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RESEARCH ON UNIVERSITY KNOWLEDGE SPILLOVER AND ECONOMIC GROWTH BASED ON SDM MODEL

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ABSTRACT

University knowledge spillover is an important source of technological innovation and an important factor in promoting China's economic growth. This paper uses the panel data of 27 provinces and cities nationwide from 2007 to 2016 to construct a spatial econometric model to study the impact mechanism of university knowledge spillover on China's economic growth. The empirical research finds that there is spatial dependence on the economic growth of various provinces in China. The knowledge spillover of the university has a significant role in promoting China's economic growth. In addition to the promotion of the local economy, the university's knowledge spillover will also promote economic growth in other regions. Make a contribution. This paper provides an empirical basis for the formulation of relevant policies.

Keywords: University Knowledge Spillover, Economic Growth, Panel Data, Spatial Dubin Model

1. INTRODUCTION

Knowledge spillover is an important concept of endogenous economic growth theory interpretation and innovation. With the rapid development of the knowledge economy era in the 21st century, the role of science and technology development in contemporary social economic growth is becoming more and more important. As an important provider of intangible assets and intellectual capital in society, universities are the main source of new knowledge and new technologies. As the university's contribution to economic development has become more and more prominent, many scholars have increased their research on university knowledge spillovers. At present, there are many literatures on the relationship between university knowledge spillovers and regional economic development, but these studies have some shortcomings: these studies mainly analyze the impact of university knowledge input, and less on the university. Knowledge output. This paper explains the university knowledge spillover from both input and output. This paper verifies the relationship between university knowledge spillovers and economic growth in Jiangsu Province by constructing a university knowledge spillover and a spatial Dubin model of China's economic growth. The results of the empirical analysis will provide guidance for universities to increase investment in research and development, conduct reasonable knowledge spillovers, and accelerate economic development.

2. LITERATURE REVIEW AND RESEARCH HYPOTHESIS

In the modern economy, there is still no certain concept about university knowledge spillover. With reference to the concept of knowledge spillover, university knowledge spillover is a dynamic process, which is university spillover knowledge, knowledge dissemination diffusion, and enterprises and other recipients absorb and absorb knowledge. The process of recreating knowledge. According to the characteristics of knowledge, knowledge can be divided into tacit knowledge and explicit knowledge, which was first proposed by Michael Polanyi in 1958. Therefore, university knowledge can also be divided into explicit and implicit. University explicit knowledge can be conveyed to the outside world through written words, charts and mathematical formulas, while tacit knowledge exists in the individual's mind, it cannot be written, etc. The formal form is passed (Zhao Yong, 2009) [1]. For the study of knowledge spillovers, domestic scholars Zhang Qingzheng (2015) [2], Zhang Tongbin (2016) [3], and foreign scholars Paula (2016) [4] and Tomohiko (2016) [5] have found that knowledge spillovers are the main source of economic growth and it is the representative externality of economic phenomena. More elaborate, Shi Shude (2009) [6] and Wang Liping (2009) [7] used panel data models to verify that knowledge spillovers and entrepreneurial activities have a positive effect on economic growth, and that entrepreneurs can filter and transform new knowledge. To be better than the incumbent.

For the study of the impact of university knowledge spillovers on the industrial economy, Wan Kunyang (2010) [8], Luo Wei (2014) [9], and weekend (2017) [10] studied the impact of university knowledge spillovers on the performance of industrial enterprises. The study finds that knowledge spillovers in colleges and universities will have a significant positive effect on the performance of industrial enterprises in neighboring universities. The greater the scale of school-enterprise cooperation, the greater the positive effect of colleges and universities on the innovation performance of enterprises, and the ability of enterprises to absorb knowledge will also be on university knowledge. Spillover affects the performance of industrial enterprises. Stephanie Monjon (2003) [11] found the importance of university knowledge spillovers to imitate the innovation of existing technology companies, and highly innovative companies can benefit from cooperation with universities at home and abroad. Spyros Arvanitis (2008) [12] analyzed the impact of different forms of university knowledge spillover on the performance of Swiss private enterprises, and found that education R&D activities can significantly promote the innovation

