Spatial Analysis on Regional Convergence at County Level in China

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Abstract. The paper judges China's regional economic growth convergence and analyzes its time-space pattern in 1998-2009 from the county scale with spatial Markov chain statistics method. The research results show that the stability of convergence clubs is featured by belt differentiation, and expressed as being the most stable in the east and the most instable in the middle part; the transition of convergence club is obviously affected by neighborhood environment. In case a region is neighboring to a high-level developed county or city, this region will have a greatly increased probability of growth, and on the contrast, the probability will be decreased; and the convergence clubs in city group areas are stable, while the transition of type is obvious in surrounding areas.

Introduction

Club convergence is one of the important fields in the study of regional economic differences, and has attracted the continuous attention of the academic field since the 1990s[1-3]. By researching the regional economic growth of many countries, the scholar has discovered the phenomenon that multiple convergence clubs are formed from polarization or stratification[4, 5]. Club convergence indicates that the spatial units which are similar in terms of initial conditions and structure characteristics, etc. have the phenomenon of mutual convergence in economic growth, for example, in less developed areas and developed areas, intro-group units have the same economic growth convergence[6]. Regional economic growth convergence includes two dimensions, the time and space[7]. Traditional research methods only pay attention to time process, but neglect the influences of spatial attributes and regional environment on economic growth. Along with the development of endogenous growth theory[8] and spatial economics, the academic circle has gradually emphasized the influences of technology and knowledge diffusion, as well as the spatial spillover effect of regional economic growth. More and more scholars have started to use spatial statistics method to analyze the club convergence of regional economic growth, in order to research the essence of economic growth under spatial background[9-11]. Through spatial analysis on China's regional economic growth convergence based on county scale, this paper aims to research the spatial effect and spatial differentiation characteristics of club convergence phenomenon at a larger scale.

Data and Methods

This paper takes county unit as the basic unit for researching the regional economic growth convergence in China and its spatial pattern, and here, the researched areas exclude Hong Kong Special Administrative Region, Macao Special Administrative Region and Taiwan Province. The administrative divisions are classified and united based on the situation of 2008, and finally, 2,345 basic units are obtained, including county, autonomous county, count-level city, and municipal district. The research index is the per capita GDP data of research units, and this index reflects the economic development level of each county and city. The period of time researched is 12 years from 1998 to 2009. The data are mainly sourced from the China Statistical Yearbook for Regional Economy and China City Statistical Yearbook of each year, the statistical yearbook of each province, the yearbooks of some provinces and prefecture-level cities, as well as the statistical communiqué on national economy and social development of some cities, counties and districts.

The paper refers to the suggestions of Quah, et al. for data processing; and persists with the principle of that the quantity of each type is similar in the initial year for type division[4,12]. Considering the scale of the whole country, the paper adopts equal quantity method to divide the per capita GDP of China's counties and cities into the following 5 types as per the average value of national per capita GDP in the past years: ①Low level: Per capita GDP is lower than 43% of national average value; ② relatively low level: Per capita GDP is 43%~63% of national average value; ③medium level: Per capita GDP is 63%~87% of national average value; ④relatively high level: per capita GDP is 87%~137% of national average value; and ⑤ high level: Per capita is 137% of national average value. This paper also analyzes other situations of type division, and the results obtained are consistent with the research conclusions.

The growth of regional economy is always affected by the economic growth of surrounding areas[13], namely the growth of regional economy is not isolated, but in a neighboring environment with state characteristics. Spatial Markov chain just, by combining with the concept of "spatial lag", makes up the deficiency of neglecting the mutual functions of regional unit spaces of traditional Markov chain method. This method calculates the weighted average attribute value (*spatial lag*) of neighboring units by introducing spatial weight matrix, and thus judges the spatial neighborhood state (*spatial lag conditions*) of regional units. Establishing Markov chain matrix in different spatial lag conditions could effectively analyze the economic development state of regional units under different spatial backgrounds, and has become an effective tool for revealing the form and process of changes in the member composition of convergence clubs[7].

Spatial Markov chain transition probability matrix, taking the spatial lag type (*k types*) of region *i* in year *t* as condition, decomposes traditional Markov chain into *k* transition probability matrixes meeting $k \times k$ conditions. For the matrix of condition *k*, the element $m_{ij}(k)$ indicates the spatial transition probability that a region belonging to type *i* this year is transited into type *j* next year based on that the spatial lag type *k* of the region in year *t* is taken as condition. The spatial lag type of a region is determined according to the spatial lag value of its attribute value. Spatial lag value is the spatial weighted average of the attribute value of areas surrounding the region, and is calculated through the product of regional attribute value and spatial weight matrix. The formula[13] is:

$$Lag = \sum Y_i W_{ij}. \tag{1}$$

Wherein, Y_i indicates the attribute value of a regional unit; W_{ij} indicates the element of line *i* and row *j* of spatial weight matrix *W*, namely the matrix of the neighborhood relationship between the region and surrounding units. The paper adopts public boundary principle to determine the spatial weight matrix, namely spatial units *i* and *j* are neighboring to each other, so W_{ij} is 1, or on the contrary, it is 0. This paper takes some counties and cities as neighboring counties and cities with traffic contact, such as Changhai County of Liaoning, Shengsi County of Zhejiang, Dongshan County of Fujian, etc..

