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Research on the Influence of Innovative Spatial Connection on Regional Innovation Performance Improvement

-Empirical Evidence from the Yangtze River Delta Urban Agglomeration

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***Abstract*—The externality of knowledge creates knowledge spillover. The spatial spillover of knowledge enables the innovation activities to interact with each other in the region, creating a spatial connection of innovation. This connection will affect the regional innovation performance at the spatial level. This paper constructs a theoretical model of the impact mechanism of innovation spatial connection on regional innovation performance. On this basis, the gravitational model is used to measure the degree of innovation spatial connection in the Yangtze River Delta urban agglomeration, and the spatial econometric model across the Production Function is used to consider the impact of the innovative spatial connection of the Yangtze River Delta urban agglomeration on regional innovation performance improvement. The study finds that the innovation of the Yangtze River Delta urban agglomeration mainly revolves around several important nodes, and gradually forms a hierarchical structure of multi-level innovation spatial connection. The innovative spatial connection has a positive adjustment effect on regional innovation performance improvement. The technology distance dimension has a more significant effect on the regional innovation performance improvement than that of geographic distance.**

Keywords—Knowledge spillover; Spatial connection of innovation; Regional innovation performance; Yangtze River Delta Urban Agglomeration

I. INTRODUCTION

Regional innovation is an important carrier for innovation-driven development. There are two main ways to enhance regional innovation performance: one is to rely on its own knowledge accumulation, and the other is to enhance innovation performance by accepting knowledge spillovers. In the era of knowledge economy and global network, relying on its own knowledge accumulation is far from meeting the needs of innovation-driven development. It also needs to make full use of external knowledge to stimulate local innovation vitality and enhance regional innovation performance. With the increasing exchanges of innovation elements in the region, the spatial connection of innovation has been continuously enhanced, and the influence of innovation on spatial connection has become increasingly prominent, and has become an important factor in the improvement of regional innovation performance. At present, China's regional innovation has made great progress, and region such as the Yangtze River Delta, the Pearl River Delta, and Beijing-Tianjin-Hebei have achieved a great results at innovation. However, it still needs to be seen that due to the lack of clarity on the internal innovation organization model and how the spatial connection of innovation influence the regional performance. Therefore, this paper though further combing the regional innovation development organization model and in-depth study of the impact mechanism of how innovation spatial connection influence regional innovation performance improvement. Though the research, we hope to find a way from innovation spatial connection aspect to stimulate regional innovation vitality and promote regional innovation performance.

II. THEORETICAL BASIS

Because of the external characteristics of knowledge, innovation behavior is not an isolated state but affects each other [1]. Innovation activities are affected by two kinds of effects, one is the innovation spillover ability based on innovation ability, and the other is innovation absorption ability based on knowledge stock [2]. The interaction of the two effects, the innovative interactions in the space create an innovative connection.

The externality of knowledge creates knowledge spillovers, and the knowledge spillover between regions makes the innovation activities in the region interact with each other [3]. The role of this interaction forms the spatial connection of innovation, which makes the regional innovation performance is influenced at the spatial level. The process from innovation spillover to absorption and innovation can be divided into the following stages: first, innovation spillover, second, innovation transmission, and third, absorption and innovation. In this process, how the innovation is transmitted in the region determines the effect of innovation spillover. The conduction process can be understood as the interaction process of innovation activities in space, that is, the innovation connection.

The greater the degree of innovation connection, the better the effect of innovation spillover.

Due to the existence of knowledge spillover and spatial role, there is a certain degree of interconnectivity in space, mainly in the advancement of technology and the spatial agglomeration of innovation activities. These two effects accelerated the regional innovation performance on the basis of innovation investment. the mechanism of the innovation space connection how to improve regional innovation performance is shown in Figure 1.

