Study on the Spatial Effect of Provincial Education Investment based on Spatial Statistics

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***Abstract*—Based on the Spatial Data Analysis, this paper constructs spatial econometric model of the factor influencing the government education investment to do an empirical study to the education investment level of China's 31 provinces. Through the study, it is found that: the education of the local government in a certain space has the spatial dependence and spillover effects between provinces. Differences also exist, and over time, spatial correlation is gradually weakening. This paper analyzes the changing tendency among different province, and put forward some suggestions.**

***Index Terms*—Spatial Statistics Analysis, Government Investment in Education, Spatial Correlation, Spatial Dependence**

I. Introduction

Education investment is the future investment. Domestic and foreign scholars have researched on the impact of education investment to regional economic growth. American economists Walsh calculated the economic benefits of education through the proportion of personal education expenses and personal income [1]. In 2008, a study on 100,000 samples which lasts for 6 years [2], revealed the impact of investment in education and income distribution to a regional economic development: given an unfair level, to increase the unfairness of social investment in education and income distribution will increase the speed of economic development.

In terms of policy research, Roland Benabou takes tax and education policy represents present income and future earnings respectively; and how to balance present income and future earnings to achieve the greatest benefit is very important [3]. On the basis of Lucas, etc, domestic scholar Yu Lingyun analyzed the balance of non-governmental investment in education and government investment in education, pointed out the importance of non-government investment in education for long-term economic growth under certain conditions [4]. Zhai Bo analyzed the equilibrium degree of fundamental education from the aspects of regional, urban and rural areas, schools and groups of educated populations, concluded that China’s basic education, especially the development of compulsory education is going to be equilibrium, from the overall tendency[5].

Summing up the above, many of the countries and regions, including China, existing imbalance problem of education resources distribution, and this kind of imbalance reflected in the properties of different geographical spaces. Whether did China’s education investment have spatial dependency or not, because of its geographical proximity? Whether did education investment have spatial spill over effect or not? This education investment would be placed in a space to be analyzed, considering the influencing modes and effects of adjacent areas and even non-adjacent areas. This paper employs spatial econometrics to make a study of the government’s expenditure on education and the influential factors in 31 provinces and autonomous regions and HK.

II. Methodology

Economic situation of China's provinces and cities have large differences. This article takes governmental education investment in 31 provinces and autonomous regions as the main research objects, regardless of non-government groups and personal education investment, etc, to reveal whether did the difference of regional economy led to the spatial difference of investment in education. On the other hand, the adjacent area, in this paper means two of the provinces or cities have a portion of their boundary in common, whether did the investment in their education have correlativity and the spatial spill over effect?

A. Data

Government expenditure on education, on the one hand, affected by payment capacity; on the other hand, affected by demands of education from the local area. Government financial revenue is the source of local government’s income; is also the source of local government investment in education. Government expenditure on education has strong relations with government finance. To a certain extent, school-aged population reflects the demands for education resources in this area. For example, from the perspective of reality in China, eastern provinces population has large quantity, so demand for education investment is also lager. Meanwhile, none of the district industrial structure is the same; the demand for education is also different. Because any one of the industry's development is inseparable from the talent, relative to the industrial and agricultural, tertiary industry development requires much more high-quality human resources.

The sample employed in this article including 31 provinces and HK region of China, basic data mainly comes from China Statistical Yearbook from 2005 to 2009, empirical research accomplished with the help of soft Arcviews3.3 and Geoda0.9.1

B. Spatial Statistical Methods

Spatial Statistical Methods Considering Space-related in

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Sequence.For a long-term, the mainstream economic theory ignored the spatial impact. Yu-min Wu pointed out the limitation of the hypothesis that space matters unconnected and homogenic, estimation algorithm of OLS which ignore spatial effect. These limitations made deviation problem exists in model specification in practical application, and further lead to all kinds of results and inferences from economic research incomplete, unscientific, lack of explanatory power [6].

Spatial metrology indicates that an economic geography phenomenon or an attribute value on a regional spatial unit is related to the same on the neighborhood; that is dependency relations exist in the spatial. Exist of spatial dependency break most basic assumptions independent of each other in classic statistical and econometric analysis, in other words, data among areas corresponding to time series and space-related. Complex structure problems of spatial interaction and dependence in regression model can be solved by using Spatial Econometrics Model [7].

This paper uses spatial statistical analysis and method of Moran' s I index to test variables (local government investment in education in different provinces) whether there is a spatial autocorrelation; if there is, then build spatial metrological model based on spatial econometrical method to estimate and test influence factors that local government investment in education.

