6(3):1–10.
3. HOFMANN C, ORR S. Advanced manufacturing technology adoption: the German experience[J].Technovation, 2005, 25(7):711–724.
4. Huang Yongming, Chen Xiaofei. The economic effect of China's information industry development [J]. Journal of Dalian University of Technology (Social Science Edition), 2020(3): 36-43.
5. Vanke, Liu Yaobin. Research on the measurement of provincial comparative advantages and spatial differences in the domestic value chain of electronic information industry[J]. Science and Technology Progress and Countermeasures, 2022(4): 1–11.
6. Yu Meng, Guo Shiming. The upgrading of the information industry in the context of the third industrial wave[J]. Science and Technology Progress and Countermeasures, 2022(4): 1–11.
7. Wang Huanfang, Zhang Xing, Bin Hou, Li Mi. Research on the Cluster Measurement and Structural Optimization of Strategic Emerging Industries – Taking the New Energy Industry as an Example[J]. Economic Issues Exploration, 2018(10): 179–190.
8. Lv P, Yuan Y M. Industrial collaborative agglomeration, technological innovation and high-quality economic development: An empirical analysis based on producer services and high-tech manufacturing[J]. the Theory and Practice of Finance and Economics, 2020, 41(06): 118–125.

9. ZaEnhar Duman, Sun Hui, Wang Shixuan. Research on the relationship between the size and distribution of new energy industry clusters and regional economic growth[J]. Research on Science and Technology Management, 2020, 40(13):78–84.
10. Jin H, Liu X. Industrial collaborative agglomeration, technological innovation and economic growth: a mediation effect model[J]. Science & Technology Progress and Policy, 2021, 38(11):46–53.
11. Zhang Zehua. The impact of information industry on manufacturing industry - empirical analysis based on Chongqing data [J]. Science and Technology Management Research, 2019, 39(15): 110–117.
12. Zhang Hu, Han Aihua, Yang Qinglong. Analysis on the Spatial Effect of the Synergistic Agglomeration of Manufacturing and producer Services in China [J]. Research of Quantitative and Technical Economics, 2017, 34(2):3–20.