

# Impact of Innovation Factor Flow on the High-quality Development of Regional Economy in the Yangtze River Delta

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**Abstract**— The economic and social development of the Yangtze River Delta has always been in the forefront of the country. The Yangtze River Delta, which is rich in science and education resources, is one of the regions with the strongest innovation ability in China, and innovation is the driving force driving high-quality economic development. In order to explore the impact of innovation factor flow on the high-quality development of regional economy in the Yangtze River Delta, based on the panel data of 26 prefecture level cities in the Yangtze River Delta from 2010 to 2019, this paper selects the indicators of high-quality economic development level, evaluates the high-quality economic development level of each city with entropy method, and calculates the flow of innovation factors of each city with gravity model. Using the spatial autocorrelation model, this paper empirically analyzes the effect of innovation factor flow on the high-quality development of regional economy in the Yangtze River Delta. The empirical results show that there is a positive spatial correlation between the high-quality economic development level of the Yangtze River Delta, that is, the improvement of the high-quality economic development level of the city will drive the improvement of the high-quality economic development level of adjacent cities. Innovation personnel flow and innovation capital flow will affect the improvement of high-quality development level of regional economy, and the impact direction is significantly positive. The research results have certain enlightenment for correctly guiding the rational flow of innovation factors among the Yangtze River Delta regions, promoting the re combination of innovation factor resources and traditional factor resources in the region, and optimizing the allocation of innovation factor resources in the region, so as to improve the high-quality development level of regional economy.

**Keywords**— Flow of innovation elements; High quality development of regional economy; Flow of innovative personnel; Flow of innovation capital; Spatial spillover effects.

## I. INTRODUCTION

It has been more than 40 years since the reform and opening up, and China's economy has transitioned from an extensive economy to an intensive economy. After comprehensively deepening the reform, the economic development has shifted from the stage of rapid growth to the stage of high-quality development. The Yangtze River Delta region covers three provinces and one city, with a population of more than 200 million. Its annual economic output is close to 1/4 of the national economic output. Promoting the high-quality development of the Yangtze River Delta region economy is of great significance to the national economic development.

The Yangtze River Delta region is rich in scientific and technological innovation resources and higher education resources. In recent years, the annual R&D expenditure in the Yangtze River Delta region has accounted for more than 1/3 of the national total. The R&D intensity in Shanghai and the three provincial capitals has exceeded 3%, and the annual number of effective patents has also accounted for about 1/3 of the national total. It can be said that the Yangtze River Delta is one of the most innovative regions in China, and innovation is the main force to promote the high-quality development of regional economy. The advantageous scientific and educational resources, high intensity R&D investment, high-quality R&D achievements and "integrated" development plan have laid a good foundation for further promoting the high-quality development of the Yangtze River Delta economy. As the main carrier of innovation resources, innovation elements carry a large amount of knowledge and technology. It is necessary to

explore the flow of innovation elements between regions, strengthen the cooperation of technological innovation between regions, guide the integration of scientific and technological innovation achievements and industries, and promote the flow of talents and resource sharing for the high-quality development of the Yangtze River Delta regional economy.

High-quality economic development is an economic term, and the understanding of high-quality economic development has experienced a long time of development and evolution in China. He Julian et al<sup>[1]</sup>, constructed an evaluation system of 28 indicators in four dimensions of economic development, social development, harmonious development and comprehensive development. For example, Wang Jingmei<sup>[2]</sup> established 20 evaluation indicators from four aspects of resource utilization, environmental protection, economic development and people's life to measure the regional economic cycle; Niu Guimin<sup>[3]</sup> constructed an economic development evaluation system from the perspective of ecological civilization, consisting of five systems and 29 indicators, including economic development, resource utilization, environmental quality, ecological security and social progress. For example, Zhang Fuxiang<sup>[4]</sup> and others have built an evaluation system covering 11 indicators from four dimensions of economic operation, economic structure, micro vitality and people's welfare. Zhang Yansheng<sup>[5]</sup> constructed the indicator system of the modern economic system with a total of 26 indicators in eight dimensions, including supply and demand, industry, market, region, urban and rural areas, green, openness, and system. Sun Hao<sup>[6]</sup> established an indicator system for high-quality development of provincial economy through 20 indicators in five dimensions of

innovation, coordination, green, openness and sharing. Li Fanglin<sup>[7]</sup> also built an indicator evaluation system for high-quality economic development with the theme of "innovation, coordination, green, openness and sharing". The indicator evaluation system for high-quality economic development has gradually been enriched and improved.