1) Spatial Autocorrelation

Spatial autocorrelation indicators, Moran' s I is the most popular method. Including global I and local I. Computational formula of Global Moran's I [8]:

$$Moran' I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(Y_i - \bar{Y})(Y_j - \bar{Y})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}} \quad (1)$$

In there, $S^2 = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \bar{Y})$; $\bar{Y} = \frac{1}{n}\sum_{i=1}^{n} Y_i$, Y_i means observed value of region I, in this article, it means the amount of educational investment of every local government. N means total number of regions.

2) Determination of Spatial Weight

W_{ij} is spatial contiguity weights matrix of binary; which is the key of spatial econometric model, also is the reflection of spatial influence among regions. This paper employs "geographical" spatial weights matrix (W), and binary weights matrix, follows the regulation of Rook adjacent, that is two areas have conjoint boundary regarded as adjacent. The judging criteria of W_{ij} is:

$$W_{ij} = \begin{cases} 1; & \text{if region i adjacent to region j;} \\ 0; & \text{if not.} \end{cases}$$

3) Calculating Method of Local Moran's I

The expression of local Moran's I is

$$I_i = z_i \sum_j w_{ij} z_j \quad (2)$$

Therein, z_i and z_j are corresponding attribute values, the deviation between x_i , x_j and mean value $\bar{x}$ can be expressed as:

$$z_i = \frac{x_i - \bar{x}}{\delta} \quad (3)$$

Therein, δ is the standard deviation of attribute value x .

The range of index Moran's I from -1 to 1, the more the absolute value I approximation to 1, the stronger dependence of regional economic behaviour is; the more the value I next to 0, the more attribute data do not correlate with each other.

According to the calculation results of Moran's I index, we can use normal distribution hypothesis to test whether there exists spatial autocorrelation among N regions, its Standardized form is:

$$Z(d) = \frac{Moran's\ I - E(I)}{\sqrt{VAR(I)}} \quad (4)$$

According to distribution of spatial data,we can get expectation and variance of Moran's I index:

$$E_n(I) = -\frac{1}{n-1} \quad (5)$$
$$VAR_n(I) = \frac{n^2 w_1 + n w_2 + 3 w_0^2}{w_0^2 (n^2 - 1)} - E_n^2(I)$$

There,

$$w_0 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij},\ w_1 = \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}(w_{ij} + w_{ji})^2,\ w_2 = \sum_{i=1}^{n}(w_{i\cdot} + w_{j\cdot})^2 ,\ w_i, w_j$$

represent sum of rows and columns respectively in spatial weights matrix. Formula (4)and(5)can be used to verify whether there is spatial autocorrelation among n regions. If value Z of normal statistics of Moran's I index greater than marginal value 1.96 at the level of 0.05 of normal distribution function, then the result suggests they are significantly correlated.

III. Empirical Analysis

A. The Spatial of Global Educational Investment Are Positive Related

This paper calculates global and local Moran's I index to test the geographical correlation of government educational investment, in order to judge whether there is spatial interdependence.

TABLE I: GLOBAL MORAN'S I INDEX AND ITS Z -VALUE OF GOVERNMENT EDUCATIONAL INVESTMENT IN CHINA'S 32 PROVINCES

year	Moran's I	Expectation of Moran's I $E(I)$	standard deviation Sd	normal statistic Z	p -value
2005	0.0945	-0.0303	0.1103	2.134545*	0.12
2006	0.0812	-0.0303	0.1058	1.963875*	0.164
2007	0.0732	-0.0303	0.1093	0.946935	0.167
2008	0.0508	-0.0303	0.1118	0.725403	0.207
2009	0.0336	-0.0303	0.1083	0.590028	0.249

*tests through the significant level of 0.05

Each global Moran's I is greater than 0 in the Table I, it explains the Chinese government education investment appearing agglomeration phenomenon between similar values on the whole rather than random state in space distribution, in other words, provinces that have more government education investment near each other. But only 2005 and 2006 passed the tests of significant level of 0.05, it indicates that spatial correlation and spatial dependence of provincial government education investment in 2005 and 2006 is the most significant.

Therefore, overall speaking, spatial clustering phenomenon exists in Chinese government education expenditures. From 2005 to 2009, Moran's I index in every year is greater than o, but sustaining declining, it indicates that spatial dependence of government investment in education become weak among various provinces.

B. *Four Kinds of Spatial Influence Model of Local Education Investment*

In order to further study the local spatial characteristics of Chinese provincial government investment in education, this paper calculates local Moran's index of 2005 which has significant spatial dependency, its scatter diagram see fig. 1.