Analysis on the Convergence of China's Regional Economic Differences

The Stability of Convergence Clubs is Featured by Belt Differentiation. In 1998~2009, the development level type transition was the most stable in the east part and the most instable in the middle part. The distribution of the counties and cities with downward transition had strong clustering feature. Among the 701 counties and cities with downward transition, 33.38% were in the east areas, and mostly concentrated in Hebei, Guangdong, Guangxi and Fujian provinces, accounting for 74.9% of the east areas; 42.8% were in the middle areas, and wherein, the counties and cities with downward transition in Anhui, Hubei, Heilongjiang, Hunan, Shanxi, and Jiangxi accounted for 88.67% of the middle areas; and 23.82% were in the west areas, and wherein, 67.1% county-level units with downward transition of the west areas were concentrated in Sichuan, Yunnan and Xinjiang. The counties and cities with upward transition were distributed in a relatively disperse way. Among the 443

counties and cities with upward transition, 21.67% were in the east areas, and mainly distributed in Shandong, Jiangsu, Liaoning and Hebei; 41.31% were in the middle areas, and mainly located in Inner Mongolia, Henan, Shanxi and Jiangxi; and 37.88% were in the west areas, and concentratively distributed in Shaanxi, Tibet and Xinjiang.

Neighborhood Environment Has Obvious Influences on the Transition of Convergence Clubs. The type transition patterns of a region and its neighboring regions are marked in the figure simultaneously (Fig. 1), in order to survey whether spatial correlation exists between the transition of the region to a different convergence club and the economic development level type transition of its surrounding regions. It may be seen from the figure that, in 1998~2009, the counties and cities whose own transition type is the same as that of neighboring areas accounted for 54.16% of the total counties and cities, and wherein, the counties and cities seeing upward transition in their own areas and neighboring areas were mainly distributed in Inner Mongolia, Ningxia, Tibet and Henan, and the counties and cities seeing downward transition in their own areas and neighboring areas were mainly concentrated in Heilongjiang, Hubei, Hunan and Hebei; the counties and cities seeing stability in their own areas and neighboring areas accounted for 32%, and more than 50% therein were high- and low-level units, and wherein, high-level units were mainly distributed in coastal developed areas such as the Yangtze River Delta, the Pearl River Delta, Beijing-Tianjin-Hebei, Liaoning, Shandong, etc., while low-level units were mainly distributed in less developed areas such as Guizhou, Gansu, Yunnan, Tibet, etc.. The abovementioned results show that, the development level type transition of the counties and cities in China is not isolated spatially, but has obvious characteristic of spatial correlation, and the direction of regional type transition is inclined to be accordant with the transition direction of neighboring areas. Such spatial mechanism is also an important reason for promoting the strengthened spatial clustering degree of high-level and low-level counties and cities, and the polarization of regional economic spaces.
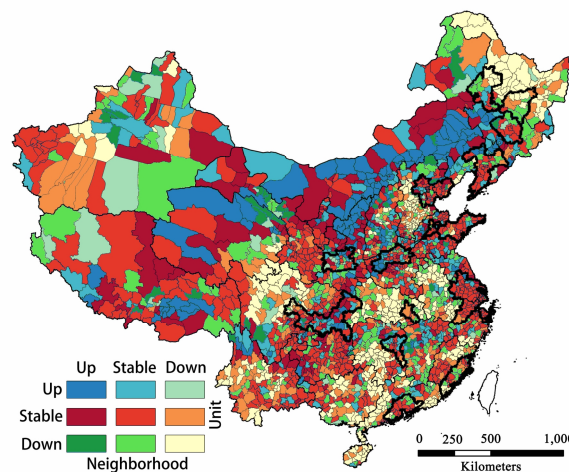

Fig.1 Spatial patterns of per capita GDP class transition of county units and neighbors in China, 1998-2009

Based on Markov chain, neighborhood environment conditions were further introduced to construct spatial Markov chain probability matrix, in order to survey in a quantitative way the influences of a region's neighborhood environment on the probability of the region's transition to a convergence club. It may be discovered from the result that, different neighborhood environments bring about different transition probabilities for a region, that's to say, spatial location has significant influences on a region's convergence club: a higher neighborhood level will be more beneficial for county and city units to transit toward a higher-level convergence club, and a lower neighborhood level will bring about a bigger probability for county and city units to transit to a lower-level convergence club.