The elements of innovation are people, money and things related to the innovation-related resources. The flow of innovative elements generally refers to innovative talents and innovative capital that can be distinguished from fixed assets, which cannot flow in the interval at any time. With the importance of innovation in evaluating the high quality development level of the economy, many domestic and foreign scholars have conducted in-depth exploration of the relevant impact theory. Some from the perspective of the optimization of the regional innovation system by the flow of innovation factors, such as Fischer<sup>[8]</sup>, think that the full flow of innovation factors among regions can accelerate the speed of knowledge diffusion, which is conducive to the realization of the optimization of the regional innovation system.

## II. MODEL SETTINGS

The spatial correlation of high-quality economic development level is not considered temporarily. Based on the general panel regression model, the impact of the flow of innovation factors in the Yangtze River Delta on high-quality regional economic development is preliminarily judged.

$$ehq_{it} = \alpha_{it} + \beta_1 flow_{1it} + \beta_1 c_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

$$ehq_{it} = \alpha_{it} + \beta_1 flow_{2it} + \beta_1 c_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

There is a strong spatial dependence between the flow of innovation factors and the high quality development level of regional economy. For 26 cities in the Yangtze River Delta, the flow of innovation factors in neighboring cities and the improvement of the high quality development level have a significant demonstration effect and spatial spillover effect. Therefore, this paper establishes the following spatial measurement model.

$$ehq_{it} = \alpha_{it} + \rho W ehq_{it} + \beta_1 flow_{1it} + \sum_{n=1}^2 \beta_n c_{it} + \mu_i + \varepsilon_{it} \quad (3)$$

$$ehq_{it} = \alpha_{it} + \rho W ehq_{it} + \beta_1 flow_{2it} + \sum_{n=1}^2 \beta_n c_{it} + \mu_i + \varepsilon_{it} \quad (4)$$

In model (1), model (2), model (3) and model (4), the flow of innovation personnel ( $flow_{1it}$ ) and innovation capital ( $flow_{2it}$ ),  $ehq_{it}$  represents the high quality development level of  $i$  city in  $t$  year.  $W$  is the spatial weight matrix,  $\rho$  is the spatial automatic regression coefficient;  $c_{it}$  is the control variable,  $\mu_i$  stands for individual fixed effect,  $\varepsilon_{it}$  is a random disturbance term, satisfying  $\varepsilon_{it} \sim (0, \delta^2)$ .

After adding this indicator, this paper evaluates the high-quality economic development level of 26 cities in the Yangtze River Delta region based on the six dimensions of comprehensive quality and efficiency, innovative development, coordinated development, green development, open development and shared development and 30 basic indicators.

The detailed indicators and descriptions are shown in Table 4. In this paper, the flow of innovation factors is the explanatory variable of the model, which is measured by the entropy method in the existing research. Among them, the flow of innovative personnel ( $flow_1$ ) and the flow of innovative capital ( $flow_2$ ). With regard to the measurement method of the flow of innovation factors, this paper has consulted a large number of literature and materials. After comprehensive consideration of the existing literature and materials, this paper refers to the method used by Bai Junhong [34] and other researchers, and uses the method of adding relevant variables to the gravity model to measure the flow of innovation personnel and innovation capital in the Yangtze River Delta.

Referring to the existing research [1], in order to more comprehensively analyze the impact of the flow of innovation factors in the Yangtze River Delta on the high-quality development of regional economy, this paper also selected two control variables that may have an impact on it: government behavior orientation (lnGov), which is expressed as the logarithm of the percentage of local government's general budget expenditure in the regional GDP; Information level (lnTel), expressed as the logarithm of the total number of regional telecommunications services.