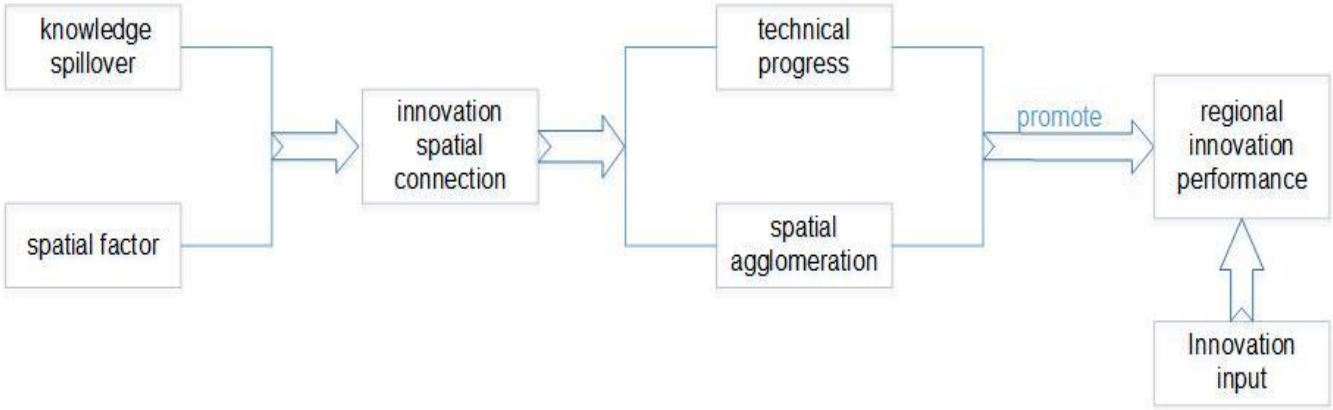

Fig. 1 The process of innovation spatial connection mechanism to improve regional innovation performance

III. Empirical Analysis

A. The Measure of Innovation Space Contact

GRAVITATIONAL MODEL have been widely used in various disciplines to measure spatial interactions [4]:

$$\mathrm{KS} = \mathrm{k}\frac{D_i * D_j}{d_{ij}^2} = \mathrm{k}w_{ij} * （D_i * D_j）$$

Which, k is the gravitational constant, generally as 1, $\mathrm{w_{ij}} = \begin{cases} 1/\mathrm{d_{ij}^2} & ,\mathrm{i} \neq \mathrm{j} \\ 0 & ,\mathrm{i} = \mathrm{j} \end{cases}$, $\mathrm{d_{ij}}$ is the distance of city i and city j,D_i, D_j is the “quality” of cities。

Knowledge spillovers are affected by geographic distances, but the spatial connectivity of innovation is not only affected by geographic distance, but also by differences in innovation levels. Generally speaking, innovation spillovers and innovation absorption between cities with small differences in innovation levels are more likely to be transformed and innovated. Based on the above considerations, this paper uses the improved gravitational model based on the technical distance spatial weight matrix to measure the innovation spatial connection degree of the Yangtze River Delta urban agglomeration：

$$\mathrm{KS} = \mathrm{k}\frac{D_i * D_j}{hd_{ij}} = kw_{hd} * （D_i * D_j）$$

Which, k is the gravitational constant, generally as 1,D_i、D_j is the innovation ability of city i and city j, $w_{hd} = w_{ij}diag(h_1, h_2, h_3, \dots\dots h_n)$,$h_i$ is the number of invention patents of city i, $\mathrm{w_{ij}} = \begin{cases} 1/\mathrm{d_{ij}^2} & ,\mathrm{i} \neq \mathrm{j} \\ 0 & ,\mathrm{i} = \mathrm{j} \end{cases}$, $\mathrm{d_{ij}}$ is the distance of city i and city j, the distance is measured by geoda software with1:4 million maps published by the China Basic Geographic Information Center .

According to the entropy method [5], weight and sum the index score of different cities, due to content limitations, the scores of urban innovation ability index is not to shown there. According to the gravitational model, the matrix of innovation spatial connection among cities in the Yangtze River Delta urban agglomeration can be obtained. Due to space limitations, the urban innovation spatial connection matrix is not lists there.

According to the intensity of innovation spatial connection between cities, though the function of natural breakpoint in ARCGIS 10.2, divided the cities into five grades according to the spatial connection strength, the visual display is shown in Figure 2. Due to the use of technical distance,the spatial connection matrix between cities becomes a directed matrix. Therefore, the spatial connection matrix of innovation between cities is an asymmetric matrix, that is, the effect of city A on city B is different from that of city B on city A.

