Research on the Influence of Human Capital Agglomeration on Regional Innovation Capability

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Abstract

Based on the panel data of 30 provinces in China from 2016 to 2020, this paper studies the impact of human capital agglomeration on regional innovation capability by building a fixed effect model, and analyzes regional heterogeneity. The results show that: from the national perspective, human capital agglomeration significantly promotes regional innovation capability; After the division of regions, human capital agglomeration has a significant role in promoting the innovation of the first and second gradient provinces, and has the greatest impact on the first gradient, but has no significant impact on the innovation of the third gradient provinces. It can be seen that it is necessary to adopt policies to promote the development of regional differentiated innovation capabilities in line with local conditions.

Keywords

Human Capital Agglomeration; Innovation Ability; Panel Data Model.

1. Introduction

Innovation is the inexhaustible driving force for a country's prosperity and development, and the soul of a nation's progress. As China's economic development has entered a new normal and made great strides towards high-quality development, the strategic positioning of "rejuvenating the country through science and education", "strengthening the country through talents" and other development strategies has gradually become prominent, and innovation has gradually become the core driving force for economic growth and the decisive force for improving comprehensive competitiveness (Li Zheng and Yang Siying, 2018) [1]. In this context, China has continued to increase its investment in scientific research and experimental development. From the statistical data of the past five years, R&D investment and the proportion of investment to GDP have shown a gradual upward trend, which proves that innovation plays an important role in the development of the national economy and the country attaches great importance to innovation.
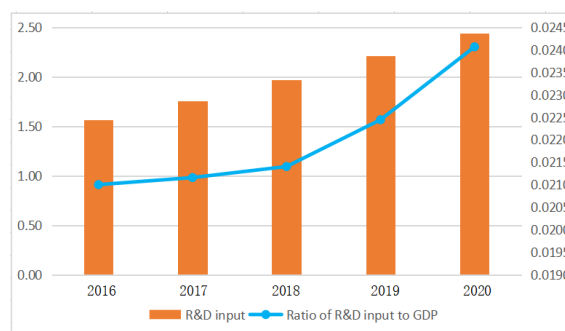

Figure 1. R&D input and its ratio to GDP in China from 2016 to 2020
Source: Based on data from the National Bureau of Statistics

However, human capital is the leading force of innovation. Human capital agglomeration makes specific labor groups flow among regions, injecting strong endogenous power into regional economic development. At the G20 Summit in 2019, the meeting pointed out that "the world economy has entered a period of transformation between new and old drivers", and the innovation driven development strategy needs a comprehensive talent training system at multiple levels, in multiple fields and in multiple industries. In particular, it is necessary to build a school and social training system for the top talent team, and provide effective protection for strengthening innovation by constantly improving the talent selection mechanism (Xu Bin, 2021) [2].

Therefore, this paper will take human capital agglomeration as the starting point and regional innovation capability as the foothold to explore the transmission mechanism of the impact of human capital agglomeration on regional innovation, and then use panel data from 30 provinces to establish a model to empirically analyze the impact of different provinces. This is of great guiding significance for realizing the coordinated development of all cities and building an innovative city.

2. Theoretical Mechanism and Research Hypothesis

According to the theory of economic growth, human capital is the source of innovation and economic growth, and the agglomeration of human capital, especially the improvement of high-end human capital, will significantly enhance the innovation capability of regions or enterprises. For example, Cuerva et al. (2014) [3] studied the driving factors of innovation, and the results show that human capital can promote innovation capability.

This paper studies the mechanism of human capital agglomeration on regional innovation from the information sharing effect and knowledge spillover effect of human capital agglomeration.

(1) Human capital agglomeration promotes regional innovation capability through information sharing effect

Information sharing effect means that the knowledge that scientific and technological talents master is a semi-public product with sharing. The information collected by highly educated scientific and technological talents is of high quality, the effectiveness of information sharing is strong, and the information transmission path is shortened to reduce the cost in the communication process. Wang Yantao and Cui Cheng (2019) [4] found that human capital can promote innovation, and senior human capital plays a major role in independent innovation. Human capital can promote knowledge and information exchange between regions. Ma Jing[5] conducted an empirical study on the influencing factors of the innovation spatial pattern and innovation output of 285 cities in China by building a Dubin regression model of static and dynamic panel data space, and found that the knowledge stock has a role in promoting urban innovation. While human capital promotes urban innovation, it also generates externalities. As a representative of regional innovation in China, it helps to learn external knowledge sources, which in turn contributes to innovation (Yang CH, 2012) [6]. Cities with higher education level will also improve the transfer of production to education intensive industries, promote the adoption of new technologies in education, and indirectly affect the innovation effect (Ciccone, A. and E. Papaionnou, 2009) [7].

