
The influence of technological innovation level on high-tech industrial agglomeration: the Chinese experience

Abstract: The report of the 20th National Congress of the Communist Party of China clearly points out that we must accelerate the implementation of the innovation-driven development strategy, and technological innovation has become a sustainable internal driving force to maintain China's economic development. Industrial agglomeration is the inevitable outcome of China's rapid economic development, which is not only a necessary process of rapid economic development, but also an inevitable result of China's economic development and adjustment. Raising the level of high-tech industrial agglomeration is conducive to the development of high-quality economy in China. This paper selects provincial panel data from 2003 to 2016 to study the relationship between technological innovation level and high-tech industry agglomeration. The results show that: (1) Technological innovation can promote the agglomeration of high-tech industries. (2) There is significant regional heterogeneity in the promoting effect of technological innovation on high-tech industrial agglomeration, and the promoting effect of technological innovation on high-tech industrial agglomeration in eastern China is greater than that in central and western China. And put forward relevant policy suggestions.

Key words: high-tech industry; Technological innovation; Industrial agglomeration

Introduction

In terms of the international situation, the unprecedented major changes have accelerated their evolution, and the trend of anti-globalization continues to surge; As far as the domestic situation is concerned, the original economic growth model is difficult to provide high-quality dynamic support for economic growth at this stage due to the constraints of deep contradictions in reform and development, resources and environment, factor costs, economic development and other factors. In this context, China's economic growth is facing a series of difficulties, including the weakening of external demand, insufficient domestic demand power, lagging virtual economy

functions, and economic development imbalances caused by the decline in real economy profit margins. Therefore, how to break through the current bottleneck of economic development and achieve high-quality economic growth is a major issue for national economic development. At present, the uncertainty of the international economy is increasing, and the domestic economy has entered an important stage of kinetic energy conversion. The competition between countries and regions has become more intense, but in fact, this is ultimately the competition between high-tech industries. With the concept of "building an innovative country" deeply rooted in people's hearts, technological innovation activities have been widely implemented nationwide, and their impact on economic growth is becoming increasingly evident. Not only can they directly promote the transformation of innovation achievements into productivity, but they can also promote economic growth by improving the quality and allocation efficiency of production factors. In recent years, industrial agglomeration has been an inevitable product of China's rapid economic development. It is not only a necessary process for rapid economic development, but also an inevitable result of China's economic development adjustment. Different types of industrial clusters can accelerate the flow and restructuring of economic resources within a spatial range, promote capital accumulation, optimize the allocation of economic resources, and thus promote economic growth. Industrial agglomeration not only provides inevitable support for economic development, but also is an inevitable requirement for China's economic development to adapt to future development trends. Since the 21st century, China has become an important component of the world's high-tech industry chain, and its high-tech industry has developed rapidly. The manufacturing of high-tech products has led to a continuous increase in China's export volume and gradually entered the advanced stage of the world's high-tech industry chain. Although the development of China's high-tech industry currently relies on investment in capital, talent, and policies, innovation is the core of its development. A scientific and accurate analysis of the internal relationship between technological innovation and high-tech industry agglomeration is conducive to the high-quality development of China's economy.

Currently, the academic community is paying more attention to the one-way effect of industrial clusters on technological innovation, while ignoring the potential adverse effects of regional innovation on industrial clusters. At present, industrial policies in various regions of China mostly focus on how to fully utilize various external effects brought about by industrial agglomeration, with little attention paid to how to promote high-tech industry agglomeration through technological innovation.

On this basis, this project introduces high-tech industry agglomeration into the analysis framework, and reveals the mechanism of technological innovation level on high-tech industry agglomeration through empirical analysis, so as to provide references for different regions to formulate different economic development policies and improve regional innovation ability.

1. Theoretical analysis and research hypothesis

In addition, there are also some scattered studies, from one side proved that technological innovation has a positive impact on the agglomeration of high-tech industries. In regional innovation, a leading and innovative enterprise can play a demonstration effect, thus attracting more enterprises to gather. Guastella and vanOort[1] pointed out that with the increase of geographical distance, the efficiency of knowledge spillover between regions will decline, so enterprises seeking technological innovation often choose to carry out technological innovation in regions with more concentrated R& D capabilities. The cooperation between enterprises and research institutes is of great significance to enhance regional innovation capability. So, when choosing a location, companies often choose areas where there is a lot of innovative activity. Forman et al. [3] found that technological innovation is an important cause of industrial agglomeration and spatial dispersion, as well as a driving force for economic growth. Ma Dalai et al. [2] believe that the regional innovation capability of a region has a considerable impact on the innovation efficiency of enterprises to a certain extent, and regional innovation can promote the competition among enterprises. The survival of the fittest among enterprises will change the distribution of enterprises in space, thus affecting the degree of industrial agglomeration. Regional innovation is the key factor to promote the upgrading of industrial structure, and the change of industrial structure will lead to the change of micro-enterprises' location.