## III. SPATIAL CORRELATION TEST

First of all, we need to make model selection. The results of model selection LM test are shown in Table 1. According to the test results in Table 1, combined with the rules of LM test, the LM test and robustness LM (RLM) test of the innovative personnel flow model and the innovative capital flow model both selected the SAR model, so this paper selected the SAR model, and selected the fixed effect model through the Hausman test.

Through regression analysis of individual fixation, time fixation and two-way fixation of the model, the results are shown in Table 2. It can be seen from Table 2 that only the individual fixed spatial regression coefficients are significant, while the time fixed and two-way fixed spatial regression coefficients are not significant, so only the individual fixed under the SAR model can be selected for spatial regression analysis.

The empirical analysis results are shown in Table 3. It can be seen from Table 3 that the spatial autocorrelation coefficient of the model  $\rho$  is positive and significant, indicating that there is a positive spatial spillover effect on the high-quality development level of the regional economy in the Yangtze River Delta, that is, the improvement of the high-quality development level of the economy will drive the high-quality development level of the economy of the associated cities. In addition, the main effects of innovation personnel flow and innovation capital flow on the high-quality development of regional economy are significant and positive, which preliminarily shows that there is a significant positive correlation between the flow of innovation factors and the high-quality development of regional economy.

TABLE 1. LM and RLM inspection results

Test	Innovative capital flow			
	Statistic	p-value	Statistic	p-value
<i>Spatial error:</i>				
Moran's I	1.295	0.195	1.200	0.230
Lagrange multiplier	1.079	0.299	0.894	0.344
Robust Lagrange multiplier	0.722	0.396	0.511	0.475
<i>Spatial lag:</i>				
Lagrange multiplier	10.980	0.001	8.777	0.003
Robust Lagrange multiplier	10.623	0.001	8.394	0.004

TABLE 2. Regression results of three fixed effects of SAR model

variable	Individual fixation		Fixed time		Bidirectional fixation	
	Innovation personnel flow	Innovation capital flow	Innovation personnel flow	Innovation capital flow	Innovation personnel flow	Innovation capital flow
$flow_1$	0.334** (2.60)		0.166*** (4.96)		-0.302 (-1.68)	
$flow_2$		0.511** (4.78)		0.138** (4.99)		0.241 (1.49)
$lnGov$	0.0384** (4.60)	0.0375** (4.53)	0.0645** (5.16)	0.0644** (5.17)	0.0324** (3.66)	0.0382** (4.23)
$lnTel$	0.00362 (1.23)	0.00197 (0.68)	0.0854** (26.22)	0.0858** (26.31)	0.00135 (0.46)	0.00127 (0.43)
$\rho$	0.748*** (15.85)	0.625** (10.84)	0.0473 (0.62)	0.0277 (0.37)	0.226 (1.95)	0.222 (1.90)
$r^2$	0.7722	0.8040	0.754	0.754	0.0177	0.0173
N	260	260	260	260	260	260

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

TABLE 3. Estimation results of common panel model and SAR model

variable	OLS		SAR	
	Innovation personnel flow	Innovation capital flow	Innovation personnel flow	Innovation capital flow
$flow_1$	0.191*** (5.76)		0.334** (2.60)	
$flow_2$		0.164*** (6.55)		0.511*** (4.78)
$lnGov$	0.0762*** (6.44)	0.0774*** (6.55)	0.0384*** (4.60)	0.0375*** (4.53)
$lnTel$	0.0882*** (27.34)	0.0883*** (27.47)	0.00362 (1.23)	0.00197 (0.68)
$-cons$	-0.310*** (-7.14)	-0.316*** (-7.27)		
$\rho$			0.748*** (15.85)	0.625*** (10.84)
$r^2$	0.752	0.754	0.7722	0.8040
N	260	260	260	260

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

In order to further reflect the interaction between variables, the model effect is divided into direct effect, indirect effect and total effect. See Table 4 for the detailed results.

First of all, it can be seen from Table 4 that the impact of innovation personnel flow and innovation capital flow in the Yangtze River Delta on the high-quality development of regional economy is significantly positive under the direct effect, indirect effect and total effect, indicating that the flow of innovation factors in the Yangtze River Delta has a positive role in promoting the high-quality development of regional economy.

