International Journal of Social Science and Economic Research

ISSN: 2455-8834

Volume:03, Issue:11 "November 2018"

ANALYSIS OF THE INFLUENCE OF UNIVERSITY KNOWLEDGE SPILLOVER ON ECONOMIC DEVELOPMENT OF JIANGSU PROVINCE

Gao Li

Nanjing University of Aeronautics and Astronautics, Nanjing 211106, China

ABSTRACT

University knowledge spillover is an important source of technological innovation and also an important factor in promoting economic growth in Jiangsu Province. Through constructing the PLS path analysis model of university knowledge spillover to the economic development of Jiangsu Province, and using the statistical data of Jiangsu province for 2008-2016 years verified the impact path and utility of university knowledge spillover on the industrial economic growth of Jiangsu Province. This research shows that university knowledge spillover has a direct impact on the development of industrial economy in Jiangsu Province. And university R&D investment will promote university knowledge spillovers. Therefore, the university needs to increase the investment of research and development funds and the number of personnel. The university should establish a good knowledge transfer mechanism, so that university knowledge spillover can be converted into commercial applications in a more complete way, thus promoting the economic growth of Jiangsu Province.

Keywords: University Knowledge Spillover, University Research and Development Input, economic development, PLS path analysis

1. INTRODUCTION

With the rapid development of the knowledge economy in the 21st century, international competition has gradually transferred from the traditional political, economic and cultural fields to the field of science and technology. All countries have realized that the important role of science and technology development for the contemporary society has increased. The concept that economic growth is mainly brought by intangible intellectual assets has been widely recognized by people. The report of the Sixteenth National Congress pointed out that the rise of the knowledge economy has brought knowledge up to the basic position of social and economic development. Knowledge has become the most important resource. "Intelligent capital" has become an important capital. And the formation of scientific and technological strength on the

ISSN: 2455-8834

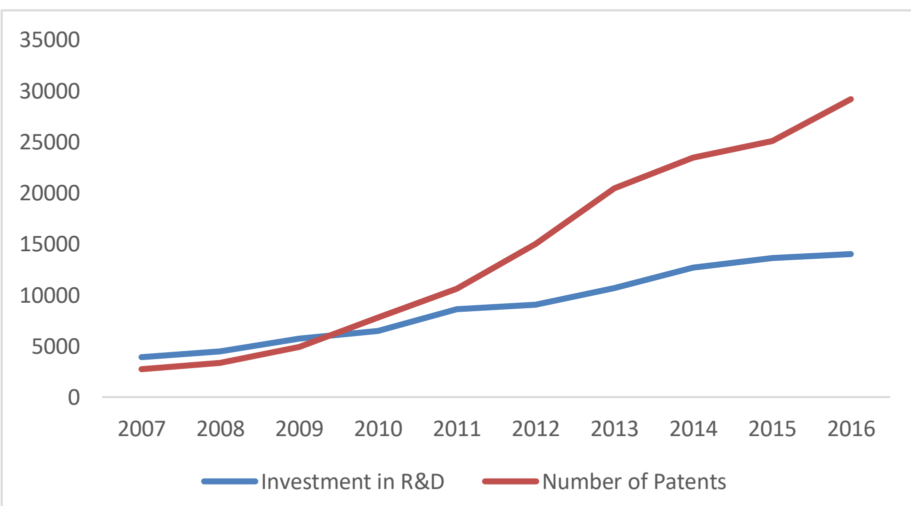
Volume:03, Issue:11 "November 2018"

basis of knowledge has become the most competitive force. As an important provider of intangible assets and intellectual capital in society, universities are the main source of new knowledge and new technologies, and their role is affected by governments, managers, companies, investors and other stakeholders. With the increasingly prominent contribution of universities to economic development, many scholars have increased their research on university knowledge spillovers.