Technological innovation is an important source of sustainable development, and it is also the main way for a region to gain competitive advantage, a region obtains higher total factor productivity and growth rate. The innovation carrier represented by high-tech industrial parks plays an obvious role in promoting regional economic growth, and becomes the growth pole of the region, thus enhancing the spatial agglomeration degree of regional industries. Enterprises will be more and more close to the central market of innovation factors, so as to form an area around the high-tech industrial park, so as to enhance the industrial agglomeration degree in the region. The innovation activities of high-tech industry also help to enhance the degree of regional industry specialization, and then promote the spatial agglomeration of industry. Various high-tech industrial parks gather a large number of different industries, and these industries have different connections with other industries. Each industry has different characteristics in the industrial value chain and regional industrial functions, resulting in different degrees of industrial agglomeration. As the innovation carrier of a region, high-tech industry concentrates the good innovation factors and resources in each region. Therefore, the innovation of high-tech industry has a better effect on promoting regional growth and improving the level of regional industrial agglomeration than ordinary industrial innovation.

In summary, the existing researches pay too much attention to the influence of industrial agglomeration on regional innovation, but neglect the influence of promoting technological innovation on industrial agglomeration. This could affect the formulation and implementation of industrial policy.

Research hypothesis: Technological innovation can promote the agglomeration of high-tech industries

2. Methodology

(1) Model construction

$$agg_{it} = \beta_0 + \beta_1 inv_{it} + \beta_2 X_{it} + \delta_i + \mu_t + \varepsilon_{it}$$

Where, subscript i is the province i , t is the year t , δ_i is the regional fixed effect, μ_t is the time fixed effect, ε_{it} is the random disturbance term, inv is the level of technological innovation, and X is the control variable.

(2) Variable selection

1、Explained variable

This paper mainly studies the role of technological innovation in the process of high-tech industry agglomeration. Considering the availability of data, this paper draws on the practice of Hu Anjun et al., and uses location quotient to measure the high-tech industry agglomeration level in various provinces. The calculation formula is as follows:

$$agg_{ij} = \frac{e_{ij} / \sum_i e_{ij}}{\sum_i e_{ij} / \sum_i \sum_j e_{ij}}$$

Where e_{ij} represents the main business income of the technology industry in region j , $\sum_i e_{ij}$ represents the main business income of industrial enterprises above designated size in region j , $\sum_i e_{ij}$ represents the main business income of the national high-tech industry, $\sum_i \sum_j e_{ij}$ represents the main business income of industrial enterprises above designated size in the country.

2、Core explanatory variable

As an important intellectual property, patent contains many key technical information, which can reflect regional innovation ability. Patent application and authorization systems in different regions are basically the same. Considering heterogeneity and data availability, this paper uses the number of patent application authorization to measure technological innovation level.

3、Control variable

(1) Economic development level

The level of economic development has a great influence on the development of technological innovation in a certain region. The ultimate goal of industrial agglomeration is to promote regional economic growth by optimizing the local environment and infrastructure for economic development. Thus, the logarithm of GDP is used to measure the level of macroeconomic development in the region.

(2) The degree of government intervention

Government financial expenditure is one of the important means of modern national economic management, which has multiple functions. Government financial expenditure can promote the stable operation and development of the national economy. Second, the government financial expenditure can realize the effective allocation and optimization of resources. By regulating the economic structure, guiding the flow of funds, and promoting the intensive use of resources, we will improve the efficiency of resource utilization and economic benefits. Third, government expenditure can provide

guarantees for social development and people's well-being. Among these functions, government fiscal expenditure plays a particularly important role in promoting and guiding economic development. This paper uses local government financial expenditure to measure the degree of government intervention.

(3) Foreign direct investment

Foreign direct investment refers to the direct investment activities of multinational companies or individuals in a country or region, including the establishment of enterprises, equity investment, purchase of real estate, etc. Foreign direct investment can bring capital, advanced technology and management experience. The amount of foreign capital actually utilized includes the registered capital of FDI enterprises, capital increase, equity transfer and other forms of investment. The purpose of taking logarithms is to eliminate the influence of the order of magnitude on the analysis results, so that the data of each year can be compared and analyzed.