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performance of the company's new product sales compared with the technical consultation methods. Xu Chun (2013) [13] empirically found that applying for a patent at a university would have an inhibitory effect on corporate innovation. How university knowledge spillovers will affect the economic development of enterprises, and there are differences between different scholars. Research on university knowledge spillovers and economic growth is a research hotspot and focus of many theories such as endogenous economic growth and regional innovation systems. Scholars usually represent university R&D investment in terms of funding and personnel, and then study university R&D investment. The relationship with the regional economy.

3. MODEL SETTINGS, VARIABLE SELECTION AND DATA SOURCES

3.1 Model Settings

3.1.1 Basic model

The knowledge production function method was first proposed by Griliches (1979) [14]. He incorporated the normal knowledge production input and technical knowledge level into the knowledge production function, which provided an effective study for the quantitative research of knowledge production and the empirical research of innovation activities. Analysis tool. Griliches constructs the knowledge production function in the form of C-D production function. The Griliches knowledge production function is of the form:

$$Y_{it} = \mathrm{A} K_{it}^{\alpha} LA_{it}^{\beta} KS_{it}^{\gamma} \varepsilon_{it} \qquad (1)$$

Among them, Y_{it} is the total output, K_{it} is the capital stock, LA_{it} is human capital, KS_{it} is the university knowledge spillover, ε is other variables affecting economic output, α, β, γ are the parameters to be estimated. University knowledge spillovers are mainly considered from the aspects of output and investment. This paper uses the university patent grant number UPL and university research and development funds to support the UAE two variables to explain the university knowledge spillover. Considering other factors affecting the economic development of a region, this paper introduces foreign direct investment FDI and technology market turnover MTV as the control variables affecting China's economic growth into the production function. The improved production function is:

$$Y_{it} = AUPL_{it}^{\beta_1} UAE_{it}^{\beta_2} K_{it}^{\beta_3} LA_{it}^{\beta_4} MTV_{it}^{\beta_5} FDI_{it}^{\beta_6} \varepsilon_{it} \qquad (2)$$

Taking the logarithm of both sides of equation（2）to obtain equation（3）:

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$$\ln Y_{it} = \alpha_{it} + \beta_1 lnUPL_{it} + \beta_2 lnUAE_{it} + \beta_3 lnK_{it} + \beta_4 lnLA_{it} + \beta_5 lnMTV_{it} + \beta_6 lnFDI_{it} + \varepsilon_{it} \quad (3)$$

3.1.2 Spatial Measurement Model

Anselin (1997) [15] was the first scholar to combine spatial econometric models with knowledge production functions to analyze knowledge spillovers and technological innovations. This paper studies the role of spatial spillovers in university knowledge on China's economic growth, using spatial econometric models. The spatial measurement model mainly includes three types: spatial error model (SEM), spatial lag model (SLM) and spatial Dubin model (SDM). The specific expression is as follows:

SEM:

$$\ln Y_{it} = \alpha_{it} + \beta_1 lnUPL_{it} + \beta_2 lnUAE_{it} + \beta_3 lnK_{it} + \beta_4 lnLA_{it} + \beta_5 lnMTV_{it} + \beta_6 lnFDI_{it} + \mu_{it}$$
$$\mu_{it} = \theta W \mu_{it} + \varepsilon_{it} \quad (4)$$

SLM:

$$\ln Y_{it} = \alpha_{it} + \rho W \ln Y_{it} + \beta_1 lnUPL_{it} + \beta_2 lnUAE_{it} + \beta_3 lnK_{it} + \beta_4 lnLA_{it} + \beta_5 lnMTV_{it} + \beta_6 lnFDI_{it} + \varepsilon_{it} \quad (5)$$