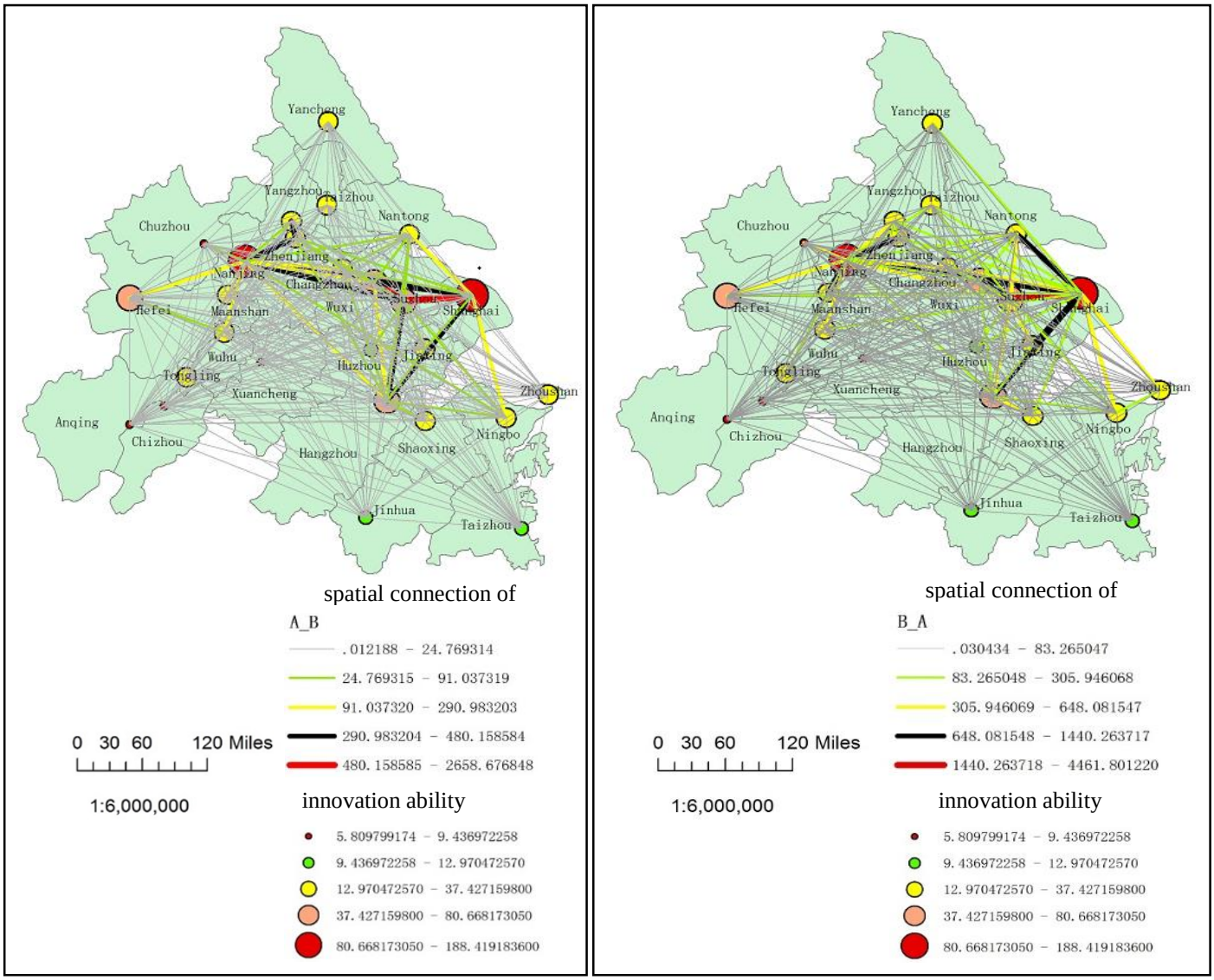

Fig. 2 The innovation spatial connection map of Yangtze River Delta urban agglomeration

We find that, the innovation connection of Yangtze River Delta urban agglomeration is mainly around several important nodes, and gradually forms a hierarchical structure of multi-level innovation spatial connection, Shanghai and Nanjing as core city between the connection, the rise of secondary cities such as Suzhou, Hangzhou and Wuxi has also played an important role in the innovation spatial connection of the Yangtze River Delta urban agglomeration.

B. The Impact of Innovation Space Connection on Regional Innovation Performance Improvement

This paper constructs a spatial econometric model of the impact of innovative spatial connection on urban innovation performance to test whether there is spillover effect, that is, whether the innovation activities of a certain city will pass to other cities though a certain spatial effect.