Table 1 Definition and measurement of variables

Variable type	Variable name	Calculation method
Explained variable	High-tech Industry Agglomeration Level (agg)	Location entropy index
	Core explanatory variable	Level of Technological Innovation (inv)
Control variable	Level of economic development (gdp)	Take logarithm of gross regional product
	Government Input (gov)	Take logarithm of fiscal expenditure
	Degree of openness	Take the logarithm of foreign direct investment

(4) Data specification

Considering the research needs and data availability, this paper studies the data of 31 provinces in China from 2003 to 2016. The relevant data are all from 《 China High-tech Industry Statistical Yearbook,》 《China Trade and Foreign Economic

Statistical Yearbook》, and 《China Statistical Yearbook》, and a small number of missing values are supplemented by interpolation method.

3. Results and Discussion

(1) Descriptive statistics

The descriptive statistical results of variables are shown in Table 2, Table 2 shows the descriptive statistical results of relevant variables: First, the maximum value of foreign direct investment (fdi) is quite different, indicating that the location distribution of fdi presents obvious regional differences, and different regions have different fdi attraction efforts. The mean value of technological innovation level (inv) is 3.8043, the minimum value is 1.2041, and the maximum value is 5.4313, indicating a large regional difference. Finally, the remaining control variables such as government intervention (gov) and economic development level (gdp) are similar to the statistical results of the existing literature, but there is no significant difference.

Table 2 Descriptive statistics of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
		0.705			
agg	434	7	0.5990	0.0204	2.5892
		3.804			
inv	434	3	0.7779	1.2041	5.4313
		3.921			
gdp	434	9	0.4982	2.2659	4.9077
gov	434	0.234	0.1792	0.0792	1.3792
		6.486			
fdi	434	1	0.6889	4.5198	7.9444

(2) Baseline regression analysis

In this paper, LR and Hausman tests were used to determine the model selection, and the results showed that mixed effect model and random effect model were rejected, and combined with the actual situation and existing literature research, this paper adopted the individual and time bidirectional fixed effect model.

Table 3 shows the estimated results of baseline regression. Sequence (1) is a regression result without control variables, where the coefficient of the core explanatory variable *inv* is positive at the 1% significance level. This indicates that the level of technological innovation has a significant positive promoting effect on high-tech industrial agglomeration. When different control variables are added, as shown in sequence (2), the coefficient of *inv* is still significantly positive at the level of 1%, which further indicates that the level of technological innovation can improve high-tech industrial agglomeration. Sequence (3) further controlled for regional fixed effects and year fixed effects, and the results were still significant.

Table 3 Baseline regression results

	(1) agg	(2) agg	(3) agg
<i>inv</i>	0.373*** (9.39)	0.760*** (7.44)	0.179** (2.68)
<i>gov</i>		0.454*** (4.04)	-0.0129 (-0.06)
<i>gdp</i>		-2.047*** (-13.22)	0.29 -0.81
<i>fdi</i>		0.830*** (9.75)	0.108 (1.03)
Region fixed	NO	NO	YES
fixed year	NO	NO	YES
_cons	-0.713*** (-4.80)	-1.003** (-2.84)	-0.36 (-0.29)
N	434	434	434

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

(3) Robustness test

Through the research of this paper, we find that there is a significant positive relationship between the level of technological innovation and high-tech industry agglomeration. This conclusion is of great significance for promoting economic development and realizing industrial upgrading. In order to ensure the robustness of the conclusion, we used alternative variables for robustness test, that is, the index parameter of technological innovation level was replaced from the number of patent applications to R&D expenditure, and logarithmic processing was taken. The results show that the regression results are still significant after replacing the variables, which further verifies the positive relationship between technological innovation level and high-tech industry agglomeration. The regression results are shown in Table 4, which shows that the results are still significant.

This conclusion is also consistent with the conclusions of similar international studies. On a global scale, technological innovation has become an important factor in the competition of countries, especially in the field of high-tech industries. By improving the level of technological innovation, it can promote the development of high-tech industries, improve their market competitiveness and innovation ability, so as to achieve economic growth and industrial upgrading.