SDM:

$$\ln Y_{it} = \alpha_{it} + \rho W \ln Y_{it} + \beta_1 lnUPL_{it} + \beta_2 lnUAE_{it} + \beta_3 lnK_{it} + \beta_4 lnLA_{it} + \beta_5 lnMTV_{it} + \beta_6 lnFDI_{it} + \delta_1 WlnUPL_{it} + \delta_2 WlnUAE_{it} + \delta_3 WlnK_{it} \delta_4 WlnLA_{it} + \delta_5 WlnMTV_{it} + \delta_6 WlnFDI_{it} + \varepsilon_{it} \quad (6)$$

Among them, Y is the explanatory variable; UPL、UAE、K、LA、MTV、FDI are explanatory variables; ρ is the spatial regression coefficient, which measures the degree of mutual influence of economic growth between regions, and θ is the spatial error coefficient, which measures the adjacent regions. The degree of mutual influence of economic growth error term, both reflect the spatial dependence of sample observations; μ is a random error term, and there is spatial dependence; ε is a random error term, δ measures the impact of knowledge spillover of the university in the adjacent region growth. W is a spatial weight matrix. The spatial weight matrix indicates the interdependencies and dependencies between the various elements of the space. The spatial weight matrix constructed in this paper is a spatial neighbor weight matrix. Generally, the economic growth of the two regions may be related to the spatial relative position of the two locations. The adjacency relationship between the two is represented by the construction of the

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spatial neighboring weight matrix, where the elements on the diagonal are 0, and the other elements satisfy:

$$W_{ij} = \begin{cases} 1 & i \text{ and } j \text{ spatial adjacency} \\ 0 & \text{i and j space not adjacent} \end{cases} (i \neq j) \qquad (7)$$

3.2 Variable Selection and Data Sources

The main variables of this paper are economic output **Y**, university patent grant number UPL, university R&D expenditure UAE, physical capital stock K, human capital LA, technology market turnover MTV, foreign direct investment FDI. Measuring university knowledge spillovers mainly comes from input and output. This paper uses the University's patent grant number (UPL) to represent the university's knowledge output; the input factors that affect the university's knowledge spillover mainly include human capital investment and cost input. The University Research and Development Expenditure (UAE) variable measures the input factors of university knowledge. The variable to be interpreted is the variable of GDP per capita in all provinces and cities across the country. The physical capital stock K is calculated by Zhang Jun (2004) [16] using the perpetual inventory method. Human capital LA is expressed in terms of the number of people employed nationwide. The control variables specifically include the two variables of technology market turnover (MTV) and foreign direct investment (FDI).

This paper collects relevant data from 27 provinces and cities (with data missing in Hainan, Tibet, Qinghai, and Ningxia) as research samples. At the same time, the original data studied in this paper are taken from the China Statistical Yearbook 2008-2017 and the Compilation of Chinese University Statistics. In addition, in order to eliminate the influence of unit inconsistency and heteroscedasticity on the research results, this paper applies all the data in logarithmic form.

4. SPATIAL MEASUREMENT TEST

4.1 Spatial autocorrelation test

4.1.1 Moran index

Before using the spatial econometric model, it is necessary to test whether the per capita GDP of each province in China has significant spatial correlation. At present, the spatial Moran index in spatial statistics is usually used to test the spatial correlation, and the calculation formula is as follows:

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$$MoranI=\frac{\sum_{i=1}^{n}\sum_{j=1}^{n}W_{ij}(X_i-\bar{X})(X_j-\bar{X})}{S^2\sum_{i=1}^{n}\sum_{j=1}^{n}W_{ij}} \qquad (8)$$

Where $S^2=\frac{1}{n}\sum_{i=1}^{n}(X_i-\bar{X})^2$, $\bar{X}=\frac{1}{n}\sum_{i=1}^{n}X_i$, X_i denotes the observed values of economic growth in i provinces and cities, n is the number of provinces and cities in this study, and W_{ij} is a spatial binary spatial adjacent weight matrix element.