TABLE 4. Direct effect, indirect effect and total effect after decomposition of main effect of SAR model

variable	Direct effect		Indirect effect		Total effect	
	Innovation personnel flow	Innovation capital flow	Innovation personnel flow	Innovation capital flow	Innovation personnel flow	Innovation capital flow
$flow_1$	0.388** (2.72)		0.912* (3.58)		1.300* (3.41)	
$flow_2$		0.555** (5.12)		0.804** (7.72)		1.359** (8.74)
$lnGov$	0.0439* (4.83)	0.0402* (4.74)	0.110* (3.29)	0.0600* (4.53)	0.154* (3.86)	0.100** (4.18)
$lnTel$	0.00451 (1.39)	0.00243 (0.80)	0.0114 (1.28)	0.00370 (0.77)	0.0159 (1.33)	0.00614 (0.79)

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Secondly, the impact of the flow of innovation factors in the Yangtze River Delta on the high-quality development level of the regional economy is greater than the direct effect under the indirect effect, which indicates that the positive spatial spillover effect of the flow of innovation factors in the Yangtze River Delta is dominant in the total effect, and further explains that the improvement of the high-quality development level of the regional economy depends not only on the flow of innovation factors in the city, but also on the flow of innovation factors in related cities.

In addition, among other control variables, the government behavior orientation is significantly positive under the main effect, and the three decomposition effects, indicating that the government behavior orientation has a promoting effect on the improvement of the high-quality development level of the Yangtze River Delta regional economy. The informatization level has no significant positive impact in each effect, the main reason may be that the informatization level of the Yangtze River Delta has reached a relatively high level during the sample period. In addition, by comparing the regression coefficients of the control variables in the ordinary panel regression, the role direction of government behavior orientation and informatization level is consistent, and the significance level of government behavior orientation ordinary panel model and SAR model are consistent and have little difference. The significance and influence of informatization level are overestimated in the ordinary panel, but the impact of innovation personnel flow and innovation capital flow is underestimated in the ordinary panel. On the whole, the model is relatively robust.

#### IV. RESEARCH CONCLUSIONS AND SUGGESTIONS

Based on the spatial panel data of 26 cities in the Yangtze River Delta from 2010 to 2019, this paper uses the spatial autocorrelation model to explore the relationship between the flow of innovation factors in the Yangtze River Delta and the high-quality development of regional economy. The conclusions are as follows: the high-quality development of regional economy in the Yangtze River Delta has significant spatial correlation and the impact direction is positive, that is, the improvement of the high-quality development level of a city's economy will drive the high-quality development of the

neighboring cities' economy; The flow of innovative elements has a driving effect on the improvement of the high-quality development level of the economy of the city and its neighboring cities. The flow of innovative elements can not only optimize the allocation of the city's element resources through the integration and utilization of the city's element resources, thus promoting the high-quality development of the city's economy, but also drive the high-quality development of the economy of the neighboring regions; The government behavior guidance can guide the flow of innovation elements in the region, thus promoting the promotion of high-quality development level of regional economy.

In view of the above conclusions, this paper puts forward three suggestions. First of all, the spatial relevance of high-quality economic development in the Yangtze River Delta determines that in the process of achieving economic development, all regions should remove barriers between regions, strengthen cooperation between each other, and continue to promote the integrated development of the Yangtze River Delta. Secondly, the flow of innovative talents should be reasonable and appropriate, give full play to the combination of innovative talents and local factor resources, and avoid the adverse impact of excessive talent flow. Finally, to give full play to the guiding role of the local government as the economic macro-control, the local government should actively coordinate the support of various departments and financial institutions to the innovation elements within a moderate range, reasonably guide the accumulation of innovation elements in the key areas of the region, improve the level of regional innovation, strengthen regional cooperation, and reduce the cost of innovation. At the same time, we should also consider that the overall development level of Anhui is lower than that of Jiangsu, Zhejiang and Shanghai, and guide the combination of

innovative elements and traditional elements in regions with lower development level, which is conducive to changing the current situation of traditional elements in the region, optimizing the allocation of elements, and promoting high-quality economic development in the region.

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