2. LITERATURE REVIEW AND RESEARCH HYPOTHESIS

In the modern economy, the knowledge spillover of university has not yet formed a definite concept. According to the concept of knowledge spillover, university knowledge spillover is a dynamic process. It is a process of the spillover knowledge of universities, the spread and diffusion of knowledge, the digestion and absorption of knowledge and recreating knowledge by companies and other recipients. For the research of knowledge spillover, Wang Li ping (2009) [1] used the knowledge filtering model and the inter provincial panel data in China to study the knowledge transformation ability of the enterprise and the incumbent enterprise. It was found that the entrepreneurial enterprise's ability to filter and transform the new knowledge is superior to the incumbent enterprise. Technological innovation and entrepreneurship are the key elements to promote China's economic growth. The more universities invest in R&D, the more university knowledge spillovers will happen. This paper selects the data of university research and development funding and total number of patents in Jiangsu Province between 2007 -2016 for analysis. From the figure below, it can be seen that the R&D investment of universities in Jiangsu Province are growing constantly, and the number of patents is also rising year by year.

Figure 2.1: R&D investment and Patent number of Jiangsu University



ISSN: 2455-8834

Volume:03, Issue:11 "November 2018"

Hypothesis 1: there is a positive correlation between university R&D investment and university knowledge spillover.

With regard to the relationship between university knowledge spillovers and economic growth, scholars at home and abroad have also conducted more research. Shi Shu de (2009) [2] used a panel data model to verify that knowledge spillovers and entrepreneurial activities have a positive effect on economic growth. Paula (2016) [3] uses the spatial econometric regression framework to identify the contribution of intellectual capital to the difference of total factor productivity in each sub region of Europe. And he also estimated the knowledge spillovers between Western and Eastern Europe. The results show that there is a lower spillover effect from the patent activities. Tomohiko (2016) [4] shows that knowledge spillover is the main source of economic growth by introducing the model of knowledge spillover network, and it is a representative externality in economic phenomena. The model shows that the average degree of long-term growth rate is irrelevant. But it is determined by the most adjacent averages. The productivity level of the company is directly proportional to its development level. The long-term growth rate increases with the increase of network heterogeneity. In order to further understand the impact of university knowledge spillovers on corporate performance, Zhou Mo (2017)[5]selected 65 universities and more than 40,000 companies as research objects and added enterprises and universities to the spatial measurement model. In the spatial relationship matrix, it is found that knowledge spillovers from universities in neighboring companies have a positive impact on the total factor productivity of related companies. But it has no significant effect on the economic profitability of the company.

Hypothesis 2: there is a positive correlation between university knowledge spillover and economic growth in Jiangsu province.

The research on University Knowledge Spillovers and economic growth is the focus and hotspot of many theories such as endogenous economic growth and regional innovation system. However, most of the research on this topic is based on the knowledge production function as a basic theoretical model or framework. This paper mainly analyzes the spillover effect of universities' R&D and innovation input on the regional or enterprise innovation output. Innovation output is measured by indicators such as patents, GDP or productivity. Many scholars have also increased the consideration of spatial distance or time lag to demonstrate the empirical measurement of the relationship between university knowledge spillover and regional development. On the whole, the scholars' researches usually represent university R&D investment in terms of funding and personnel, and then study the relationship between university R&D investment and the regional economy. This paper mainly studies the influence of university R&D investment on university knowledge spillover from the perspective of university

ISSN: 2455-8834

Volume:03, Issue:11 "November 2018"

knowledge spillover and considers the influence of university knowledge spillover on the industrial economy of Jiangsu province. The scholar Li Wen (2016) [6] proposed that there are two types of university knowledge spillover, one is the intraorganizational spillover of university knowledge, that is, the university derivation enterprise is established by the university itself or the innovator of related technology; the other is the transfer of university knowledge to the industry. The university knowledge spillover in this paper is the university knowledge spillover for enterprises, whether it is technology transfer or industry-academia cooperation.