4.1.2 Global spatial autocorrelation

Global spatial autocorrelation is a description of the spatial characteristics of an attribute in an entire region, reflecting the degree of similarity between spatially adjacent or spatially adjacent unit observations to determine whether a phenomenon is spatially agglomerated. Using the Moran index test, the test results are shown in Table 4.1:

Table 4.1: Spatial correlation index of China's per capita GDP in 2007-2016

year	2007	2008	2009	2010	2011
Moran's I	0.080	0.092	0.097	0.104	0.110
P value	0.001	0.000	0.000	0.000	0.000
year	2012	2013	2014	2015	2016
Moran's I	0.110	0.106	0.098	0.087	0.066
P value	0.000	0.000	0.000	0.000	0.001

It can be seen from the above table that the spatial correlation index of GDP per capita in all provinces and cities in China is significantly positive, indicating that the distribution of per capita GDP in various provinces and cities in China is not in a random state, but is per capita in the neighboring provinces. The impact of regional GDP has a significant positive correlation in spatial distribution. Positive correlations indicate that areas with higher yields tend to be closer to areas with higher yields, and areas with lower yields tend to be adjacent to areas with lower yields. Therefore, in the analysis of inter-regional economic correlation data, it is necessary to use spatial econometric model considering spatial dependence for estimation, which lays a foundation for the use of spatial econometric model analysis.

4.2 Spatial model selection

4.2.1 Selection of spatial lag model and spatial error model

To establish a spatial panel model, you first need to perform a selective test of the model. The specific form of the spatial panel data model is determined by two Lagrange multiplier forms LMLAG and LMERR, robust LMLA, and LMERR. The test results are shown in Table 4.2:

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Table 4.2: Results of LM and R-LM test

test		Statistic	P value
spatial error model	Lagrange multiplier	6.17	0.013
	Robust Lagrange multiplier	18.25	0.000
spatial lag model	Lagrange multiplier	56.27	0.000
	Robust Lagrange multiplier	68.35	0.000

It can be seen from the above table that under the 5% confidence level, the maximum likelihood estimates for the spatial error model and the spatial lag model reject the null hypothesis at the 5% significance level, but the value of maximum likelihood estimation of the spatial lag model rejects the null hypothesis at a 1% significance level, while the spatial error model accepts the null hypothesis at a 1% significance level. However, the robust maximum likelihood estimates for the spatial error model and the spatial lag model reject the null hypothesis at the 1% significance level. According to the spatial model judgement proposed by Anselin and Florax, the LMLAG and ELMLAG are more significant. The significance of LMERR and RLMERR, so this paper will choose the spatial lag model for analysis.

4.2.2 Test individual effect

Table 4.3: Results of Wald、LR and Hausman test

Statistics	Statistics	P value
Wald test	142.16	0.0000
LR test	663.64	0.0000
Hausman test	252.24	0.0000

All the variables in the Wald test have a P value of 0.0000. The 1% significance test indicates that the spatial Dubin model cannot be reduced to the spatial error model. The test results also show that the fixed effect model is better than the mixed OLS model. Table 3.3 shows that the LR test strongly rejects the null hypothesis that there is no individual random effect, that is, rejects mixed regression between random effects and mixed regression, and the random effect model is better than the mixed effect model.

In order to judge whether the individual effect of the panel data is an individual fixed effect or an individual random effect, the Hausman test is further performed on the data. The null hypothesis is that the individual effect in the random effect model is not related to the explanatory variable. If the statistic of the Hausman test is less than the critical value, the original hypothesis cannot be rejected, and the individual influence should be determined as the random effect form; if the statistic is greater than the critical value, the null hypothesis is rejected and should be set as the

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fixed effect model. From the above table, the Hausman statistic test result is 252.24, the statistic is positive and greater than the critical value, and the statistic is significant at the significance level of 1%, indicating that the null hypothesis should be rejected and the fixed effect model should be selected for regression.

Based on the above test, this paper should establish a spatial Doberman fixed effect model. Because the spatial Dubin model (SDM) adds the spatial lag term of the explanatory variable and the spatial lag term of the dependent variable to the common spatial panel model (SAR model and SEM model). Compared with the ordinary space panel model, the spatial Dubin model space Dubin model can express the dependence of the independent variables and dependent variables between regions. Therefore, this paper selects the spatial Doberman model fixed effect model for research.

