Research on the Impact of Collaborative Industrial Agglomeration of City Clusters on Enterprises' Green Innovation

Cuiping Wang [1,a]; Yidong Qin [2*]; Beier Luo[3,b]

[1] School of Economics, Wuhan University of Technology, Wuhan China
[2]Lecture, School of Economics, Wuhan University of Technology, Wuhan China
[3]School of Accountancy, Wuhan Business University, Wuhan China

[a]wang1999@whut.edu.cn; *1264762924@qq.com;
[b]13343454726BB4726@outlook.com

Abstract. In the context of new industrialization and green development strategy, it remains to be tested whether industrial synergistic agglomeration in city clusters can promote green innovation behaviors of firms in the region. We measured the degree of synergistic agglomeration of productive services and manufacturing industries in 19 city clusters in China, and also empirically tested and analyzed the green innovation effect of industrial synergistic agglomeration in city clusters using data from 2007-2019. The results of the study show that the collaborative industrial agglomeration of city clusters facilitates the occurrence of green innovation behavior of enterprises in the region. And this promotion effect is more significant in areas with weaker development conditions, such as central and western regions and small and medium-sized cities.

Keywords: Urban agglomeration; Industrial collaborative agglomeration; Green innovation

1 INTRODUCTION

City clusters are an important driving force for regional economic development. The development of urban agglomerations can promote the spatial agglomeration of innovative factors such as technology and talents, which is of great significance in optimizing the allocation of resources and promoting innovative development. Since the reform and opening up, China has vigorously promoted industrialization. Due to over-reliance on the crude economic development model of "high input, high energy consumption and high pollution", China now has problems such as environmental pollution, resource depletion and overcapacity (Chai Zeyang and Shen Weining, 2016). These problems have become the resistance that restricts the high-quality development of China's economy. In the future, China should build a coordinated development pattern of large, medium and small cities based on city clusters, put the focus of economic development on the real economy, and vigorously promote new industrialization. And the focus and

R. Magdalena et al. (eds.), *Proceedings of the 2024 9th International Conference on Social Sciences and Economic Development (ICSSED 2024)*, Advances in Economics, Business and Management Research 289,
https://doi.org/10.2991/978-94-6463-459-4_116

difficulty of the real economy lies in the manufacturing industry (Guo Weijun and Huang Fanhua, 2020).

Manufacturing and production services are usually highly clustered in a space, forming a synergistic industrial agglomeration, as the two industries are closely vertically and horizontally interconnected. This will generate positive externalities on the green innovation behavior of enterprises. Due to the crowding effect of single-industry agglomeration, industrial synergistic agglomeration within an economic region is transforming from monolithic cities to network-type city clusters with multiple centers, levels and nodes. This is important for strengthening the agglomeration economic advantage and stimulating the synergistic innovation effect (Chen Lu et al., 2020). In the era of knowledge economy, city clusters are changing from economic agglomeration centers to innovation factor highlands. The innovation connotation of urban agglomerations in this context has received renewed attention. These issues are of great significance for China to realize high-quality economic development.

2 THEORETICAL ANALYSIS AND RESEARCH HYPOTHESIS

Collaborative industrial agglomeration has the dual attributes of "industry" and "space". First, the cost theory holds that in the production process, enterprises usually shorten the distance to enterprises in the neighboring industrial chain in order to reduce trade costs. City clusters gather a large number of production factors, which can reduce the transportation cost of enterprises and increase the opportunity of face-to-face exchanges, and stimulate the green innovation power of enterprises. Secondly, according to Krugman's "center-periphery" theory[1], in the industrial distribution of city clusters, non-core industries such as labor-intensive industries move to the periphery. The core industries with high value-added such as advanced productive service industries will move to the center. This can optimize the spatial allocation of industries and the allocation of resource factors, and promote the green innovation of enterprises[2].

Based on the above analysis, this paper puts forward the following hypotheses:

Hypothesis: The synergistic industrial agglomeration under the spatial perspective of urban agglomeration has a promoting effect on the green innovation of enterprises in the region.

3 STUDY DESIGN

3.1 Sample selection and data source

We select all A-share listed companies in China from 2007 to 2019 as our research samples, and screen the sample data as follows: (1) exclude the samples of financial companies; (2) exclude the samples of ST, ST* and PT listed companies; and (3) exclude the samples of companies with missing values of the core variables during the period of 2007-2019.The data used for the calculations are based on the processed data.

3.2 Model setting and variables

In order to test the impact of collaborative industrial agglomeration of city clusters on green innovation of enterprises, we construct the following model:

$$envpatr_{ijt} = \beta_0 + \beta_1 citycluster_{jt} + \beta_2 coagg_{jt} + \beta_i Controls + Year + Ind + \varepsilon_{ijt} \quad (1)$$

The definitions and data sources of each variable in the model are described before, and i for China, j for RCEP trading partners, p for semiconductor products, and t for time.