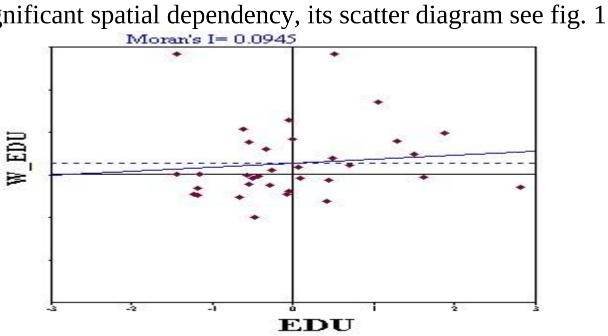

Fig. 1. 2005 Scatter diagram of local Moran's I index of Chinese various provincial government investment in education.

In figure 1, EDU is investment quantity of governmental education; W_EDU is weighted mean of its neighbouring values. It can be observed that most data measured in 32 provinces and regions scattered around four-quadrant, only some extraordinary points near to origin. Government investment in education of every province falls into four-quadrant cluster model.

Quadrant 1, indicates areas that have high government investment in education are surrounded by areas have high government investment in education (HH model), represents positive spatial autocorrelation clusters. Quadrant 2, indicates areas that have low government investment in education are surrounded by areas have high government investment in education (LH model), represents negative spatial autocorrelation clusters. Quadrant 3, indicates areas have low government investment in education are surrounded by areas have low government investment in education (LL model), represents positive spatial autocorrelation clusters. Quadrant 4, indicates areas have high governmental education investment are surrounded by areas have low government investment in education (HL model), represents negative spatial autocorrelation clusters.

Positive spatial autocorrelation in 1st and 2nd quadrant reveals regional collection and similarity, however, negative spatial autocorrelation in 3rd and 4th quadrant reveals regional heterogeneity. If observed values are distributed symmetrically around origin point, it indicates spatial autocorrelation isn't exists among areas, only several particular points exist in fig. 1.

Provinces and cities with four kinds of distribution model see as Table II

TABLE II: PROVINCIAL SPATIAL CORRELATION MODEL OF AGGLOMERATION DEGREE OF GOVERNMENT INVESTMENT IN EDUCATION

	Spatial correlation model	region
1st quadrant	HH(High-high)	Hebe, Shanghai, Jiangsu ,Zhejiang, Shandong, Henan, Hunan, H.K., Anhui
2nd quadrant	LH(Low-high)	Tianjin, Shanxi, Fujian, Jiangxi Guangxi
3rd quadrant	LL(Low-low)	InnerMongolia,Jilin,Heilongjiang,Hainan,Chongqing,Tibet,Gansu,Yunnan,Guizhou,Shanxi,Xinjiang,Qinghai,Ningxia
4th quadrant	HL(High-low)	Beijing, Liaoning, Hubei, Guangdong, Sichuan

From Table II, we can see 9 provinces and cities located in quadrant 1, mainly concentrated in the eastern and Yangtze River delta; indicates that education investment generates positive spatial correlation, and great radiation and spill over effect to neighbouring area. Only 10 provinces located in quadrant 2 and 4, each provincial education investment located in quadrant 1, 3 has partial HH and LL differentiation. These fully show that education investment in each province in China exist dependence and heterogeneity with the geographical distribution.

Take Peking and Shanghai for example, they are all municipalities and their economic level are more or less the same, both of their government's education investment are high. However, this paper measured out Shanghai located in quadrant 1, Peking in quadrant 4 at local Moran's scatter diagram. That is because areas surrounding Peking whose education investment compared with Peking is low, such as Tianjin, Liaoning, reflecting its heterogeneity at geographical distribution. However, Shanghai, areas surrounding it have high investment such as Jiangsu, Zhejiang, Shandong, etc. That is, areas have high government education investment surrounded by other high investment areas, reflecting dependence at geographical distribution of education investment.

IV. Conclusion

Based on techniques of spatial econometrics, we study the spatial effect of our governmental education investment. Constructing spatial econometrics model of local government education investment, empirical analyzing on 31 provinces and H.K. area of China, we can conclude that, on the whole, local government education investment in China exists spatial autocorrelation, spatial dependence with certain intensity and positive spatial spill over effect have formed among provinces, at the same time, spatial differentiation of education investment is exist. However, viewed from local space, there are 4 kinds of spatial influence model: HH, HL, LH, LL, Shanghai and Hong Kong belonged to HH, but Beijing belonged to HL.

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