4.2.3 Three fixed effect choices for space Dubin model

Table 4.4: Three fixed effect spatial Dubin models

variable	Space fixed effect	time fixed effect	space-time fixed effect
Lnupl	0.0567***	-0.0208	0.0569***
	(4.34)	(-0.82)	(4.64)
Lnuae	-0.0003	0.0058	0.0139
	(-0.02)	(0.18)	(0.71)
Lnk	0.3987***	0.1388***	0.3915***
	(8.61)	(2.92)	(8.90)
Lnla	0.1286***	-0.3937***	0.1257***
	(2.80)	(-7.22)	(2.99)
Lnmtv	0.0344***	0.1075***	0.0373***
	(3.95)	(6.92)	(4.37)
Lnfdi	0.1299***	0.2923***	0.1630***
	(5.89)	(14.66)	(7.79)
W*Lnupl	-0.0578	0.2315*	0.1662**
	(-1.46)	(1.67)	(2.52)
W*Lnuae	0.1934***	-0.0360	0.1882**
	(4.01)	(-0.21)	(2.12)
W*Lnk	-0.3343***	0.3800	0.5049*
	(-3.10)	(1.14)	(1.87)
W*Lnla	-0.0848	-0.9499***	-0.5324**
	(-0.90)	(-3.02)	(-2.30)
W*Lnmtv	0.1277***	0.7265***	0.1914***

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	(2.82)	(6.89)	(3.50)
W*Lnfdi	-0.1451**	-0.1511	0.1830**
	(-2.47)	(-1.16)	(2.03)
R^2	0.9757	0.9409	0.9618
Log-likelihood	419.0234	105.0501	447.8165
Spatial rho	0.4042***	-0.4942**	-0.5789***
	(4.03)	(-2.38)	(-2.93)
sigma2_e	0.0026***	0.0265***	0.0021***
	(11.57)	(11.53)	(11.52)

It can be seen from the above table that the spatial correlation coefficients of the three fixed effect models are tested by hypothesis at a significance level of 5%, indicating that the model is spatially dependent. In the three fixed effect models of the spatial Dubin model, the goodness of fit R2 from large to small is the spatial fixed effect model, the space-time fixed effect model and the time fixed effect model; from the aspect of explanatory variable significance, the space-time fixed effect model is obviously better than the other two models, followed by the spatial fixed effect model and the time fixed effect model. Combined with the real economic significance, the space-time fixed effect model is more economical. Therefore, considering the goodness of fit, the significance of explanatory variables and the economic significance, the space-time fixed effect model is better.

4.3 Result analysis

The following is an analysis of the test results of the spatial Dubin model of space-time fixed effects. In order to better reflect the impact of university knowledge spillover on economic growth, the total effect is decomposed into direct and indirect effects. The decomposition results are shown in Table 4.5:

Table 4.5: Effect decomposition of university knowledge spillover on China's economic growth

variable	direct effect	indirect effect	total effect
Lnupl	0.0533***	0.0864**	0.1397***
Lnuae	0.0078	0.1177**	0.1255**
Lnk	0.3863***	0.1910	0.5773***
Lnla	0.1445***	-0.3965**	-0.2520*
Lnmtv	0.0322***	0.1096***	0.1418***
Lnfdi	0.1613***	0.0629	0.2242***

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From the test results in the above table, it can be found that in the total effect of the spatial Dubin space-time effect model, the number of university patent grants for the core explanatory variables is significant and the coefficient is positive for the university R&D expenditure, which indicates that the university's knowledge spillovers have contributed to China's economic growth. There is a clear promotion. Other control variables such as the total social capital stock, the number of employed people, the turnover of the technology market, and the coefficient of total foreign direct investment are all significantly under the confidence of 10%, except that the coefficient of variable employment is negative, and the coefficients of other control variables are positive.

