Frontiers in Business, Economics and Management
ISSN: 2766-824X | Vol. 10, No. 1, 2023

Research on the impact of Industrial Synergy Agglomeration on Regional Innovation and Development

Yanxin Geng[1, *]

[1]Department of Finance, Anhui University of Finance and Economics, Bengbu, CO 233030, China
[*]Corresponding author: Yanxin Geng (Email: 821559684@qq.com)

Abstract: Collaborative agglomeration of producer services and manufacturing can effectively improve resource mismatch, enhance the height of industrial structure, and then promote regional innovation and development. This collaborative clustering model plays a significant role in promoting optimized resource allocation, driving industrial upgrading, and fostering innovation development, which is of great significance for achieving economic growth and regional sustainable development. This paper constructs the panel data of 281 prefecture level cities in China from 2004 to 2019 to empirically analyze the impact of Industrial Synergy on the development of regional innovation. It is found that the collaborative agglomeration of producer services and manufacturing industry is conducive to the development of regional innovation, especially the collaborative agglomeration of high value-added producer services and manufacturing industry has a more significant role in promoting innovation. Therefore, local governments should accelerate the coordinated development of industries, thus promoting the improvement of innovation level and ultimately achieving high-quality economic development.

Keywords: Collaborative agglomeration, Regional innovation, Producer services.

1. Introduction

After 40 years of reform and opening up, China's economy has experienced two stages of development, namely, "factor driven" and "investment driven", and has made remarkable achievements in economic development. However, today, China's economy can no longer rely on a steady flow of factor investment and huge investment to continue to grow, and the bottleneck of China's sustained and healthy economic development lies in the traditional extensive economic development model. Subsequently, the state issued a series of policies to encourage innovation and entrepreneurship to promote the transformation of economic development momentum to innovation driven. However, compared with the economic volume, there is a certain dislocation in China's innovation and entrepreneurship ability, which does not give full play to the advantages of market players and has become a long-term shackle restricting China's innovation ability. Therefore, it is urgent to expand the path to improve regional innovation ability in line with the national conditions.

With the development of economy and society and the deepening of social division of labor, the industries once located at both ends of the manufacturing supply chain have gradually differentiated from manufacturing to independent producer services. With the continuous emergence of new formats such as digital economy and service economy, producer services and traditional manufacturing industries have more synergy and interaction at both ends of supply and demand, bringing about the geographical agglomeration of human resources, knowledge resources and R&D capital, promoting the expansion of industrial clusters and improving the level of industrial structure. However, at this stage, China's industrial structure is relatively single, there is a phenomenon of industrial homogenization in some areas, and there is a lack of full interaction and exchange among industries. Therefore, the coordinated agglomeration of producer services and manufacturing is very important for the improvement of regional innovation ability. At present, studies have discussed the relationship between industrial agglomeration and innovation ability, most of which start with the second and third industries in a broad sense. Although a few studies start from the perspective of specific manufacturing or service industries, the main research direction is still single industrial agglomeration or extensive research on Industrial Synergy agglomeration and economic growth. This paper aims to focus on producer services and manufacturing, construct panel data from macroeconomic indicators of 281 prefecture level cities in China from 2004 to 2019, and study the impact of industrial agglomeration on regional innovation capacity.

In the early research, domestic and foreign scholars did not directly study the impact of industrial agglomeration on innovation, but the research on knowledge spillover brought about by industrial agglomeration is relatively rich. For example, knowledge spillover in industrial clusters reduces the cost of innovation, and knowledge spillover effect is regarded as one of the main reasons for the improvement of innovation ability in industrial agglomeration areas. Many scholars have studied this and put forward relevant theories according to the different knowledge spillovers, which can be divided into two theories. Marshall spillover theory holds that industrial agglomeration shortens the spatial distance between enterprises, reduces the threshold of knowledge spillover, and makes it easier for enterprises to spread and share knowledge and technology; Jacob's spillover theory holds that diversified industrial agglomeration can bring economies of scope, so that knowledge among various industries can complement each other and promote the spillover of knowledge and technology.