3. RESEARCH METHOD

Partial Least Squares Regression (PLSR) was first proposed by S. Wold (1987) and C. Albano. PLSR combines the characteristics of linear regression analysis, principal component analysis and canonical correlation analysis (partial least squares regression= multiple linear regression analysis + canonical correlation analysis + principal component analysis), which can well carry out multi to multi linear regression modeling. Compared with the traditional multiple linear regression method, PLSR can be modeled in the case of multiple collinear variables. And it is suitable for the problem that the number of variables is larger than the number of samples. Structural Equation Modeling (SEM) is a research method based on statistical analysis technology. The linear equation is used to test the relationship between latent variables and the relationship between observed variables and latent variables. SEM consists of two basic equation models: Construct Model and Measurement Equation. The structural model mainly describes the relationship between latent variables, and the measurement model mainly describes the relationship between latent variables and observed variables. Herman Wold (1979)firstly elaborated the use of PLS method in the path model of latent variables. The structural equation model based on PLS is called the PLS path model.

3.1 Construction of PLS Path Model

There are two types of measurement models, first is the reflection type（Model A）:

$$x_{il} = \lambda_{il}\xi_i + \varepsilon_{il} \qquad (1)$$

Among them, ξ_i is latent variable, ε_{il} is a random error term, λ_{il} is the marginal strength of llatent variable on the L observation variable, that is, the load coefficient. (1) need to satisfy the hypothesis:

$$\mathrm{E}\big((x_{il}|\xi_i)\big) = \lambda_{il}\xi_i \qquad (2)$$

Second is the composition type:

ISSN: 2455-8834

Volume:03, Issue:11 "November 2018"

$$\xi_i = \sum \bar{w}_{il} x_{il} + \delta_i \qquad (3)$$

(3) also need to satisfy the hypothesis:

$$\mathrm{E}(\xi_i | x_{i1}, x_{i2}, \cdots, x_{in}) = \sum_l \bar{w}_{il} x_{il} \qquad (4)$$

The structural model mainly reflects the relationship between latent variables:

$$\xi_i = \sum \beta_{ik} \xi_k + \gamma_i \qquad (5)$$

Among them, β_{ik} is the marginal strength directly affected by$\xi_k$onξ_i, that is, the path coefficient.

3.2 Parameter Estimation of Structure Model in PLS Path Model

The partial least squares regression is used to estimate the parameters of the linear equation of the structural model.

It is assumed that there are m dependent variables $\{y_1, \cdots, y_m\}$and n independent variable $\{x_1, \cdots, x_n\}$, and there are s sample points, thus forming matrix $X = [x_1, \cdots, x_n]_{s\times n}$ and $Y = [y_1, \cdots, y_m]_{s\times m}$. Partial least squares regression needs to extract components t_1 and u_1 in X and Y respectively, of which t_1 is linear combination of $x_1, \cdots, x_n$, u_1 is linear combination of $y_1, \cdots, y_m$, $t_1$and u_1 should carry the variation information in each set as much as possible and the degree of correlation can reach the maximum. After the first component t_1 and u_1 were extracted, the regression of X to t_1 and the regression of Y to t_1 were established respectively. If the regression equation has reached a satisfactory precision, the algorithm is terminated; otherwise, the second round of components will continue to be extracted until a satisfactory precision has been achieved. If the X is finally extracted a components $t_1, \cdots, t_a$, partial least squares regression will be y_k to $t_1, \cdots, t_a$ regression, and then expressed as the regression equation of y_k on the original variable $x_1, \cdots, x_n$,,that is,

$$y_k^* = a_{k1} x_1^* + \cdots + a_{kn} x_n^* + F_{Ak}, \quad k = 1,2, \cdots, m$$

This paper studies the influence of university knowledge spillover between 2008-2016 years on the economic development of Jiangsu province. There are many independent variables and dependent variables, and the number of samples is less than the number of variables, so it is appropriate to use the PLS path model to analyze.

