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The Study on Evaluating Urban Development Level and Regional Difference Based on a Competitiveness Model

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Abstract: With the development of economic globalization and regional economic integration, the competition between nations and regions demonstrate the trend that urban agglomerations participate in. Through accelerating the development of urban agglomerations which improve the competitiveness of urban agglomeration, thus boost national or regional economic development. In this study we present a method for evaluating urban agglomeration development level and region difference. The method exploits a competitiveness model of Generalized Principal Component Analysis (GPCA) to analyze the structure of urban agglomeration. The research result shows that the triangular model and evaluation method is effective in computational regional study. Based on the system structure modeling, we can develop a model for the urban competitiveness reorganization to get the core competency of the urban agglomerations.

Key words: Generalized principal component analysis, evaluation model, urban agglomeration

INTRODUCTION

Urban population has increased in the recent times (Raghukanth, 2011). With the development of economic globalization and regional economic integration, the competition between nations and regions demonstrate the trend that urban agglomerations participate in. The knowledge economy and information technology exert an impact on change of urban agglomeration effects in total amount, content and distribution and reforming industrial structure. Through accelerating the development of urban agglomerations which improve the competitiveness of urban agglomeration, thus boost national or regional economic development. Urban agglomeration has gradually become a new spatial organization form of organization of international productivity distribution system and the regional division of labor. The competition between countries will highlight the performance of the city level, the competition between cities also will be replaced by urban agglomerations and urban agglomeration competition will become the main form of market competition. As a result, the development of the urban spatial structure goes to the model what we call annular tree network structure of immense decentralization in urban region. Being a new topic in researches on contemporary regional economy, competitiveness of urban agglomerations puts the research object in specific domain from the perspective of improving competitiveness of urban agglomerations, provides reference for local government to make development policies and economic strategies (Chen and Zheng, 2009). Competitiveness of urban agglomerations is a composite system consisting a great many branch systems on one hand; and on the other, it is a branch of larger system. Competitiveness of urban agglomerations has complicated structure, jointly determining the competiveness and value gains of urban agglomerations.

CONCEPT

In 1957 the city geographer Jean Gotten first proposed the original specific concept of urban agglomeration: megalopolis. Jean Gotten mainly used two indicators to define Megalopolis; the total population size and density. Competitiveness of urban agglomeration refers to comprehensive competitiveness of urban agglomeration made up of key cities. Meanwhile, the competitiveness of component cities in the cluster is major factor to decide competitiveness of the cluster.

The economic level of urban competitiveness comprehensively reflects the urban agglomeration in this region, especially in industrial production capacity, the development level of the service sector etc. The core competitiveness of urban agglomeration is the division of labor and cooperation city better in certain region. The urban agglomerations can be formed a specialized and comprehensive service function area.

The essential characteristics of competitiveness of the urban agglomeration are the function of agglomeration and diffusion. The emphasis is the each city has the ability to attract the agglomeration and diffusion of radiation between urban areas. From the perspective of space, urban agglomeration embodies a kind of radiation ability to attract the stream of people, logistics and information flow(Yu, 2011). Competitiveness of urban agglomeration shares similarities with regional competitiveness, but they are different. The former is superior to the latter, which could be expressed as 1+1+1>3.

There is no unanimous agreement on the definition of competitiveness of urban agglomeration. In this study, competitiveness of urban agglomeration is defined as sum total of forces that realize maximum value of urban agglomeration during urban competition and development by obtaining competitive edge through correlations and interactions of different elements. The definition could be construed in the following ways. Urban agglomeration is an integral system; competitiveness hereof has functions of an integral system and is composite forces of systems. Competitiveness of urban agglomeration derives from competitive advantages and has the features of "factor", "structure" and "ability". Competitiveness of urban agglomeration is both a process and a result itself and more of a process. It is a complex system of dissipative structures, meeting the conditions of openness, non-equilibrium, nonlinearity, fluctuation (Yu and Wang, 2012).

In this research, the triangular model (Fig. 2) of comprehensive competitiveness of urban agglomeration is established based upon studies on elements and integration mechanism of urban agglomeration and with reference to domestic and foreign research results of urban, regional and national competitiveness. Comprehensive competitiveness of urban agglomeration is composite results of structural, functional and performance competitiveness, which could be expressed as comprehensive competitiveness of urban agglomeration = F (structural, functional and performance competitiveness of urban agglomeration).