In equation(1), I, j, t denote firm, region and time, respectively. The explanatory variables areenvpatr, which means the level of green innovation of enterprises, including envpatr_total and envpatr_inv. The core explanatory variable is citycluster, which indicates the degree of industrial synergistic agglomeration of city clusters, and its coefficient reflects the magnitude of the influence of industrial synergistic agglomeration of city clusters on the green innovation level of enterprises. coagg denotes the degree of industrial synergistic agglomeration of individual cities, which is added to the model to control the synergistic agglomeration effect of cities themselves. Controls is the control variable. Year is the year fixed effect, andInd is the industry fixed effect.ε_ijt denotes the random perturbation term of the model. Standard errors are clustered at the firm level.

The core independent variable is the level of city cluster synergistic agglomeration (citycluster), referring to the existing studies, we use the location entropy index to construct and calculate the level of industrial synergistic agglomeration at the level of city clusters. Referring to the "Six-industry theory" of Chen et al. (2016), the productive service industries we selected include: transportation, storage, post and telecommunications; leasing and business services; finance; information transmission, computer services and software; scientific research, technical services and geological exploration; and real estate.

The core dependent variable is the green innovation level of enterprises (envpatr), we use the number of green patent applications as a percentage of total patent applications to measure the green innovation level of enterprises.[3] We categorize two variables based on patent type: [4] (1) the ratio of total green patent applications to total patent applications (envpatr_total). (2) The ratio of green invention patent applications to total invention patent applications of enterprises (envpatr_inv). With reference to existing studies, we selected control variables including firm-level variables (Controls 1) and city-level variables (Controls 2).

4 EMPIRICAL TEST AND RESULT ANALYSIS

4.1 Baseline regression analysis

Our empirical results show that the collaborative industrial agglomeration of city clusters significantly promotes the green innovation level of enterprises in the region. From the regression results in columns (1)-(6) of Table 1, it can be clearly seen that the

regression coefficients are significantly positive, [5] indicating that the higher the degree of the city cluster's industrial cooperative agglomeration is, the more it can promote the development of the enterprises' green innovation activities and increase the level of the enterprises' green innovation.[6]

Table 1. Regression Analysis Table

	(1)	(2)	(3)	(4)	(5)	(6)
	envpatr_total			*envpatr_inv*		
citycluster	0.012**	0.012**	0.010*	0.015***	0.016***	0.014**
	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)
coagg			0.001			0.001
			(0.001)			(0.001)
_cons	0.032**	0.052***	0.081	0.018	0.031	0.057
	(0.016)	(0.020)	(0.120)	(0.016)	(0.020)	(0.126)
*Controls*1		Yes	Yes		Yes	Yes
*Controls*2			Yes			Yes
ind FE	Yes	Yes	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	25824	23769	23769	25824	23769	23769
r2	0.119	0.127	0.128	0.110	0.117	0.118
r2_a	0.116	0.124	0.125	0.107	0.114	0.114

* p<0.1, ** p<0.05, *** p<0.01

4.2 Robustness Tests

First, the main explanatory variables are replaced. Referring to the "Five-industry theory" proposed by Zhang Hu et al. (2017), the five categories of transportation, storage and postal industry, information transmission, computer services and software industry, financial industry, leasing and business services, and scientific research and technology services are selected to represent the productive service industry. Second, because municipalities may have more policy advantages and support, enterprises in the region may have more willingness and motivation to engage in green innovation than others. Considering the differences, the sample firms in municipalities are excluded from this paper to control for more unobserved factors. Third, due to the proportion of enterprises' green innovation applications (envpatr_total and envpatr_inv) has a significant left-truncated feature at 0, in order to eliminate the interference of this phenomenon on the regression results, this paper further adopts the Tobit model regression for the robustness test. The regression results show that the coefficient of city-cluster that the coefficients of remain significantly positive. The results are shown in Table 2.

Table 2. Robustness Tests

	"Five-industry theory"		Excluding municipalities		Replace regression methods	
	(1)	(2)	(3)	(4)	(5)	(6)
	envpatr_total	*envpatr_inv*	*envpatr_total*	*envpatr_inv*	*envpatr_total*	*envpatr_inv*

cityclus	0.010*	0.013**				
	(0.006)	(0.006)				
*coagg*1	0.001	0.001				
	(0.001)	(0.001)				
cityclus			0.011*	0.014**	0.023**	0.044***
			(0.006)	(0.007)	(0.011)	(0.016)
coagg			0.001	0.001	0.006**	0.008**
			(0.001)	(0.001)	(0.002)	(0.003)
_cons	0.080	0.057	0.098	0.071	-1.945***	-2.859***
	(0.120)	(0.126)	(0.124)	(0.130)	(0.337)	(0.483)
Control	Yes	Yes	Yes	Yes	Yes	Yes
ind FE	Yes	Yes	Yes	Yes		
year FE	Yes	Yes	Yes	Yes		
N	23769	23769	18468	18468	23772	23772
r2	0.128	0.118	0.124	0.114		
r2_a	0.125	0.114	0.119	0.109		
Pseud o R2					0.0573	0.0496

4.3 Heterogeneity analysis

According to the "Notice on the Adjustment of the Criteria for the Division of City Size" issued by the State Council in 2014, we divided the city into small and medium-sized cities and large and mega cities based on the average data of the city's population size during the sample period. The regression results are shown in Table 3.