Table 4 Robustness test results

	(1)	(2)	(3)
	agg	agg	agg
rd	0.390*** (11.35)	0.788*** (8.68)	0.453** (3.27)
gov		0.537*** (4.80)	-0.178 (-0.74)
gdp		-2.126*** (-13.19)	0.205 (0.59)
fdi		0.861*** (13.74)	0.145 (1.44)
Region fixed	NO	NO	YES
fixed year	NO	NO	YES
_cons	-1.608*** (-7.83)	-2.949*** (-15.32)	-1.968 (-1.36)

N	434	434	434
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Note: * p<0.05, ** p<0.01, *** p<0.001

(4) Heterogeneity test

Considering that technological innovation levels in different regions may have heterogeneity on high-tech industrial agglomeration, this paper divides 31 provinces into four regions for further exploration, and the regression results are shown in Table 5. As can be seen from Table 5, sequence (1) is the regression result of eastern cities as samples, that is, technological innovation level in eastern regions can promote high-tech industrial agglomeration, which is consistent with the research conclusion under the whole sample. For central, western and northeastern cities, the coefficient of technological innovation level in sequence (2) - (4) is positive, but it fails the significance test. In other words, considering the existence of regional heterogeneity, technological innovation can directly promote the high-tech industrial agglomeration in the eastern region, but has no obvious effect on the central and western regions, namely the northeast region. The eastern region includes Hebei province, Beijing City, Tianjin City, Shandong Province, Jiangsu Province, Shanghai City, Zhejiang Province, Fujian province, Guangdong Province, Hainan province. The central region includes Shanxi, Henan, Anhui, Hubei, Jiangxi and Hunan. Western region refers to Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Sichuan, Chongqing, Yunnan, Guizhou, Tibet . The north-east includes Heilongjiang, Liaoning and Jilin provinces.

Table 5 Results of heterogeneity test

	Eastern region (1) agg	Central region (2) agg	Western region (3) agg	North-east region (4) agg
inv	0.503*** (3.46)	0.0293 (0.51)	0.138 (0.92)	0.0641 (0.36)
gov	1.334*	-0.884*	-0.274	-0.0422

	(2.41)	(-2.54)	(-0.66)	(-0.06)
gdp	-3.451*** (-3.46)	-0.132 (-0.39)	0.194 (0.35)	1.016 (1.94)
fdi	-0.583*** (-4.32)	-0.321 (-1.82)	0.437** (3.01)	-0.604** (-2.90)
Region				
fixed	YES	YES	YES	YES
fixed year	YES	YES	YES	YES
_cons	12.82*** (4.28)	4.683** -3.34	-2.675 (-1.34)	0.685 (0.23)
N	140	84	168	42

4. Conclusions and policy recommendations

This paper analyzes the relationship between technological innovation and high-tech industry agglomeration from the theoretical level, and empirically verifies the relationship between technological innovation and high-tech industry agglomeration by using the panel data of 31 provinces in China from 2003 to 2016. The results show that technological innovation can promote the agglomeration of high-tech industries. The policy implications of the study are as follows:

It emphasizes the reasonable expansion of scale, and promotes the technological progress of the industry through the scale economy effect generated by agglomeration. Promote the optimization of the industrial structure and upgrade the regional innovation capacity of the region, increase the investment of public services in the region, in order to obtain an extreme growth advantage, use the regional innovation capacity to improve labor production efficiency and promote industrial agglomeration in the region.

On the premise of attaching importance to the protection of intellectual property rights, all localities and enterprises should strengthen the sharing and collaboration of innovation resources to maximize the spillover effect of technology. For example, it is necessary to strengthen the exchanges between enterprises and universities in various regions, encourage university researchers to participate in the innovative production of enterprises, and promote the free flow of innovative talents in universities between regions, so as to enhance the spillover of knowledge and technology. Secondly, strengthen the technical benefit of industrial clusters and the knowledge benefit of regional innovation, and make use of regional innovation ability.

According to the industrial development needs of each region, the high-tech industry agglomeration policy suitable for China's national conditions is formulated. At present, China's industrial policies mostly ignore the role of regional innovation in promoting industrial agglomeration. In high-tech industrial clusters, differentiated cluster strategies should be formulated according to the industrial development of different regions. For example, in areas with a solid foundation for high-tech industries, policies should be formulated to support the localized development of high-tech industries to ensure exchanges and cooperation between high-tech enterprises. However, in regions with weak high-tech industry base, corresponding policies should be formulated to promote communication and cooperation among enterprises in the region, ensure the diversity of high-tech industry clusters in the region, and create a better innovation environment.

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