Research on the spatial effect of innovation factor flow on regional high-quality economic development

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Abstract. Based on the new development concept, the entropy weight method and the gravity model are used to explore the spatial characteristics of the flow of innovation factors and the level of high-quality economic development from 2004 to 2020, and a spatial econometric model is established to empirically analyze innovation factors from the perspective of national and regional heterogeneity. The spatial effect of mobility and high-quality economic development. Research shows that China's high-quality economic development level has significant spatial effects, and regional high-quality economic development can be improved through the flow of innovative elements. The direct effect and negative spillover effect in the western region have a completely positive spatial effect.

Keywords: Innovation elements flow; High-quality economic development; Regional economy; Spatial effect; Spatial panel mode

1 Introduction

China's economic development has shifted from a high-growth stage to a high-quality development stage, and science and technology innovation is the necessary path for China to build a new development pattern and achieve high-quality development (Xi Jinping, 2021). The innovation-driven strategy will become an important engine for China's high-quality economic and social development, and innovation factors (mainly including innovative talents and innovative capital, etc.) are one of the core strategic elements to achieve high-quality economic development. Studying the correlation between the flow of innovation factors and the development of high quality economic quantity is conducive to promoting the flow of innovation factors to follow the market law and achieve reasonable and efficient flow when market players and major regions compete for relatively limited innovation resources, so as to maximize their utility to create maximum economic development benefits [1]

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2 Measurement model construction

2.1 Measurement of Innovation Factor Flows

In economic research, the double gravity model is often appropriately changed according to the desirability of information, and in this paper, drawing on the relevant experience of Junhong Bai et al [2] and taking into full consideration the collectability of information data, we adopt an output-constrained double log gravity model that introduces only attractiveness variable [3].

Build the model (1), let the number of innovators who move from region m to region n be pfl_{mn}:

$$pfl_{mn} = lnP_m \times \ln(wage_m - wage_n) \times ln(house_m - house_n) \times R^{-2} \quad (1)$$

In the above equation, P_m is the number of R&D personnel in province m, $wage_n$ and $wage_m$ are the average wage of employed persons in provinces m and n, respectively, and $house_m$ and $house_n$ are the average market price of houses in provinces m and n, respectively. R is the distance between province m and the capital city of province n, which is measured by Geoda software on the national GIS website.

Build the model (2), let the number of innovators who move from region m to region n be cfl_{mn}:

$$cfl_{mn} = lnC_m \times \ln(rate_m - rate_n) \times ln(market_m - market_n) \times R^{-2} \quad (2)$$

C_m is the R&D capital of province m, $rate_m$ and $rate_n$ represent the average profit rate of enterprises in provinces m and n, respectively, and $market_m$ and $market_n$ represent the market index of financial industry in provinces m and n, respectively. The factor flow of province m in year t is obtained by summing up the factor flows from province m to other provinces in year t. In this paper, the methods of Bai Junhong et al.[4] and Wu Yanbing [5] are used for reference in the calculation of R&D capital stock

2.2 Measurements of regional economic high-quality development

Referring to the approaches of researchers such as Hua Jian [6] and Yang Mo [7], the article starts from the five new development concepts of "innovation, coordination, green, openness and sharing". Five secondary indicators and 15 tertiary indicators are selected to establish a framework system for measuring high-quality economic development, and the specific structure of the indicators is shown in Table 1, in which the three tertiary indicators of innovation dimension come from the China Regional Innovation and Entrepreneurship Index (IRIEC) of Peking University's Enterprise Big Data Research Center. This paper uses the entropy weight method (TOPSIS) to create an indicator system for measuring high-quality development[8].

Table 1. Economic quality development measurement system

Primary indicators	Secondary indicators	Tertiary indicators	point
Innovation	Regional Innovation Degree	Regional Innovation Index Aggregate Index Score	+
	Innovation per capita	Per capita innovation index aggregate index score	+
	Innovation Aggregation	Regional Average Innovation Aggregate Index Score	+
Coordination	Regional disparities	GDP per capita by province / GDP per capita nationwide	+
	Urban and Rural Structure	Per capita income of urban residents/per capita income of rural residents	–
	Industrial Structure	Tertiary Industry GDP/Total GDP	+
Green	Environmental Pollution	Sulfur dioxide emissions	–
	Green Governance	Harmless disposal rate of domestic waste	+
	Greenery construction	Forest coverage rate	+
Open	Openness	Total Import and Export/Regional GDP	+
	Investment	Actual Utilization of Foreign Investment/Regional GDP	+
	Tourism	Number of international tourists received	+
Share	Old-age Security	Number of urban workers participating in pension insurance	+
	People's Livelihood Security	The proportion of local financial expenditure on education, health care, housing security, social security and employment to local budget expenditure	+
	Infrastructure	Public transport vehicles	+

3 Analysis of the empirical study

3.1 Model Selection

Based on the Moran index test and spatial autocorrelation analysis in the previous section, there is a significant spatial correlation between the degree of regional economic quality development in China, and the two spatial effects of innovation factor flow on economic quality development cannot be ignored.

The model (3) and model (4) were constructed as follows:

$$lnh_{it} = \beta_0 + \delta Wlnh_{it} + \beta_1 lnflp_{it} + \beta_2 lnC_{it} + \theta_1 Wlnflp_{it} + \theta_2 WlnC_{it} + \varepsilon_{it} \quad (3)$$

$$lnh_{it} = \alpha_0 + \gamma Wlnh_{it} + \alpha_1 lncfl_{it} + \alpha_2 lnC_{it} + \mu_1 Wlncfl_{it} + \mu_2 WlnC_{it} + \varepsilon_{it} \quad (4)$$

Where h is the explanatory variable, i.e., the level of high quality economic development, flp and cfl are the independent variables, i.e., the amount of innovation personnel flow and innovation capital flow, C is the control variable, and W denotes the

spatial weight matrix, which satisfies independent identical distribution. Since the element of geographic distance is currently the primary consideration for the flow of innovators and innovation capital, the geographic distance weight matrix is selected for spatial regression analysis in this paper.