Domestic scholars have also made some contributions to the research of industrial agglomeration and regional innovation. For example, Marshall externalities and Jacob

externalities have a positive impact on Regional Innovation in China, but the impact of Jacob externalities is significantly higher than Marshall externalities [16]. Industrial agglomeration has spillover effects in space, thus promoting local innovation. The impact of industrial related and unrelated agglomeration on regional innovation from a more specific perspective, and found that innovation is linked in the region of industrial agglomeration, industrial related collaborative agglomeration can significantly promote the efficiency of regional innovation, while unrelated diversified agglomeration may hinder the efficiency of regional innovation [17]. In addition, industrial synergy agglomeration has a positive spillover effect on innovation efficiency in adjacent regions under the former matrix, while it will have a negative spillover effect under the latter matrix [26].

2. Mechanism Analysis

This paper mainly analyzes the impact of collaborative agglomeration on innovation and development from three perspectives, namely, industrial linkage, knowledge spillover and technology correlation.

Industrial Synergy agglomeration improves regional innovation ability through industrial linkage mechanism. Specifically, the industrial linkage mechanism promotes the two industries to reach a partnership through contract agreements and other means, effectively reducing transportation costs and transaction costs. The rational division of labor between producer services and manufacturing makes both industries obtain excess profits, which promote innovation momentum. In addition, the industrial linkage mechanism makes the producer service industry not only meet its own development needs for innovation, but also cooperate with the development of manufacturing industry, so that the innovation momentum of upstream industries can be transmitted to another industry through the industrial linkage mechanism. Finally, as an industry at both ends of the manufacturing value chain, the business scope changes of the two industries are related to each other, so the two industries expand their respective business areas in the process of industrial linkage, so as to promote innovation and development in the agglomeration area.

According to the previous introduction, Jacob spillover effect will cause the continuous accumulation of knowledge stock in industrial agglomeration areas and empower innovation and development. Specifically, Industrial Synergy agglomeration brings diversified knowledge spillovers to enterprises in the region, which is mainly completed through production cooperation among enterprises. Diversified industrial types lead to diversified knowledge among enterprises, and cooperation among enterprises further promotes knowledge complementarity, which leads to the improvement of innovation ability. In addition, Industrial Synergy brings about the flow of human capital, which also leads to knowledge spillover effect. Human capital includes skilled workers and R&D personnel with professional knowledge, which accumulates with the flow of personnel, accelerates the flow of knowledge in the agglomeration area, and then accelerates the innovation process. Finally, the diversified agglomeration of industries in the region reduces the cost of imitation learning. Enterprises in the same region can effectively reduce the cost of absorbing and transforming innovative achievements, and further innovate on the basis of predecessors. To sum up, Industrial Synergy agglomeration brings various forms of knowledge spillover effects and promotes innovation and development in the agglomeration area.

From the perspective of technological relevance, manufacturing and producer services bring technological complementarity and cooperation in collaborative agglomeration. First of all, producer services themselves are separated from manufacturing, and their technical core is still related to production. Technological relevance makes producer services innovate in the direction of meeting production demand, so that manufacturing industry can obtain more specialized services, thus forming a virtuous circle. Secondly, the technology of manufacturing enterprises has certain standardization characteristics and industry normative requirements, which limits their innovation ability. Producer services industry has no more unified industry standards and has relatively fewer restrictions on innovation, and the synergistic agglomeration of the two is conducive to complementary advantages. Finally, technological linkages reduce the threshold for the transformation of innovative achievements. The ultimate goal of innovation is to transform technology into results and improve production efficiency. Whether it is producer services or manufacturing, its innovative achievements will be transformed into new technologies in another industry through technological linkages, thus promoting technological progress in the region.

3. Index Calculation and Current Situation Analysis

3.1. Calculation method of Industrial Synergy agglomeration

Firstly, the level of single industrial agglomeration is calculated. At present, the main methods in the research are location entropy and fendal index. According to the practice of some scholars, this paper uses the location entropy method to measure the agglomeration degree of a single industry.

$$LQ_{ij}=(l_{ij}/l_i)/(L_j/L) \quad (1)$$

L_j indicates the number of employed people in j industries nationwide, and L indicates the number of employed people in all industries nationwide. l_{ij} indicates employment in j industries in region i and l_i indicates employment in all industries in region i. The higher the LQ value, the higher the degree of agglomeration of the industry in the region.