4. VARIABLE SELECTION AND DATA SOURCE

4.1 Variable selection

Exogenous potential variables are mainly knowledge spillover X and university R&D investment U. University knowledge spillover is a dynamic process of knowledge production, knowledge transfer and knowledge absorption. In this paper, university knowledge spillovers are measured mainly through university knowledge production. The corresponding observation variables are the number of papers and monographs, the number of technology transfer contracts and the number of patents. Latent variable of university R&D investment U uses university research and development personnel investment and university research and development funds input two observation variables to manifest.

The endogenous potential variables are Jiangsu's total economic output Q and Jiangsu's economic efficiency Y. Measuring the economic development level of a region is mainly based on the two aspects of the total economic and economic benefits of the region. The economic aggregate index of this article mainly includes the Gross Regional Product, the third industry added value and the new product sales income, and the economic benefit index can be explained by indicators such as disposable income of urban residents and total factor productivity. The observed variables in this paper are shown in the following table:

Table 4.1: Index System of PLS Path Analysis Model

Latent variable	observation variable
	Publication of papers and Monographs X_1
University Knowledge Spillover ***X***	Number of technology transfer contracts X_2
	Patent number X_3
University R&D Investment **U**	University R&D staff U_1
	University R&D funding U_2
	GDP Q_1
Total industrial economy in Jiangsu **Q**	Tertiary industry added value Q_2
	Sales revenue of new products Q_3
The industrial economic benefit of Jiangsu **Y**	Per capita disposable income Y_1
	Total factor productivity Y_2

ISSN: 2455-8834

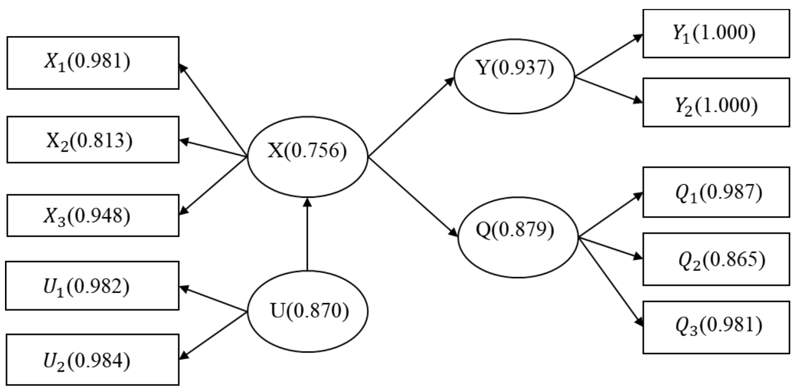
Volume:03, Issue:11 "November 2018"

4.2 data source

The data of this paper mainly come from "Statistical Yearbook of Jiangsu Province 2009-2017" and "Statistical Statistics of China's Colleges and Universities 2009-2016". Some of the data are compiled according to statistical yearbook and data compilation which ensures the reliability of the data. This article uses the relevant data from the period of 2008-2016 in Jiangsu Province to study and standardize the acquired data, so as to eliminate the impact of different units and orders of magnitude on the model.

5. EMPIRICAL AND RESULT ANALYSIS

Using Smart-PLS software, the path coefficient map is obtained, as shown in Figure 5.1.
Figure 5.1 SEM-PLS model diagram of the impact of university knowledge spillovers on Jiangsu's economic development



5.1 Unique dimension test

In this paper, the observed variables in the partial least squares path model are all reflective models, which need to be tested by a single dimension. By examining the Cronbach's α coefficient, Dillon − Goldstein′s ρ coefficient, and the characteristic root of principal component analysis, the results are shown in Table 5.1:

ISSN: 2455-8834
Volume:03, Issue:11 "November 2018"

Table 5.1: Unique dimension test

Latent variable	Cronbach's α	Dillon − Goldstein's ρ	characteristic root 1	characteristic root 2
X	0.904	0.953	2.526	0.423
U	0.966	0.969	1.934	0.066
Q	0.941	0.980	2.687	0.309
Y	0.999	0.999	1.999	0.001