In the expression here above, the structural, functional and performance level of urban agglomeration represent development, capacity and performance of the urban agglomeration respectively. Performance of urban agglomeration is dependant upon structural and functional level thereof and the functions of the urban agglomeration, in return, is de-pendant of the structure thereof. Structural competitiveness is the fundamental factor of urban agglomeration for which, the structural level is of special importance.

As shown in Fig. 1, comprehensive competitiveness of urban agglomeration is composite results of structural, functional and performance competitiveness.

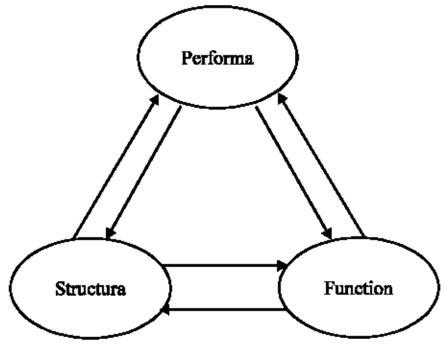

Fig. 1: Triangular model of Comprehensive competitiveness of urban agglomeration

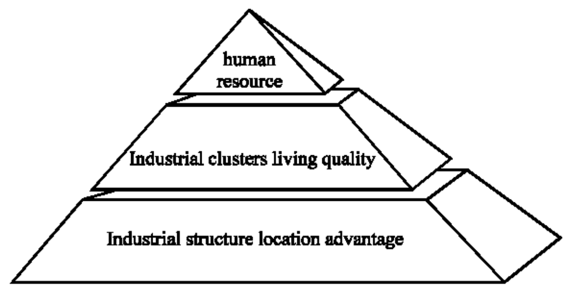

Fig. 2: The composition of the core urban competitiveness

Structural competitiveness of urban agglomeration: Urban agglomeration needs a city having strong attraction capacity as its core, a complete urban stratus system as its basis and sound economic structure as foundation for development. Structural level of urban agglomeration refers to status of structure of the urban agglomeration, which indicates development of the urban agglomeration and aims to measure completeness thereof. All the factors here above serve as sound foundation for comprehensive competitiveness of urban agglomeration.

Functional competitiveness of urban agglomeration: Comprehensive competitiveness of urban agglomeration is based on existing functional level of urban agglomeration; capacity, potential and continuity for attracting, possessing, taking and controlling resources represent comprehensive competitiveness of urban agglomeration by large degree. Functional level of urban agglomeration refers to evaluation of existing development capacity of urban agglomeration, which includes cognition of the foundational and environment capacity of urban agglomeration and cultivation of the innovational capacity thereof. The internal input and consumption capacity are apparently research objects. It could be safely concluded that functional competitiveness is core competitiveness among the three categories.

Performance competitiveness of urban agglomeration: The charm of urban agglomeration resides in its higher performance in comparison with performance of conventional economic models. Market economic principles together sound competitive, cooperative and innovative mechanism that are supported by internal system of urban agglomeration could facilitate development of the urban agglomeration. The performance level of urban agglomeration aims to provide evaluation for efficiency of the performance model of the urban agglomeration. It include economic development level of urban agglomeration, social progress and fortune growth rate hereof.

GENERALIZED PRINCIPAL COMPONENT ANALYSIS

The aim of the GPCA: In this study, we propose an algebra-geometric approach to subspace segmentation called Generalized Principal Component Analysis (GPCA), which is based on fitting, differentiating and dividing polynomials. Unlike prior work, we do not restrict the subspaces to be orthogonal, trivially intersecting, or with known and equal dimensions. Instead, we address the most general case of an arbitrary number of subspaces of unknown and possibly different dimensions and with arbitrary intersections among the subspaces. GPCA is a general method for modeling and segmenting such mixed data using a collection of subspaces(Shen, 2010). GPCA offers a new spectrum of algorithms for data modeling and clustering that are in many aspects more efficient and effective than traditional methods (e.g., Expectation Maximization and K-Means). GPCA can be used in many aspects, such as face recognition (Yang *et al*., 2012), wavelet image (Enesi and Zanaj, 2011), scalable coding method (Liu *et al*., 2007), environmental noise directive(Battaner-Moro *et al*., 2007),etc. So we can estimate urban development level with GPCA.

The aim of the method is both finding common dimensions in K sets of variables and describing each set of variables. GPCA provides components in different sets of variables, which are mutually uncorrelated within these sets.