E-G co agglomeration index is an index constructed by Ellison to measure the level of CO agglomeration [2]. On this basis, a domestic scholar, has constructed an index that can be used to measure the synergy of different industries at the regional level [13], but this index can not reflect the height and quality of industrial synergy. Therefore, they further constructed indicators that can reflect both the degree of collaborative agglomeration and the quality of collaborative agglomeration. The indicators are as follows:

$$\theta=1-|LQ_{i1}-LQ_{i2}|/(LQ_{i1}+LQ_{i2})+LQ_{i1}+LQ_{i2} \quad (2)$$

Among them, LQ_{i1} and LQ_{i2} represent the single industrial agglomeration level of industry 1 and industry 2. The larger the θ value, the higher the level of Industrial Synergy agglomeration. Equation 2 can not only reflect the height of Industrial Synergy, but also reflect the matching degree of the two industries in collaborative agglomeration.

For the classification criteria of producer services, this paper mainly divides the transportation, warehousing, post and telecommunications industry into two categories according to the practices of scholars [24]; Information transmission, computer services and software; Scientific research, technical services and geological exploration; Leasing and business services; The five sub sectors of the financial industry are regarded as producer services, and the data of the statistical yearbooks of cities from 2004 to 2019 are collected.

3.2. Analysis of the current situation of Industrial Synergy agglomeration

This paper first calculates the agglomeration degree of producer services and manufacturing industries in cities across the country according to equation 1, and then calculates the synergistic agglomeration degree of the two industries according to equation 2. The degree of synergy is shown in Table 1 below.

Table 1. National collaborative agglomeration

Year	National average	Eastern average	Central average	Western average
2004	2.56	2.73	2.35	2.27
2005	2.58	2.72	2.30	2.25
2006	2.54	2.71	2.27	2.22
2007	2.57	2.72	2.26	2.20
2008	2.57	2.72	2.23	2.16
2009	2.58	2.70	2.22	2.17
2010	2.54	2.69	2.19	2.13
2011	2.51	2.68	2.22	2.11
2012	2.44	2.69	2.22	2.09
2013	2.43	2.64	2.30	2.13
2014	2.39	2.61	2.30	2.12
2015	2.36	2.59	2.30	2.10
2016	2.34	2.59	2.30	2.08
2017	2.36	2.58	2.28	1.99
2018	2.38	2.59	2.24	1.99
2019	2.44	2.60	2.27	1.98

According to Table 1, compared with the national average, the level of Industrial Synergy in the eastern region is higher, while the level of Industrial Synergy in the central and western regions is relatively low. As a relatively developed region in China, the eastern region has a complete industrial chain and abundant clusters, and the relationship between manufacturing and producer services is closer, so their level of collaborative agglomeration is also higher. With the attention paid by the policy to the central region and the adjustment of industrial structure in recent years, the level of Industrial Synergy agglomeration in the central region has increased year by year. In the early stage of collaborative agglomeration, producer service enterprises tend to cluster in economically developed eastern provinces, mainly due to the role of spatial spillover effect. With the adjustment of industrial structure and the implementation of two wheel drive strategies in the central region, more industries choose to gather in the central region, so the level of collaborative agglomeration in the central region has been improved.

At the same time, it can be found that the overall level of coordinated agglomeration in China shows a downward trend, the decline rate of industrial coordinated agglomeration in the eastern and central regions of China is relatively slow, while the decline rate in the western region is faster. This trend is mainly due to the gradual transformation of China's industrial structure to capital and technology intensive manufacturing, while enterprises pursuing efficiency and technological innovation tend to gather in the eastern and central regions. It leads to the decline of industrial scale and the proportion of employees, and the decline of manufacturing agglomeration and collaborative agglomeration. In order to more specifically describe the level of collaborative agglomeration of producer services and manufacturing industry among different cities, this paper chooses 2009, 2014 and 2019 as three time points to select the top ten cities in that year for analysis. From Table 2, we can see that the top ten cities with synergistic agglomeration are mainly distributed in Beijing Tianjin Hebei Urban Agglomeration, Yangtze River Delta urban agglomeration, Guangdong Hong Kong Macao Greater Bay area and other urban agglomerations, and the differences between cities are also very obvious. It shows that the regional imbalance of industrial agglomeration in China is insufficient, and the cities with developed economy or manufacturing industry are preferred in industrial agglomeration areas.