(2) Human capital agglomeration promotes regional innovation capability through knowledge spillover effect

Knowledge spillover effect includes knowledge spillover and knowledge dissemination, both of which are the ways of knowledge diffusion. Knowledge dissemination is the reproduction of knowledge, while knowledge spillover is the reconstruction of knowledge.

Peng Weibin and Cao Wenjian (2020) [8] analyzed the impact of human capital agglomeration on high-quality development from the two directions of reducing labor productivity and trade

barriers, and found that talent agglomeration can promote the optimization of regional human capital structure, which is conducive to urban innovation. The flow of high-quality labor force and high-end talents brought about by population agglomeration in the region will also promote the diffusion of technology and effectively drive the improvement of innovation level in the whole region (Liu Ye et al., 2021) [9]. Pater (2015) [10] thinks that talent gathering effect is reflected in that people learn from each other's experience through face-to-face communication, and tacit knowledge can be "explicit" and produce spillover effect, forming knowledge spillover effect.

Some scholars also divided provinces from the east, west, central and provincial levels, or discussed the differences of human capital factors on innovation in terms of whether they are central cities and provincial capitals. It is found that the information sharing effect and knowledge spillover effect of human capital agglomeration make the impact of human capital regional heterogeneity. It is found that the information sharing effect and knowledge spillover effect of human capital agglomeration make the impact of human capital regional heterogeneity(Zhang Qi, Cao Ze, 2022; Chen Junjie, Zhong Changbiao, 2020; Wu Zhenhua, 2020)[11-13].

To sum up, the following assumptions can be made:

H1: Human capital agglomeration plays a positive role in promoting regional innovation capability.

H2: The impact of human capital agglomeration on regional innovation capacity is heterogeneous.

3. Research Design

(1) Model building

This paper aims to explore the impact of human capital agglomeration on regional innovation capability. Build panel data measurement model:

$$\text{inno}_{\text{it}} = \partial_0 + \partial_1 hca_{\text{it}} + \partial_2 x_{\text{it}} + \lambda_{\text{it}} v_{\text{it}} + \varepsilon_{\text{it}} \tag{1}$$

Among them, "inno" means regional innovation capability; "hca" stands for human capital agglomeration; "i"and "t" represent province and city and year respectively; "ε" is a random disturbance term; "λ" refers to the fixed effect of provinces and cities; "v" It refers to time fixed effect; "xit" is the control variable.

(2) Variable selection

1. Interpreted variable

This paper selects regional innovation capability as the explained variable. The regional innovation process mainly includes scientific research funds, innovation input and innovation output. As the direct embodiment of innovation output and innovation capability, patents have strict approval standards and horizontal comparability. Therefore, this paper refers to the research methods of Zhu Haijiu (2004) [14] and Feng Zongxian et al.(2011) [15], and measures the regional innovation capability with the amount of patent authorization in each province.

2. Explanatory variable

Human capital agglomeration (hca): human capital agglomeration describes the intensity of talents or labor force in a certain region. In view of this, this paper uses the research method of Shayipugami Rouzi and Deng Feng (2021) [16] for reference, and selects the number of people with college degree or above as the amount of human capital agglomeration.

3. Control variable

Considering that the labor force will also be affected by various factors at the macro level, in order to ensure the authenticity of the experimental conclusions, the impact of missing

variables should be minimized. With reference to the research of Chen Dafeng (2020) [17] and Li Chao (2015) [18], the following control variables are selected.

①Economic development level (gdp): Economic development provides the necessary material basis for innovative development. Therefore, this paper takes the regional economic development level as the control variable, and adopts the logarithmic measurement of urban gdp.

②Opening up(open): The external exchange is highly related to innovation and creativity, and the open environment has also created good conditions for the occurrence of high-level human capital agglomeration. This paper selects the logarithmic measurement of total import and export.

③Government expenditure on science and technology (tec): government expenditure plays a key role in regional innovation and development. This paper uses the proportion of government financial science and technology expenditure in general budget expenditure to measure.

④Per capita disposable income (pgdi): Per capita disposable income also affects labor input in innovation. This paper chooses the logarithm of per capita disposable income to measure.

⑤Traffic level (tra): Traffic level will affect the level of human capital agglomeration. This paper uses the per capita urban road area to measure.

(3) Data source

The sample selected in this paper is panel data of 30 provinces and cities, and the sample period is 2016-2020. The data sources are China Urban Statistics Yearbook, the National Bureau of Statistics, and statistical bulletins of provinces and cities. In this paper, some missing data are processed by interpolation.