1) Model construction

Based on the Griliches-Jaff production function, the Model I of the impact of innovative spatial connection on regional innovation performance is constructed:

$$lnzl_i = \mathrm{c} + \lambda \mathrm{W}(\ln\theta_i\theta_j) + \beta_1 \mathrm{lnrdry}_i + \beta_2 \mathrm{lnrdjf}_i + \mu_i$$

which, θ_i is the innovation ability of city i, W is distance weight matrix, $\mathrm{W}(\ln\theta_i\theta_j)$ is Spatial weighted variables of urban innovative spatial connection, λ is its' Influence coefficient; rdry、rdjf is the Funding and human investment of innovation activity, β is the corresponding variable coefficient.

Then we constructed Model II with the control variables:

$$lnzl_i = \mathrm{c} + \lambda \mathrm{W}(\ln\theta_i\theta_j) + \beta_1 \mathrm{lnrdry}_i + \beta_2 \mathrm{lnrdjf}_i + \sum_k lnx_{ki}\,\delta_k + \mu_i$$

Where x is a series of control variables, including the degree of urban extroversion (jckbz); the level of regional informatization (info); regional economic development level

(rjgdp); the degree of government supports to the innovation, (czbz). δ is the coefficient of the control variable.

2) Analysis of model result

Model I and Model II were estimated based on geographic distance and technical distance using MATLAB2014a software. The regression result is shown in TABLEI.

TABLE I GEOGRAPHIC DISTANCE WEIGHT AND TECHNICAL DISTANCE WEIGHT SPACE MEASURE REGRESSION RESULT

Geographic Distance Weight				
	Model I	T value	Model II	T value
c	-2.213663		-4.337399***	-2.927647
$W(\ln\theta_i\theta_j)$	0.001906***	4.904091	0.001721***	3.706214
lnrdry	1.606060***	2.958584	1.265437***	2.630932
lnrdjf	-1.226586**	-2.355167	-1.218115***	-2.630033
lnjckbz	-	-	-0.121138	-0.863155
lninfo	-	-	0.523349***	2.923705
lnrjgdp	-	-	0.192606	0.511058
lnczbz	-	-	0.417039*	1.692987
R^2	0.8335	/	0.8890	/
sigma^2	0.2424	/	0.1616	/
LogL	-18.933105	/	-13.660304	/
Technical Distance Weight				
	Model I	T value	Model II	T value
c	-2.562927	-1.363363	-3.866412**	-2.343268
$W(\ln\theta_i\theta_j)$	0.029007***	4.078053	0.019003***	4.725932
lnrdry	1.149313*	1.790966	1.223965**	2.200101
lnrdjf	-0.508739	-0.877886	-1.082195**	-2.026364
lnjckbz	-	-	0.069277	0.515117
lninfo	-	-	0.634027***	3.249364
lnrjgdp	-	-	0.658687*	1.624698
lnczbz	-	-	0.407863	1.432592
R^2	0.7593	/	0.8517	/
sigma^2	0.3503	/	0.2159	/
sigma^2	0.3503	/	0.2159	/

notes：***,**,* represented at significant levels of 0.01, 0.5, 0.1.

It can be seen from the regression results that the statistics of R2、sigma^2、LogL of Model I and Model II have a good fitting degree, and the influence of innovation spatial connection on regional innovation performance has passed the significance test and elasticity. The coefficients are positive, indicating that in the perspective of technical distance and technical distance, the spatial connection between innovations in cities has a positive effect on regional innovation performance. The technology distance dimension has a more significant effect on the regional innovation performance improvement than the geographic distance.

IV. CONCLUSION

This paper constructs the theoretical model of the innovation spatial connection from the perspective of knowledge spillover, and builds the impact model of innovation spatial connection on regional innovation performance improvement. In order to verify this theoretical model, this paper constructs a spatial econometric model of the innovation spatial connection of the Yangtze River Delta urban agglomeration to the regional innovation performance from the perspectives of geographical distance and technical distance. It is found that the innovation spatial connection has positive adjustment effect to the regional innovation performance improvement. And the technical distance dimension has a more significant effect on the regional innovation performance improvement than the geographical distance dimension.

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