Producer services can be subdivided into five industries, among which information transmission, scientific research and technology services and finance are regarded as high value-added producer services, while transportation and warehousing, leasing and commercial services are regarded as low value-added producer services. According to the previous calculation method, this paper calculates the level of collaborative agglomeration between producer services and manufacturing after five subdivisions, as shown in Table 3. The results show that there is a high level of collaborative agglomeration between financial industry and manufacturing industry. On the one hand, because the government attaches great importance to the financial industry, it has issued a series of policies to benefit the development of the financial industry; On the other hand, the financial industry is closely related to the development of manufacturing industry. Small scale manufacturing needs initial loans, while the financing and listing of large and medium-sized manufacturing also needs corresponding financial services, so the financial industry will develop to areas with high manufacturing agglomeration, and eventually achieve coordinated agglomeration.

Table 2. Top ten cities in the coordinated agglomeration level of producer services and manufacturing in China

2009			2014			2019		
ranking	city	Synergistic agglomeration	ranking	city	Synergistic agglomeration	ranking	city	Synergistic agglomeration
1	Shenzhen City	4.03	1	Shenzhen City	3.92	1	Shanghai	3.99
2	Dongguan	3.93	2	Dalian	3.71	2	Shenzhen City	3.90
3	Dalian	3.82	3	Shanghai	3.70	3	Guangzhou City	3.72
4	Zhuhai	3.80	4	Guangzhou City	3.55	4	Dalian	3.53
5	Suzhou	3.76	5	Beijing	3.47	5	Xi'an	3.51
6	Foshan	3.69	6	Dongguan	3.41	6	Beijing	3.49
7	zhongshan	3.62	7	Suzhou	3.37	7	Nanjing City	3.48
8	Jiaxing	3.62	8	Zhuhai	3.31	8	zhongshan	3.48
9	Huizhou	3.56	9	Jiaxing	3.29	9	Shenyang	3.47
10	Wuxi	3.48	10	zhongshan	3.27	10	Tianjin	3.45

Table 3. Average value of collaborative agglomeration water in sub sectors

Year	Finance	information service	Technology R&D	Transportation	Commercial leasing
2005	2.68	2.50	2.30	2.37	2.21
2007	2.65	2.44	2.29	2.34	2.17
2009	2.63	2.40	2.26	2.29	2.14
2011	2.58	2.35	2.25	2.28	2.14
2013	2.59	2.34	2.27	2.35	2.16
2015	2.58	2.22	2.25	2.35	2.17
2017	2.54	2.13	2.20	2.31	2.15
2019	2.54	2.04	2.16	2.27	2.24

4. Empirical Analysis

4.1. Model setting

In view of the possible impact of Heteroscedasticity in this model, in order to eliminate its impact, this paper takes logarithms of the variables in the model, and constructs the measurement model as follows:

$$\ln CR_{it}=\beta_0+\beta_1 \ln ICO_{it}+\sum_{j=1}^{n} \propto_j control_{it}+\varepsilon_{it} \quad (3)$$

CR_{it} represents the degree of regional innovation development in t period of i region, ICO_{it} represents the level of Industrial Synergy agglomeration in t period of i region, and $control_{it}$ is a control variable and ε_{it} is a random disturbance term.

4.2. Variable selection and data source

The explanatory variable of this paper is the level of regional innovation development (CR), which comes from the report of China Regional Innovation Index 2020 issued by the enterprise big data research center of Peking University. The index assesses the level of innovation and development in each region by measuring the number of trademark registrations, attracting foreign investment, the number of new enterprises, attracting venture capital and patent licensing. In order to ensure the robustness of the results, this paper uses both regional per capita innovation development level (PCR) and regional per unit area innovation development level (pacr) as explanatory variables. The core explanatory variable is industrial co agglomeration (ICO), which has been detailed in the previous chapter. The control variables are scientific and technological R&D investment (SCI), government support (Gov), economic level (GDP), industrial structure (Ind), financial development level (Fin) and other indicators.