From the above table, we can see that Cronbach's α coefficient value and Dillon-Goldstein's ρ value are all greater than 0.7, which means that the observation variables corresponding to the university knowledge spillover, the university R&D investment, the Jiangsu economic output and the Jiangsu economic benefit can be uniquely measured. The Cronbach′s α coefficient is greater than 0.7, which also indicates that the model has a good level of reliability. The first characteristic value of the observational variable matrix corresponding to the corporate knowledge absorption ability obtained and the economic development level of Jiangsu by principal component analysis is greater than 1, while the other characteristic values are less than 1. It means that the test is passed through the unique dimension. If the other characteristic values are also greater than 1, but far less than the first characteristic value, it can be considered that the observation variable of university knowledge spillover is the only dimension. In summary, the observed variables in the PLS-SEM model all pass the unique dimension test.

5.2 Bootstrap test

The Bootstrap test is mainly based on repeated random sampling of the initial sample with randomized re-sampling. The re-sampled samples of each group are subjected to the same model estimation. Then the t-statistics are constructed using the estimated values of the multiple sets of parameters. The estimated load coefficient and external weight in the PLS-SEM model are tested to see if the relationship between observed variables and the relationship between latent variables is significant. The original hypothesis is that the value of a certain coefficient being tested is equal to 0. If the original hypothesis is rejected, the coefficient is not significantly equal to 0. If the original hypothesis is accepted, the corresponding variable of the coefficient fails the Bootstrap test.

In this paper, Smart-PLS software is used to perform Bootstrap test on load factors and external weights in the above model.

ISSN: 2455-8834

Volume:03, Issue:11 "November 2018"

Table 5.2: Bootstrap Test of Load Factor and External Weights in Measurement Model

Latent variable	Observation variable	t-statistics of Load Factor	t-statistics of External Weights
X	X_1	84.49	11.02
	X_2	3.33	2.86
	X_3	50.60	9.58
Y	U_1	54.78	11.01
	U_2	29.62	12.67
Q	Q_1	217.96	10.71
	Q_2	3.90	3.22
	Q_3	147.53	10.34
Y	Y_1	3755.3	329.79
	Y_2	3690.6	353.5

According to the results of Bootstrap test, the load coefficient T value and the T statistics of the external weight in the model used in this paper are greater than that of t at 95% confidence, 200 degrees of freedom, P (t>1.96) =0.05. This shows that the load factor and the external weight of the measurement equation are tested by Bootstrap.

5.3 Evaluation of the effect of PLS measurement model

5.3.1 Load coefficient of observation variables

In the path model, the measurement model can be evaluated by the load coefficient between the observed variables and the respective latent variables. The evaluation criterion is that the load coefficient is more than 0.7.

ISSN: 2455-8834

Volume:03, Issue:11 "November 2018"

Table 5.3: Load coefficient of observation variables in PLS model

Latent variable	Observation variable	Load coefficient
	X_1	0.981
X	X_2	0.813
	X_3	0.948
Y	U_1	0.982
	U_2	0.984
	Q_1	0.987
Q	Q_2	0.865
	Q_3	0.981
Y	Y_1	0.99
	Y_2	1.000

From the above table, it can be found that the load coefficients between all observed variables and their corresponding latent variables are greater than 0.7, which is higher than the general standard.

5.3.2 Average variance extraction rate

The average variance extraction rate is mainly used to evaluate the discriminant validity of the measurement model. In evaluating the measurement model, on one hand, the average variance extraction rate value is required to be greater than 0.5, which indicates that a latent variable can explain more than the sum of the variance of the measurement variables it reflects. As can be seen from the next table, the average variance extraction rate of the measurement model is greater than 0.5. The latent variable of the university knowledge spillover can reflect the variance of 84% of the three observation variables, and the university R&D investment can reflect the variance of 96.7% of the two observation variables, and the latent variables of the provincial economy can reflect the variance of 89.5% of the three observation variables. The latent variable of provincial economic efficiency can reflect the variance of 99.9% of the two observation variables.