(4) descriptive statistics

Table 1. Descriptive Statistics

Variable	Symbol	Number of samples	Mean value	Standard deviation	Maximum	Minimum
Regional innovation capability	inno	150	7.7292	10.8880	70.9725	0.1357
Human capital agglomeration	hca	150	624.1571	358.9290	1978.2909	53.8835
Economic development level	gdp	150	607.8075	1111.8027	4904.2139	0.0415
Opening up	open	150	29879.6180	23548.3427	111151.6000	2258.2000
Government expenditure on science and technology	tec	150	0.0225	0.0157	0.0676	0.0054
Per capita disposable income	pgdi	150	28475.8200	11642.9608	72232	14670
Traffic level	tra	150	17.0824	4.8198	26.7800	4.3700

4. Empirical Results and Analysis

(1) Panel data regression of the impact of human capital agglomeration on regional innovation capability

The panel data model mainly includes fixed effect model, random effect model and mixed model. The following table conducts regression analysis on fixed effect model and random effect model. Meanwhile, the Hausman test is also used to select the random effect model and fixed effect model. The test results reject the original hypothesis at the significant level of 1%, indicating that the fixed effect model should be used. And the fixed effect model can effectively control the unobservable factors that do not change with time, so the subsequent panel data regression analysis uses the fixed effect model.

Model 1 is used to verify the impact of human capital agglomeration on regional innovation capability. The regression results are shown in Table 2.

Table 2. Estimated results of human capital agglomeration on urban innovation capacity

VARIABLES	(Fe) Lninno	(Re) Lninno
Lnhca	0.313**	0.302**
	(0.138)	(0.137)
Lngdp	-1.094**	0.991***
	(0.537)	(0.158)
Lnopen	-0.167***	-0.056
	(0.054)	(0.034)
Tec	2.877	5.996
	(5.088)	(4.337)
Lnpgdi	3.421***	1.158***
	(0.532)	(0.158)
Lntra	0.0929	0.168
	(0.188)	(0.140)
Constant	-24.16***	-22.63***
	(1.398)	(1.381)
Observations	150	150
R-squared	0.826	
Number of region	30	30

Notes to observation samples: *, * *, * * * indicate that the significance level is 10%, 5% and 1% respectively; The values in parentheses are the t values of the estimated coefficients.

The estimated results of the model show that the agglomeration of human capital significantly promotes the improvement of regional innovation capability at the level of 5%, and the regression coefficient of human capital is 0.313, indicating that the regional innovation capability will increase 0.313 for every unit of human capital. This validates hypothesis 1. The main explanation for this result is: First, the gathering of human capital in specific areas will not only reduce the cost of knowledge transmission and the transmission path, but also produce effective matching of knowledge. Creative gathering is promoted through knowledge sharing and information matching. There is also knowledge spillover in the process of knowledge sharing, which is conducive to a more reasonable allocation of resources and the most powerful innovation points in the shortest time. Second, human capital is the main body of innovation. The gathering of human capital drives the high-tech agglomeration and the renewal of knowledge. For enterprises, the agglomeration of high human capital plays a leading role in the management of enterprise business mode and technological transformation. Enterprise technological innovation also leads to the upgrading of industrial structure and the promotion of economic efficiency throughout the province.

(2) Regional heterogeneity analysis

China is a vast country. Under the comprehensive effect of geographical factors, cultural environment, historical factors and policy factors, the development levels of different provinces are quite different. Considering this, 30 provinces have been divided into three segments of population size according to the relevant data of the seventh population survey released by the National Bureau of Statistics, to explore the different urban sizes, Whether the impact of human capital agglomeration on regional innovation capability is heterogeneous. The regression results are shown in Table 3.

Table 3. Estimated Results of Regional Heterogeneity Analysis

	(Province of the first gradient)	(Province of the second gradient)	(Province of the third gradient)
VARIABLES	Lninno	Lninno	Lninno
Lnhca	0.550**	0.326*	0.917
	(0.256)	(0.182)	(1.183)
Lngdp	-1.416	-1.241*	-2.362
	(1.202)	(0.709)	(7.945)
Lnopen	-0.349*	-0.165**	-0.0298
	(0.189)	(0.0685)	(0.255)
Tec	2.147	8.890	41.46
	(7.509)	(8.158)	(102.4)
Lnpgdi	3.307***	3.616***	5.363
	(1.154)	(0.701)	(7.222)
Lntra	0.175	0.0598	-0.586
	(0.469)	(0.246)	(1.329)
Constant	-18.22***	-25.33***	-38.51
	(2.715)	(1.825)	(16.86)
Observations	45	95	10
R-squared	0.894	0.801	0.946
Number of region	9	19	2

Notes to observation samples: *, **, *** indicate that the significance level is 10%, 5% and 1% respectively; The values in parentheses are the t values of the estimated coefficients.