3.2 Empirical results

SDM model was used for regression analysis from the perspective of national heterogeneity and regional heterogeneity. The results are presented in Table 2, models ① - ⑧ were regression analysis of the impact of innovation factor flow on high-quality regional economic development in China, eastern, central and western regions, respectively.

By observing the flow coefficient of innovation factors, it can be found that: Except for the negative coefficient of innovation capital flow in model ⑦, the coefficients of R&D personnel flow and R&D capital flow in all models are positive and pass the significance test at the 1% level, indicating that the flow of innovation factors has an obvious promoting effect on the regional high-quality economic development level, and this promoting effect is most obvious in the western region of the three regions. It is higher than the central and eastern regions in turn. The flow of innovation capital in the central region has an inhibiting effect on the high-quality development of its economy. Local governments and enterprises may deviate from the characteristics of local resource endowment and blindly siphon innovation factors, leading to vicious competition and other influences [9].

From the perspective of the coefficient of spatial lag term, the coefficients of R&D personnel flow and R&D capital flow in all regions except the western region are negative, and pass the significance test, which indicates that the flow of innovation factors in geographical proximity has an inhibitory effect on the high-quality economic development of the region. This inhibitory effect may be due to the siphoning and crowding out of the local innovation factors in the geographical proximity[10].

Among them, the spatial lag terms of the flow of innovative personnel and the flow of innovation capital in the western region were significantly positive, which showed that for the western region, the flow of innovation factors in the adjacent areas of the space can promote the optimization of factor allocation through knowledge spillover and regional coordinated innovation, thereby promoting the high-quality economic development of the region. The western region is rich in natural resources, has strong market potential, and has a major strategic location, and a series of policies for the large-scale development of the western region issued by the state, such as "promoting the construction project of the Chengdu-Chongqing Twin Cities Economic Circle" and "adding pilot free trade zones and comprehensive bonded zones in the central and western regions" have improved the scientific and orderly flow of innovative factors, thereby promoting the high-quality economic development of the western region and narrowing the regional economic gap in the eastern, central and western regions.

Table 2. Spatial Durbin model regression analysis of regional heterogeneity

	Whole		East		Central		Western	
	①	②	③	④	⑤	⑥	⑦	⑧
Main								
lflp	1.457***		0.122*		0.809***		1.385***	
lcfl		5.066***		2.400**		-2.937**		36.939***
Wx								
lflp	-1.235***		-1.223**		-0.641*		7.852***	
lcfl		-4.683*		-4.382**		11.254***		240.950***
rho	0.257***	-0.265**	-0.254**	-0.137	0.682***	0.639***	-0.606***	-1.375***
sigma2_e	0.003***	0.001***	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
N	510	510	187	187	136	136	187	187
r2	0.691	0.864	0.904	0.894	0.251	0.346	0.463	0.349

note：*** ** * represent passing the test at the significance level of 1%, 5% and 10%.

4 Conclusion

Taking the panel data of 30 provinces (municipalities and autonomous regions in China from 2004 to 2020 as samples, this paper uses the entropy weight method to construct an index system based on the new development concept to measure the high-quality economic development level of regions and analyze the spatial correlation, uses the gravitational model to measure the flow of innovation factors, and finally constructs the spatial Dubin model to empirically examine the impact of inter-provincial innovation factor flow on China's high-quality economic development from the perspective of national and regional heterogeneity.

(1) There is a significant positive spillover effect and spatial agglomeration effect among high-quality economic development.

(2) From the perspective of the national sample, the flow of innovation factors has a significant promotion effect on the high-quality economic development of the region, but there is a negative spillover effect on the spatial neighboring regions, and the total effect shows a positive promotion effect, in which the flow of innovation capital has a greater impact than the flow of innovation personnel.

(3) Analyzed from the perspective of regional heterogeneity in the east, central and west, the direct effect and spillover effect of innovation factors in the western region are both positive, and the degree of effect is much greater than that in the eastern and central regions.

The above conclusions have important enlightenment significance for scientifically and accurately guiding the flow of innovation factors between regions, improving the level of collaborative innovation, optimizing the efficiency of factor allocation, and promoting the high-quality development level of regional economy:

(1) When formulating policies to improve their own high-quality economic development, local governments should not only pay attention to their own development status and potential, but also pay attention to strengthening cooperation and exchanges with other regions, and actively build a sharing platform, so as to promote the high-quality and coordinated development of the regional economy.

(2) The flow of innovation factors can effectively promote the improvement of high-quality development level, and policies should pay attention to the scientific and orderly flow of innovation factors while encouraging the flow of innovation factors, promote the rational and scientific allocation of innovation factors in accordance with market demand, and guide each region to scientifically attract talents and industrial clusters based on its own resource endowments and comparative advantages, so as to avoid the phenomenon of "one trade-off and the other" and "blind herd".

(3) At the same time, the central and western regions should pay attention to their own comparative advantages, implement innovation-driven strategic plans guided by big data intelligence, promote the transformation of old and new kinetic energy, firmly seize the opportunities of the times, formulate reasonable and effective measures and policies to attract innovative talents and innovative capital, so as to promote the high-quality development of the regional economy.

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