On the other hand, the square root of the average variance extraction rate of latent variable is greater than the correlation coefficient between latent variables. This indicates that the measurement variables corresponding to the latent variables are quite different from those measurement variables corresponding to other latent variables.

ISSN: 2455-8834

Volume:03, Issue:11 "November 2018"

Table 5.4: the average variance extraction rate of the measurement model and the correlation coefficient between latent variables

	X	U	Q	Y	the average variance extraction rate
X	1.000				$\sqrt{0.840}$=0.917
U	0.870	1.000			$\sqrt{0.967}$=0.983
Q	0.938	0.815	1.000		$\sqrt{0.895}$=0.946
Y	0.968	0.842		1.000	$\sqrt{0.999}$=0.999

By comparing the square root of the average variance extraction rate and the correlation coefficient between the latent variables, we can see that the square root of the average variance extraction rate is not completely larger than the correlation coefficient value between the latent variables. Specifically, there is a clear difference between the latent variables of economic benefits of Jiangsu Province and the university's R&D investment and the total economic output of Jiangsu Province, but there is no obvious difference between the knowledge spillovers of universities and the economic variables of Jiangsu Province and the latent variables of economic benefits of Jiangsu Province. The knowledge spillover from universities, the total economic output of Jiangsu Province and the economic benefits of Jiangsu Province are exogenous and endogenous latent variables of the model, which indicates that this model still has good discriminant validity.

5.4 Evaluation of the effect of PLS structure model

The evaluation of structural models is mainly determined by the significance level of path coefficients. The results are shown in table 5.5:

Table 5.5: Bootstrap test of the path coefficient of a structural model

path of Latent variable	T value of Path coefficient	Hypothesis test results
University Knowledge Spillover - The total amount of industrial economy in Jiangsu	62.32	pass
University Knowledge Spillover - The industrial economic benefit of Jiangsu	87.43	pass
University R&D Investment - University Knowledge Spillover	11.63	pass

To sum up, the measurement model can be obtained as follows:

$$\text{University Knowledge Spillover：} = \begin{cases} X_1 = 0.981X \\ X_2 = 0.813X; \\ X_3 = 0.948X \end{cases}$$

ISSN: 2455-8834

Volume:03, Issue:11 "November 2018"

$$\text{University R\&}D\ Investment:\ =\begin{cases}U_1 = 0.982U\\ U_2 = 0.984U\end{cases}$$

$$\text{The total amount of industrial economy in Jiangsu}:\ =\begin{cases}Q_1 = 0.987Q\\ Q_2 = 0.865Q;\\ Q_3 = 0.981Q\end{cases}$$

$$\text{The industrial economic benefit of Jiangsu}:\ =\begin{cases}Y_1 = 0.999Y\\ Y_2 = 1.000Y\end{cases}$$

The relationship between the latent variables and the measured variables: in the model, the number of published papers and monographs has the greatest correlation with university knowledge spillover, while the number of technology transfer contracts has the least correlation with university knowledge spillovers. University R&D funding and personnel investment and university R & D investment are highly correlated, but university R&D funding is slightly higher. For the total economic output of the province, the correlation between the Gross Regional Product and the sales income of new products and the latent variables of the total economic output of the province is higher than the third industrial added value. The correlation between per capita disposable income and total factor productivity is also significant.

The impact of university knowledge spillovers on economic efficiency is slightly greater than the impact on total economic output. The difference between the two is very small. The structural model estimated from the PLS model is as follows:

$$\mathrm{X} = 0.87\mathrm{U};$$
$$\mathrm{Y} = 0.968\mathrm{X};\ \ \mathrm{Q} = 0.938\mathrm{X}$$

After testing, the path coefficients of the latent variables are significantly unequal to zero in the PLS model with a certain probability. This indicates that latent variable of university knowledge spillover has a significant positive effect on the latent variable of industrial economic benefits of Jiangsu Province and the latent variable of Jiangsu's industrial economy.