As for low-level development areas, in the neighborhood environments of low level, relatively low level, medium level, relatively high level and high level, the probability for them to transit to relatively

low-level convergence club was 0.034, 0.064, 0.114, 0.121 and 0.235 respectively. It indicates that, a higher neighborhood level is more beneficial for low-income areas to realize economic growth and thus to transit towards relatively low-level convergence club. As for relatively low-level development areas, in the 5 levels of neighborhood environment, the probability for them to transit to medium-level convergence club was 0.060, 0.055, 0.079, 0.111 and 0.191 in turn, and the probability for them to transit to low-level convergence club was 0.172, 0.119, 0.072, 0.073 and 0.046 respectively. This shows that, being neighboring to areas of higher economic level will bring about a bigger probability for relatively low-level areas to transit to medium-level convergence club, and on the contrary, being neighboring to areas of lower economic level will bring about a bigger probability for such relatively low-level areas to transit to low-level convergence club. The transition probability of medium-level and relatively high-level counties and cities in neighborhood environments except for relatively low-level neighborhood areas, on the one hand, reflects similar rule, and on the other hand, shows that low-level neighborhood areas have relatively weak influences on medium-level and relatively high-level counties and cities. The transition probability of high-level counties and cities in neighborhood environments does not have regular characteristics. As seen from the spatial distribution of development type of the counties and cities, the counties and cities of high-level type were concentratively distributed in coastal areas, had relatively high stability, and were not easily affected by neighborhood environment and subject to type transition, so their transition probability did not have the law of diminishing.

Convergence Clubs in City Group Areas Present the "Core-Periphery" Pattern. By combining the boundary of city groups and the development level type distribution of counties and cities, we may draw some important conclusions: As seen from the overall distribution of types, the development level type distribution of the counties and cities in China is featured by that, high-level counties and cities are concentrated inside the city group regions, while other types of counties and cities are gradually distributed from high to low level by centre city of city group, peripheral areas of city group, and influenced area of city group, that's to say, obvious "core-periphery" spatial pattern exists between a city group and its surrounding areas.

The city groups in east coastal areas had relatively stable development level type transition, while their surrounding areas saw different transition directions due to different spatial effects. The counties and cities surrounding Yangtze River Delta and Shandong City Group had upward transition due to the influences of trickling-down effect; large-scale areas surrounding Tianjin-Beijing-Tangshan City Group saw downward transition; the centre city of the city group in the southeast of Fujian Province had insufficient driving ability, so the counties and cities at poor location surrounding the city group realized slow growth; the peripheral areas of the Pearl River Delta relatively depended on export-oriented economy, so had the phenomenon of slow growth due to the influences of financial crisis. In the middle regions, the city groups like Wuhan, Changsha-Zhuzhou-Xiangtan, Changchun-Jilin, etc. saw gradual rise of their own development level type, but most areas surrounding them presented the trend of downward transition, reflecting the insufficient driving ability of city groups at a certain degree. In west areas, city groups were not highly developed, had relatively weak connection with surrounding areas, so it's difficult for them to form relatively strong influences. For example, Chengdu-Chongqing and Guanzhong City Group areas saw the co-existence of the development level type stability and rise pattern, while their surrounding areas saw the pattern of multiple transition types.

Conclusions

This paper conducts spatial analysis on the economic convergence clubs of the counties and cities in China in 1998~2009 with spatial Markov chain method. The results show that, China's regional economic growth has obvious club convergence and spatial polarization phenomenon; the transition of convergence club is obviously affected by spatial background, namely neighborhood environment type has the function to promote or restrict the transition of regional development level type; the belts

sequenced from high to low stability of convergence clubs are the east, middle, and west parts in turn; the convergence club is stable in city group areas, and transits obviously in surrounding areas.

Spatial correlation is shown between the economic type transition of China's counties and cities and the type transition of their neighboring areas. Regional economy presents obvious clustering phenomena, and neighborhood environment plays an important role in regional development. Concretely, in case a region is neighboring to counties and cites of relatively high-level development, the region will have a greatly increased probability of growth, and on the contrary, the probability will be decreased. This law of spatial correlation makes the spatial clustering of China's regional economy have relatively high stability and continuity. It shall be pointed out that, the research results of this paper will possibly be inconsistent due to different scales; in addition, the spatial statistical method still depends on administrative boundary at present, along with the promotion of market-oriented mechanism reform, the construction of economic geographical scale will be more inclined to the attention to he flowing space of economic elements, and how to introduce "endogenous boundary" into analysis framework will also be an issue to be further researched and discussed in future.

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