Table 4. Descriptive statistics of variables

Variable name	Variable symbol	Number of samples	average value	standard deviation	minimum value	Max
Regional innovation index	Cr	4480	51.929	28.095	0.000	100.000
Industrial Synergy	Ico	4481	2.391	0.536	0.645	4.233
R&D investment	SCI	4481	53410	192523	34	5549817
Government support	Gov	4481	0.172	0.100	0.040	1.485
Financial development level	Fin	4481	1.285	0.606	0.245	20.100
Economic level	Gross domestic product	1680	1680	2230	35.857	26900
industrial structure	Ind	0.90	0.896	0.464	0.095	4.946

This paper selects the macroeconomic indicators of 281 prefecture level cities in China from 2004 to 2019 as the

research data, of which the regional innovation index comes from the China Regional Innovation Index 2020, and the rest of the data are collated from the statistical yearbooks of each city. The descriptive statistics of variables are shown in Table 4.

4.3. Benchmark regression results

In order to judge whether there is a multicollinearity problem, the variance expansion factor coefficient is used to test each variable. The specific test results are shown in Table 5. As can be seen from Table 5, the variance expansion factor of each variable is less than 10, so it can be considered that there is no multicollinearity between variables.

Table 5. Coefficient of variance expansion factor

Variable name	Vif	1/VIF
Economic level (lng.d.p.)	6.2	0.161312
Technology R&D investment (lnsci)	5.86	0.170657
Government support (lngov)	2.46	0.406327
Industrial Synergy agglomeration (lnico)	1.71	0.584231
Financial development level (lnfin)	1.63	0.611859
Industrial structure (lnind)	1.5	0.667242
Mean Vif	3.23	

In order to determine whether fixed effect regression or random effect regression is used in this paper, Hausman test is carried out, and the original hypothesis is random effect regression. The test results show that the original hypothesis is rejected, so this paper uses fixed effect regression. From Table 6 of the benchmark regression results, we can see that the core explanatory variable Industrial Synergy agglomeration (ICO) has a significant positive impact on the development level of regional innovation (CR), indicating that Industrial Synergy agglomeration promotes regional innovation. At the same time, the control variable coefficient is positive and significant, which represents that the investment in scientific and technological research and development, the increase of government support, the improvement of financial level, the improvement of economic level and the upgrading of industrial structure have played a positive role in improving regional innovation ability. In this paper, the explanatory variables were replaced by regional per capita innovation index (PCR) and regional per unit area innovation index (pacr) for fixed effect regression, and the positive effects of each variable remained unchanged and still significant.

Table 6. Fixed effect regression results

variable	(1) Innovation and development level (CR)	(2) Per capita innovation and development level (lnpcr)	(3) Innovation and development level per unit area (lnpacr)
Industrial Synergy agglomeration (lnico)	0.196***	0.191***	0.0665***
	(0.0564)	(0.0543)	(0.0221)
Technology research and development (lnsci)	0.0286**	0.0548***	0.0336***
	(0.0112)	(0.0108)	(0.00441)
Government support (lngov)	0.238***	0.148***	0.0988***
	(0.0424)	(0.0406)	(0.0166)
Financial level (lnfin)	0.238***	0.297***	0.222***
	(0.0499)	(0.0478)	(0.0196)
Economic level (lng.d.p.)	0.733***	0.695***	0.478***
	(0.0559)	(0.0536)	(0.0219)
Industrial structure (lnind)	0.108***	0.137***	0.0401***
	(0.0298)	(0.0285)	(0.0117)
Constant term	-8.089***	-7.931***	-4.190***
	(0.845)	(0.811)	(0.331)
Observations	4467	4431	4467
R ²	0.845	0.883	0.976

***P.01, * * p.05, * p.1

4.4. GMM regression results

In order to ensure the robustness of the empirical research results and avoid endogenous impact on the empirical conclusions, this paper uses GMM method to re regress the variables. Because innovation is a dynamic process, this paper uses the systematic GMM method to test, and the regression results are shown in Table 7. The first set of regression only includes the first order lag term (L.lnCR) and Industrial Synergy agglomeration (ICO) of the dependent variable innovation ability, and the regression results show that the positive effect is unchanged and significant. After gradually adding the control variables, the core explanatory variables are still significant, indicating that the conclusion of this paper is relatively stable. After the use of systematic GMM regression, the promotion effect of financial level (Fin) and economic level (GDP) on regional innovation did not pass the t test, and the impact effect was not significant, indicating that economic level and financial development level will not have an impact on innovation development level in the long run.