The GPCA method

The first step: GPCA is the first step of a PCA on the super matrix X. As a matter of fact, PCA finds an auxiliary variable z^1 such that:

$$\sum_{k=1}^{K}\sum_{j=1}^{m_k} R^2(z^1, X_{k,j})$$

is maximized over z^1, under the constraint $Var(z^1) = 1$. Let z^1_k be the projection of z^1 onto W_k; then $R^2(z^1, X_{k,j}) = Cov^2(z^1, X_{k,j}) = Cov^2(z_k^1, X_{k,j})$ because z^1-z^k is orthogonal to $X_{k,j}$. Consequently:

$$R^2(z^1, X_{k,j}) = Var(z_k^1)R^2(z_k^1, X_{k,j})$$

$$Var(z_k^1) = R^2(z^1, z_k^1)$$

And, because Var $(z^1_k) = R^2$ (z^1, z^1_k):

$$\sum_{k=1}^{K}\sum_{j=1}^{m_k} R^2(z^1, X_{k,j}) = \sum_{k=1}^{K}(R^2(z^1, z_k^1\sum_{j=1}^{m_K} R^2(z^1, X_{k,j}))$$

So, PCA can be seen as a method to optimize a compromise between two conflicting objectives:

- Maximizing R^2 (z^1, z^1_k) over z1 for k=1, K, in other words, maximizing correlations between z^1 and its projections onto spaces Wk. The higher the R^2 (z^1, z^1_k) for k = 1, K are, the closer the components z^1_k are to each other; the first objective is finding common variables in the K sets
- Maximizing:

$$\sum_{j=1}^{m_K} R^2(z^1, X_{k,j})$$

for k = 1, 2, ..., K over z^1.

$$\sum_{j=1}^{m_k} R^2(z_k^2, X_{k,j})$$

is the variance of the variables in the *k*th group explained by z^1_k; consequently, the second objective is optimally describing each of the *K* sets of variables

The other steps: In order to provide a decomposition of the variance of the variables in the different sets, GPCA computes an orthogonal basis of each subspace W_k. Consequently, at the second step, the constraints are: for k = 1, ..., K R^2 $(z^1, z^1_k) = 0$, where z^2_k is the second component of the *k*th data set.

In other words, for a particular value, it is a linear combination of variables $X^2_{k,j}$ (for j = 1, 2, ..., m_k), where $X^2_{k,j}$ is the residual of the regression of $X_{k,j}$ on Z^1_k.

Let X^2_k be the data table whose columns are variables $X^2_{k,j}$ (for j = 1, 2, ..., m_k), Wk2 be the subspace of W^2_k spanned by variables $X^2_{k,j}$ (for j = 1, 2, ..., m_k) and X^2 be the super matrix $[X_1^2, X^2_2, ..., X^2_k]$.

Let Z^2 be the second auxiliary of GPCA; Z^2 is the first principal component (PC) issued from a PCA (using a covariance with Z^2. matrix) on the super matrix X^2 and Z^2_k is the variable of W^2_k which has the highest correlation coefficient.

As a matter of fact, PCA on the super matrix X^2 finds an auxiliary variable Z^2 such that:

$$\sum_{k=1}^{K}\sum_{j=1}^{m_k} Cov^2(z^2, X^2_{k,j})$$

is maximized over Z^2 under the constraint $Var(Z^2) = 1$. Then:

$$Cov^2(z^2, X^2_{k,j}) = Cov^2(z_k{}^2, X^2_{k,j})$$

because z^2-z^2_k is orthogonal to $X^2_{k,j}$ $=Cov^2(Z_k{}^2, X_{k,j})$ because $X_{k,j}$-$X^2_{k,j}$ is orthogonal to X^2_k and z^2_k belongs to W^2_k:

$$Var(z_k{}^2)R^2(z^2_k, X_{k,j})$$

$$R^2(z^2, z^2_k)R^2(z^2_k, X_{k,j})$$

and consequently:

$$\sum_{k=1}^{K}\sum_{j=1}^{m_k} Cov^2(z^2, X^2_{k,j}) = \sum_{k=1}^{K}(R^2(z^2, z^2_k)\sum_{j=1}^{m_k} R^2(z^2_k, X_{k,j})$$

So, in the second step, GPCA optimizes a compromise between two conflicting objectives:

- Maximizing R^2 (z^2, z^2_k) over z^2, for k = 1, 2, …, K; the first objective is finding common variables in the K sets, under the constraint that z^2_k must be orthogonal to the first component of the set, z^1_k: the higher the R^2 (z^2, z^2_k) are, the closer the components z^2_k are to each other
- Maximizing:

$$\sum_{j=1}^{m_k} R^2(z^2_k, X_{k,j})$$

for k = 1, K over z^2:

$$\sum_{j=1}^{m_k} R^2(z^2_k, X_{k,j})$$

is the variance of the variables in the kth group explained by z^2_k; the second objective is optimally describing the variance which has not been explained in the first step, under the constraint that z^2_k must be orthogonal to the first component of the set, z^2_k

Let us now consider the rth stage, in order to provide an orthogonal basis of each subspace Wk•zkr, the rth component of the k-set of variables, is orthogonal to previous components of this set. In other words, z^r_k is a linear combination of variables X^r_{kj} (for j = 1,…,mk), where X^r_{kj} is the residual of the regression of $X_{k,j}$ on $[X^r_1,...X^r_k,...X^r_K]$.