(1) The increase in the number of university patent grants will promote China's economic growth. For every additional unit of university patent grants, the local per capita GDP will increase by 0.0533 units. The increase in the number of university patent grants will have a positive effect on the local economy and will also positively affect the neighboring regions. Impact, for every additional unit of university patent grants, the per capita GDP of neighboring regions will increase by 0.0864 units. It can be seen that the number of university patent grants affects the economic growth of neighboring regions is greater than that for local economic growth. influences. The total effect coefficient of university patent grants on economic growth is 0.1397, which is smaller than the influence coefficient of other variables, indicating that the development of university knowledge spillover is not perfect enough to become a key factor affecting economic growth.

(2) The increase in university R&D expenditure will have a positive effect on the per capita GDP of neighboring regions. For each additional unit of research and development funding, the per capita GDP of neighboring regions will increase by 0.1177 units. The impact of increased R&D investment on local economic growth is positive, but not significant. In general, an increase of one unit in university R&D expenditure will increase China’s economy by 0.1255 units. Combined with the impact of university patent grants and university R&D expenditures on economic growth, it can be found that university knowledge spillovers have a significant and significant impact on China's economic growth.

(3) The physical capital stock and foreign direct investment will have a positive impact on local economic growth. The local physical capital stock will increase by one unit, and the local economy will increase by 0.3863 units. For each additional unit of foreign direct investment, the local GDP will increase by 0.1613 units. It can be seen from Table 4.9 that the impact of local physical capital stock and foreign direct investment on economic growth in neighboring regions is not significant, but the total effect of physical capital

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stock and foreign direct investment on China's economic growth is positive and significant. This shows that the increase of physical capital stock and foreign direct investment will promote the development of the local economy and is the driving force for economic development.

(4) The direct and indirect effects of human capital are significant. The direct effect of human capital on economic growth is positive, which means that local human capital will increase by one unit, and the local economy will increase by 0.1445 units; human capital pair The indirect effect of the impact of economic growth is negative, which means that the local human capital will increase by one unit, and the economic development in the adjacent area will decrease by 0.3965 units, indicating that the increase of local human capital will hinder the economic growth of the neighboring areas. The reason is that the national human capital was fixed in the past, and the increase of human capital in a certain region will inevitably lead to the reduction of human capital in other regions, which is not conducive to the economic development of other regions.

5. CONCLUSION

This paper uses the spatial panel data from 2007-2016 in China to study the role of university knowledge spillovers on economic growth. The research finds that: (1) From the perspective of total effect, the spillover of university knowledge in various provinces and cities in China has a significant positive effect on economic growth. The physical capital stock, technology market turnover and foreign direct investment are positive to economic growth. The spillover effect, while human capital has a significant negative spillover effect; (2) From the perspective of direct and indirect effects, the number of university patent grants and technology market turnover will not only affect local economic growth, but also neighboring regions. Economic development has a positive effect; university R&D expenditures will only affect economic growth in neighboring regions, and there is a lag in the impact of university R&D expenditures on economic growth; physical capital and foreign direct investment will only have an effect on economic growth in the region; Human capital has a positive impact on the local economy. Because human capital is limited, the more local human capital for neighboring regions, the more it will hinder the economic development of neighboring regions.

With the rapid development of the era of knowledge economy, countries have increased their investment in scientific research. As an important provider of new knowledge and new technologies in contemporary society, the university has received extensive attention. In the medium and long-term development plan of the country, the Chinese government clearly proposes to build a regional innovation system and give play to the important role of higher

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education institutions, scientific research institutions and high-tech development zones in regional innovation. From the scientific research level, the government should continue to give support to university research funding, improve the research environment, accelerate the birth of new technologies, establish and improve the intellectual property protection system, actively promote patent incentives, and actively cooperate with the government to improve the technology-to-product transformation. In terms of personnel, from the personnel side, we must first cultivate scientific research talents, strive to improve the level of talents in the region, and secondly strengthen cooperation with high-level talents in other regions, share scientific research resources, and strive for a win-win situation.

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