According to the benchmark regression results, economically developed cities can attract more talents and capital in the early stage, so they can promote innovation. In the long run, however, it is unsustainable and no longer has an impact on innovation.

Table 7. Robustness test results

variable	(1) Lncr	(2) Lncr	(3) Lncr	(4) Lncr	(5) Lncr	(6) Lncr
50. Lncr	0.554***	0.530***	0.488***	0.494***	0.502***	0.509***
	(0.0295)	(0.0312)	(0.0380)	(0.0435)	(0.0368)	(0.0338)
Lnico	0.618***	0.742***	0.444***	0.400***	0.381***	0.393***
	(0.115)	(0.120)	(0.116)	(0.116)	(0.102)	(0.0965)
Lnsci		0.0316***	0.0647***	0.0655***	0.0519***	0.0520***
		(0.00490)	(0.00936)	(0.00755)	(0.0126)	(0.0125)
Lngov			-0.268***	-0.295***	-0.267***	-0.275***
			(0.0503)	(0.0613)	(0.0495)	(0.0417)
Lnfin				0.0679	0.0389	-0.0158
				(0.0668)	(0.0478)	(0.0659)
LnGDP					0.0385	0.0389
					(0.0304)	(0.0299)
Lnind						0.0888**
						(0.0420)
Constant term	1.184***	0.825***	0.417***	0.362***	-0.0892	-0.117
	(0.0847)	(0.0852)	(0.108)	(0.104)	(0.368)	(0.355)
Observations	4187	4187	4187	4187	4187	4187
AR (1)	0.000	0.000	0.000	0.000	0.000	0.000
AR (2)	0.278	0.272	0.236	0.236	0.241	0.251
Hansen test	0.424	0.366	1.000	1.000	1.000	1.000

***P.01, * * p.05, * p.1

4.5. Industry heterogeneity analysis

According to the classification of producer services in the previous chapter, the fixed effect regression is carried out again, and the results are shown in Table 8. The coordinated agglomeration of transportation and warehousing, science and technology research and development, finance and commercial leasing industries with manufacturing industry has significantly promoted regional innovation. This is consistent with our previous conclusion. At the same time, this paper divides producer services into two categories: high value-added and low value-added. From the regression results, we can see that the coordinated agglomeration of high value-added producer services and manufacturing has a greater role in promoting the development of regional innovation than that of low value-added producer services.

Table 8. Results of heterogeneity analysis

Industry segments	Transportation and warehousing	information service	Technology R&D	Commercial leasing	finance	Low value-added	high added value
Lnico	0.0890**	-0.00115	0.0825**	0.0513*	0.0592**	0.110**	0.120**
	-0.0429	-0.0374	-0.0419	-0.0278	-0.046	-0.0452	-0.0531
Lnsci	0.0355***	0.0370***	0.0364***	0.0360***	0.0372***	0.0350***	0.0368***
	-0.0113	-0.0113	-0.0113	-0.0113	-0.0113	-0.0113	-0.0112
Lnhc	0.0367**	0.0367**	0.0371**	0.0356**	0.0372**	0.0363**	0.0376**
	-0.0154	-0.0154	-0.0154	-0.0154	-0.0154	-0.0154	-0.0154
Lngov	0.228***	0.222***	0.225***	0.226***	0.221***	0.231***	0.224***
	-0.0419	-0.0418	-0.0418	-0.0419	-0.0418	-0.0419	-0.0418
Lnfin	0.235***	0.243***	0.243***	0.235***	0.241***	0.234***	0.238***
	-0.0497	-0.0496	-0.0496	-0.0498	-0.0496	-0.0497	-0.0496
LnGDP	0.645***	0.648***	0.647***	0.641***	0.647***	0.644***	0.645***
	-0.0516	-0.0516	-0.0516	-0.0518	-0.0516	-0.0516	-0.0516
Constant	-6.506***	-6.506***	-6.538***	-6.409***	-6.541***	-6.492***	-6.543***
	-0.79	-0.79	-0.79	-0.791	-0.79	-0.789	-0.79
Observations	4424	4424	4424	4424	4424	4424	4424
R-squared	0.846	0.846	0.846	0.846	0.846	0.846	0.846