Let X^r_k be the data table whose columns are variables (for), be the subspace of spanned by variables X^r_{kj} (for j = 1, 2, …, m_k) and be the super matrix $[X_1{}^r, …, X_k{}^r, …, X^r{}_K]$.

GPCA is the first step of a PCA (using a covariance matrix) of the super matrix Xr and finds an auxiliary variable z^r such that:

$$\sum_{k=1}^{K}\sum_{j=1}^{m_k} Cov^2(z^r, X^r_{k,j})$$

is maximized over z^r, under the constraint Var $(z^r) = 1$. z^r_k is the projection of zr onto W^r_k. And, GPCA optimizes a compromise between two conflicting objectives, finding common dimensions in the K sets of variables and describing each set of variables: the relationship between zr and the kth group of variables is measured by

URBAN COMPETENCE ANALYSIS AND RECOGNITION LEVEL

Urban competitiveness indices: According to the constituent elements of the urban agglomeration core competitiveness of the three-dimensional recognition model, we will carry out the expansion, adding that evaluation indices system of urban agglomeration competitiveness. Urban agglomeration is a complex giant system and the evaluation indices system of must pay close attention to the structure and indices of urban agglomeration , economic structure, expanding progress adjustment, living environment and other aspects. In addition, we consider not only the common international standard, but also the urban development phases and the actual change. So the urban competitiveness elements include a very broad range.

Modeling: The competitiveness of urban agglomerations is a comprehensive definition, involving many aspects of economic, social, environmental and other content. We selected the economic competitiveness, environmental competitiveness, radiation competitiveness and social competitiveness. The evaluation system is consisting of

11 specific evaluation aspects, each of which mainly contains multiple specific evaluation indicators.

Elements of the system vector:

$$S=\begin{bmatrix}\text{Industrial structre}\\ \text{Primate urban function}\\ \text{Traditionat culture}\\ \text{.........................}\\ \text{Infrastructure}\end{bmatrix}=\begin{bmatrix}S_1\\ S_2\\ S_3\\ .....\\ S_{11}\end{bmatrix}$$

Contribution degree is a quantitative factor to determine the elements in the system in which the status of key indicators. Contribution degree indicates that the elements of the system relative to other elements in the control and the status of each pot. We find: the contribution degree of S_4 and S_5 is 4.63 and 4.35. Respectively, it shows these two elements is much greater than a competitive factor in the city system, compared to other elements of a dominant position is the core of the system affect the elements of the operation of the system play a leading role.

Element S_6, S_7, S_9, S_{10} ranked second, these four elements constitute the city competitiveness. Elements of industrial agglomeration and industrial productivity, reflect the urban industrial competitiveness of the state's economic strength tend to promote the rapid development of the urban economy, therefore, industrial development and industrial development around the other elements of the service is also an important city competitiveness elements .

The contribution degree of S_1 and S_2 indicates that primate urban function and industrial competitiveness in the formation of the city has an important role in the foundation. The role of other elements for the system is relatively small. Therefore, the city elements of core competence can be said to have three components: in order to geographical advantages and industrial-based, industry cluster is characterized by technological innovation and human resources, represented by trapezoidal pyramid.

Elements from the above position and degree of analysis that contribute to the industrial competitiveness and the competitiveness of government services determine the 1 system development process and the evolution of the direction.

CONCLUSION

As discussed above, how to study the evolution of urban agglomerations core competitiveness is still a hard problem in the academic researches. Based on the system structure modeling, we can develop a model for the urban competitiveness reorganization. We can get the core competency of the urban agglomerations. In the empirical study, the results also show that GPCA can form an intuitive graphical structure. GPCA is an effective method to analyze the large sample, multi index and time-varying system. It is useful to promote the flow of economic elements, deepen the division and cooperation of the industry among the urban agglomeration and improve the urban hierarchy urban agglomeration to achieve its development.

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