Table 3. Heterogeneity analysis

	Small or medium size city		Large and mega-cities	
	(1)	(2)	(3)	(4)
	envpatr_total	*envpatr_inv*	*envpatr_total*	*envpatr_inv*
citycluster	0.020*	0.018	0.010***	0.013***
	(0.011)	(0.012)	(0.003)	(0.004)
_cons	0.007	-0.206	0.115	0.120
	(0.228)	(0.250)	(0.108)	(0.113)
Controls	Yes	Yes	Yes	Yes
ind FE	Yes	Yes	Yes	Yes
year FE	Yes	Yes	Yes	Yes
N	2174	2174	21598	21598
r2	0.097	0.093	0.137	0.127
r2_a	0.065	0.061	0.133	0.123

Since large and mega cities naturally have the advantages of capital, technology and talent agglomeration, they can fully utilize the dividends brought by synergistic agglomeration of city cluster industries. They can enhance the level of green innovation and green invention innovation, as well as improve the quality of green innovation of

enterprises. Small and medium-sized cities lack the enthusiasm for green invention and innovation due to insufficient innovation resources. However, the collaborative industrial agglomeration of city clusters can also improve the level of green innovation of enterprises in these regions.

5 CONCLUSION AND COUNTERMEASURES

We use listed companies from 2007-2019 as a research sample to study the relationship between collaborative industrial agglomeration and corporate green innovation based on the spatial perspective of city clusters. Our study finds that the industrial synergistic agglomeration of city clusters significantly promotes the green innovation activities of enterprises, which is manifested in the increase in the share of the number of green patent applications of enterprises.[7] Meanwhile, this finding still holds after several robustness tests. We find that this facilitating effect is more obvious in central and western regions and small and medium-sized urban areas, which indicates that the city cluster development model can effectively compensate for the disadvantages of some regions in terms of insufficient local market resources and lack of policy dividends.

Based on the above conclusions, we put forward the following suggestions:

(1) Take city clusters and metropolitan areas as economic centers to promote industrial agglomeration and realize "two-wheel" driven economic growth. Promoting city clusters to realize synergistic industrial agglomeration, facilitating the formation of an efficient division of labor between central cities and surrounding small and medium-sized cities, and helping to reduce the external uneconomical impacts of congestion on central cities.

(2) Give full play to the role of the market and build a platform for inter-industry and inter-enterprise exchanges and interactions. In this regard, the government should increase education expenditure, encourage the training of talents in composite fields, promote the combination of industry, academia and research, provide a favorable policy, economic and social environment for enterprises to carry out green innovation, and guide enterprises to improve green innovation output through technical exchange and cooperation.

ACKNOWLEDGMENT

Fund Project: National Science Foundation of China "Research on the Collaborative Evolution and Governance of Key Core Technology Innovation Systems from the Perspective of Multi-Layer Coupled Networks" (72274147).

REFERENCES

1. Krugman P. Geography and Trade [M]. Cambridge, MA: MIT Press, 1991.
2. Ma Xinru,He Jingbin. air pollution and corporate green innovation in China[J]. Economic Modelling,2023,124.

3. Rodrigues Margarida and Franco Mário. Green Innovation in Small and Medium-Sized Enterprises (SMEs): A Qualitative Approach[J]. Sustainability, 2023, 15(5) : 4510-4510.
4. Rubashkina Y, Galeo Giii M, Verdolini E. Environmental regulation and competitiveness: empirical evidence on the Porter hypothesis from European manufacturing sectors[J].Energy Policy,2015,83:288-300.
5. Weiping Zeng,Lin Li,Yue Huang. Industrial collaborative agglomeration, marketization, and green innovation: Evidence from China's industrial collaborative agglomeration, marketization, and green innovation: Evidence from China's provincial panel data[J]. Journal of Cleaner Production,2021,279.
6. Yang Haochang,Xu Xiezu,Zhang Faming. industrial co-agglomeration, green technological innovation, and total factor energy efficiency.[J]. Environmental science and pollution research international,2022,29(41).
7. Yang Ran,Hu Zhigao,Hu Shihui. The failure of collaborative agglomeration: From the perspective of industrial pollution emission[J]. Journal of Cleaner Production,2023,387.