***P.01, * * p.05, * p.1

5. Conclusion

Taking 281 prefecture level cities in China as samples, this paper explores the impact of collaborative agglomeration of producer services and manufacturing on regional innovation and development. Through mechanism analysis, it is found that collaborative agglomeration may have an impact on the development of regional innovation from three perspectives: industrial linkage, knowledge spillover and technological correlation. After empirical analysis, it is found that the level of Industrial Synergy agglomeration has a significant impact on the level of regional innovation development, and with the

improvement of synergy agglomeration, the regional innovation ability will be enhanced accordingly. Further research shows that there are significant differences in the impact of different types of producer services and manufacturing synergy on regional innovation and development. In particular, the synergistic agglomeration of manufacturing industry and high value-added producer services has a more obvious role in promoting the improvement of innovation level, while low value-added producer services are relatively weak. Based on the research conclusions, we put forward corresponding policy suggestions to promote regional innovation and development and realize the transformation and upgrading of economic development model.

First of all, it is suggested that local governments provide more support and help for innovative subjects. In the study, it is found that producer services and manufacturing have been proved to be the main body of innovation. Therefore, the government should introduce more policies to encourage innovation to support the development of these two types of enterprises. The government can provide human capital and financing channels for innovative subjects through talent introduction to help them obtain financial support, actively reduce taxes and burdens for innovative enterprises, reduce innovation costs, and enhance their willingness to innovate.

Secondly, it is suggested that local governments should pay attention to the coordinated agglomeration development of different industries and rationally adjust the structure of industrial clusters. Research shows that Industrial Synergy agglomeration can directly promote the improvement of innovation level, thus driving the high-quality development of local economy. Local governments can give preferential policies to producer services through investment promotion and other means, and cooperate with local manufacturing to promote regional innovation and development. For example, in the construction planning stage, producer service enterprises and manufacturing enterprises are set up in the same zoning, reducing the threshold of their exchanges and cooperation in terms of spatial distance. In addition, we should strengthen the guidance and planning of industrial clusters, encourage cooperation and exchanges between different industries, and promote the diversified and coordinated development of industrial clusters.

Finally, we should encourage the agglomeration of high-end producer services and manufacturing enterprises, improve synergies, and promote the sharing and exchange of innovative resources. The synergistic agglomeration of producer services and manufacturing in different industries has different effects on innovation. Therefore, it is suggested to refine the development of producer services, focusing on the development of high value-added industries. For traditional enterprises with low efficiency and weak innovation ability, the government should play the role of overall planning, strengthen cooperation with innovative enterprises through mechanisms such as technological linkage, industrial linkage and knowledge spillover, so as to make innovative elements flow in clusters.

References

[1] Billings S B, Johnson E B. Agglomeration within an urban area[J]. Journal of Urban Economics, 2016, 91: 13-25.

[2] Ellison G, Glaeser E L. Geographic concentration in U.S. manufacturing industries: a dartboard approach[J]. Journal of Political Economy, 1997, 105(5): 889-927.

[3] Duranton G, Puga D. Diversity and specialisation in cities: why, where and when does it matter?[J]. Urban studies, 2000, 37(3): 533-555.

[4] Ke S, He M, Yuan C. Synergy and co-agglomeration of producer services and manufacturing: A panel data analysis of Chinese cities[J]. Regional Studies, 2014, 48(11): 1829-1841.

[5] Krugman P,Venables A J. Globalization and the inequality of nations[J]. Quarterly Journal of Economics, 1995, 110:850-857.

[6] Koh H J, Riedel N. Assessing the localization pattern of German manufacturing and service industries: A distance-based approach[J]. Regional Studies, 2014, 48(5): 823-843.

[7] Morris M, Handcock S, Hunter R, Specification of Exponential-family Random Graph Models: Terms and Computational Aspects[J]. Journal of Statistical Software, 2008, 24(4): 1-24.

[8] Pellegrino G, Piva M, Vivarelli M. Young firms and innovation: A microeconometric analysis[J]. Structural Change and Economic Dynamics, 2012, 23(4): 329-340.