5.5 Model economic significance

The direct economic effect of university knowledge spillover. With the rapid development of the knowledge-based economy, many countries have stepped up 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 national long-term development plan, the Chinese government clearly proposed to build a regional innovation system and play an important role in regional innovation in Institutions of universities, scientific research institutions, and high-tech development zones. According to the path structure model of this paper, it is found that university knowledge spillover has a direct impact on the economic

ISSN: 2455-8834

Volume:03, Issue:11 "November 2018"

development of Jiangsu Province. The path coefficient is 0.968 and 0.938, which indicates that the university knowledge spillover plays a key role in promoting the economic development of Jiangsu Province, and the direct effect of economic growth is significant. University knowledge spillover is more significant economic benefits. The main reason is that university knowledge spillovers will play a role in promoting technological innovation, and the total factor productivity is closely related to technological progress and technological efficiency. Therefore, the university knowledge spillover in Jiangsu Province promotes technological innovation of local industrial enterprises and then promotes the growth of total factor productivity.

6. CONCLUSION AND PROSPECT

This paper analyzes the impact of university knowledge spillovers on the level of industrial economic development in Jiangsu Province from 2008 to 2016 by constructing a partial least-squares path analysis model of university R&D investment, university knowledge spillover and Jiangsu economic development level. After the analysis of the software SmartPLS3.0, the results show that university R&D investment has a significant role in promoting university knowledge spillover. Therefore, the increase of R&D investment and the number of R&D personnel has a positive effect on increasing university knowledge spillover. In addition, the increase of university knowledge spillovers reflected by the amount of patent authorization, published papers and monographs and the number of technology transfer contracts has an obvious positive effect on the economic development level of Jiangsu province. In the later development process of Jiangsu Province, it is necessary to provide technical and financial support for the research and development of the University to support the university to do a good job in technological innovation. And the university should improve the transformation mechanism from academic knowledge to commercial application, so as to better promote the economic growth of Jiangsu.

This paper expresses university knowledge spillovers based on the number of published papers and books, the number of patents and the number of technology transfer contracts. It uses university R&D funds and the number of R&D personnel to represent university R&D investment. Compared with most of the articles, university knowledge spillovers only use input or results to measure. In this paper, university knowledge spillover is represented by the two aspects of process input and R & D achievement, so it can reflect the impact of university knowledge spillovers on the level of economic development in Jiangsu. This study considers the direct impact of university knowledge spillovers on economic growth. The indirect effects do not take into account. Whether the university knowledge spillover can affect the economic performance of the enterprise and then influence the economic development level of the whole region, which needs to be considered in the later research.

ISSN: 2455-8834

Volume:03, Issue:11 "November 2018"

REFERENCES

[1] Wang L P. (2009) Entrepreneurship, knowledge filtering and regional economic growth, Journal of Industrial Economics Research, (5):60-66.

[2] Shi S D. (2009) The impact of knowledge flow and entrepreneurial activities on economic growth: a perspective of explaining regional economic differences in China, Journal of Science of Science and Management of S.& T., (11):134-140.

[3] Paula Puškárová，Philipp Piribauer. (2016) The impact of knowledge spillovers on total factor productivity revisited: New evidence from selected European capital regions, Economic Systems, (40):335-344.

[4] Tomohiko Konno. (2016) Knowledge spillover processes as complex networks, Physica A, (462):1207-1214.

[5] Zhou M, Zhang Y J, Liu J W, Tang Y F. (2017) Spatial impact of knowledge spillover in colleges and universities on the performance of local industrial enterprises, Studies in Science of Science.

[6] Li W. (2016) Research on the construction of dual entrepreneurship ability driven by university knowledge spillover, Studies in Science of Science, (12):1847-1855.