The above analysis results show that the impact of human capital agglomeration on the innovation capacity of the first and second gradient of provinces and cities is significantly positive, indicating that in most regions, population agglomeration, human capital agglomeration and high-level human capital agglomeration play a key role in building innovative cities. The size of the regression coefficient also proves that labor plays a leading role in the innovation process. The provincial regression coefficient of the first gradient is 0.550, the second gradient is 0.326, and the third gradient is 0.917. The significance levels are 5%, 10%, and non-significant respectively, which verifies the regional heterogeneity and hypothesis 2. According to the data of the seventh population census, the number of permanent residents in Guangdong Province has reached 126 million, and the total number of permanent residents in Shandong Province and Henan Province is close to 100 million. In such a populous province, the phenomenon of population agglomeration is obvious, which is bound to lead to the agglomeration of high-level human capital, laying a solid foundation for the human, financial and energy needed for regional innovation. Therefore, the provincial coefficient and significance level of the first gradient are higher than those of the second gradient. It is possible

to explain that the provincial regression result of the third gradient is not significant: Ningxia and Qinghai are located in the western region of China, and both population resources and economic resources are relatively scarce compared with the central and eastern regions. Their advantages lie in the vast land and sparsely populated people. However, the improvement of innovation ability largely depends on the quantity and quality of labor force. Therefore, the human capital agglomeration in western regions, such as Qinghai and Ningxia, is not obvious, the improvement effect on regional innovation ability is not significant.

(3) Robustness analysis

The regional heterogeneity analysis has identified the robustness of the results of the article to a certain extent. In order to further increase the persuasiveness and robustness of the article, the method of removing 20% of the sample size of explanatory variables was adopted for the robustness test. Considering that the national samples, the first gradient and the second gradient provincial regression results of the above analysis are significant, this link verifies the significance and coefficient changes among them. The regression results are shown in Table 4.

Table 4. Estimation Results of Robustness Analysis

	(Nationwide)	(Province of the first gradient)	(Province of the second gradient)
VARIABLES	Lninno	Lninno	Lninno
Lnhca	0.322**	0.442	0.348*
	(0.141)	(0.365)	(0.180)
Lngdp	-0.980	-1.801	-1.498
	(0.837)	(1.857)	(1.083)
Lnopen	-0.141**	-0.166	-0.130
	(0.0625)	(0.267)	(0.0774)
Tec	2.181	-0.277	17.13*
	(5.696)	(9.974)	(10.02)
Lnpgdi	3.736***	4.071**	4.309***
	(0.770)	(1.644)	(1.012)
lntra	-0.143	-0.147	-0.0900
	(0.227)	(0.594)	(0.274)
Constant	-28.03***	-21.29***	-29.96***
	(2.038)	(6.448)	(2.406)
Observations	120	36	76
R-squared	0.834	0.872	0.832
Number of region	30	9	19

Notes to observation samples: *, * *, * * * indicate that the significance level is 10%, 5% and 1% respectively; The values in parentheses are the t values of the estimated coefficients.

The results show that the regression coefficients and significance of the national samples and the second gradient provinces remain basically unchanged, while the results of the first gradient are no longer significant, which indicates that for provinces with large populations and cities with fast development, the improvement of their comprehensive strength depends on the accumulation and promotion of annual development. Excluding the data of 2016, it has a great impact on them, but the other data are highly consistent, which proves the robustness of the experimental results in this paper.

5. Conclusion and Main Recommendations

This paper takes panel data of 30 provinces in China from 2016 to 2020 as a sample to explore the impact of human capital agglomeration on regional innovation capability, and divides provinces to study their regional heterogeneity. The results show that:

(1) From the national sample, human capital agglomeration has significantly promoted regional innovation capability.

(2) From the perspective of sub samples, the impact of human capital agglomeration on regional innovation is positive. The provincial impact is significant in the first and second gradient, but not significant in the third gradient, and the degree of impact is the largest in the first gradient.

Based on the above research contents and conclusions, the following suggestions are proposed in this paper:

(1) Break down talent barriers and promote population mobility. We will effectively relax the restrictions on the settlement of talents from other places, absorb diverse talents from other provinces, open the channels for knowledge spillovers to promote industrial structure upgrading and urban innovation and development, and maximize the incubation effect of high-level human capital flows on technological innovation and innovation efficiency.

(2) Increase investment in urban innovation and increase urban innovation vitality. Innovation input is the key and primary element of innovation. Local governments should increase the development and training of talents, improve industrial policies related to innovation, accumulate more innovative achievements for urban development, and continue to promote the construction of innovative cities.

(3) Implement policies based on the city to narrow the provincial gap. The central and western regions should pay attention to talent training and talent introduction, optimize the system, give play to the advantages of local resources, prevent brain drain, pay attention to the innovation effect of human capital agglomeration, narrow the difference between the level of human capital and developed regions, and improve the level of technological innovation and resource utilization efficiency.

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