[9] Storper M, Venables A J. Buzz: face-to-face contact and the urban economy[J]. Journal of economic geography, 2004, 4(4): 351-370.

[10] Wang E C, Huang W. Relative efficiency of R&D activities: A cross-country study accounting for environmental factors in the DEA approach[J]. Research policy, 2007, 36(2): 260-273.

[11] J. H. Bai, F. X. Jiang, Collaborative innovation, spatial correlation and regional innovation performance[J]. Economic research, 2015(7): 74-87.

[12] J. H. Bai, F. X. Jiang, Research on regional innovation efficiency considering environmental factors - based on Three-stage DEA method[J]. Finance and trade economy, 2011(10): 104-112.

[13] G. L. Chen, J. J. Chen, Industrial Association, spatial geography and common agglomeration of secondary and tertiary industries-An Empirical Study from 212 cities in China[J]. Management world, 2012(04): 82-100.

[14] J. Chen, L. Liang, H. Wu, Research on the relationship between industrial agglomeration and innovation performance under the background of open innovation: Taking China's high-tech industry as an example[J]. Scientific research, 2013-31(4): 623-629.

[15] X. Cao, C. J. Song, An Empirical Study on the impact of cognitive proximity and geographic proximity on dual innovation[J]. China soft science, 2017(4): 120-131.

[16] Z. H. Cheng, L. S. Li, J. Liu, Spatial spillover effect of producer services agglomeration on industrial efficiency improvement[J]. Scientific research, 2017, 35(03): 364-371.

[17] J. Guo, Z. Q. Xu, Industrial diversification agglomeration, spatial spillover and regional innovation efficiency - An Empirical Analysis Based on spatial Dubin model[J]. Soft science, 2019, 33(11): 120-124.

[18] Z. G. Hu, Y. Z. Wang, G. J. Yin, Labor mobility, collaborative agglomeration and urban structure matching[J]. Financial research, 2015, 41(12): 26-39.

[19] Z. Li, S. Y. Yang, Fiscal decentralization, government innovation preference and regional innovation efficiency[J]. Management world, 2018, 34(12): 29-42.

[20] N. Q. Liu, Y. Wu, G. Z. Zhao, The impact of specialized agglomeration and diversified agglomeration on regional innovation efficiency-An Empirical Analysis Based on spatial Dubin model[J]. Exploration of economic issues, 2016(2): 89-96.

[21] Y. Liu, J. C. Xia, Y. Li, Producer services agglomeration and manufacturing upgrading[J]. China industrial economy, 2017 (07): 24-42.

[22] X. Peng, C. H. Jiang, Industrial agglomeration, knowledge spillover and regional innovation-An Empirical Test Based on China's industrial sector[J]. Economics (quarterly), 2011. 10(03): 913-934.

[23] Z. Su, S. D. Xu, Measuring the convergence of China's technological progress and economic growth from the perspective of innovation and efficiency[J]. China Social Sciences, 2015(07): 4-25.

[24] Y. Xuan, Y. Z. Yu, Research on the impact of producer services agglomeration on the improvement of total factor productivity of manufacturing enterprises evidence from micro enterprises in 230 cities[J]. Quantitative economic and technological economic research, 2017, 34(02): 89-104.

[25] Y. Z. Yu, D. Y. Liu, Spatial spillover effect and value chain spillover effect of regional innovation efficiency in China-A Study on multi-dimensional spatial panel model from the perspective of innovative value chain[J]. Management world, 2013(07): 6-20.

[26] Y. J. Yuan, K. Gao, Industrial Synergy agglomeration, spatial knowledge spillover and regional innovation efficiency[J]. Scientific research, 2020-38(11): 1966-1975.

[27] Z. Y. Zhao, J. J. Zhou, N. Shen, Empirical Study on the impact of financial development and regional innovation efficiency-mediating effect based on openness[J]. Scientific research, 2016(9): 1408-1416.

[28] H. Zhang, A. H. Han, Q. L. Yang, Spatial effect analysis of collaborative agglomeration of manufacturing and producer services in China[J]. Quantitative economic and technological economic research, 2017, 34(02): 3-20.