Evaluation Method of Urban Economic Competitiveness and Its Application: a Case Study of Liaoning Province

Qiang Mao

School of Management, Bohai University, Jinzhou 121013, China.

maoqiang_163@163.com

Abstract. Nowadays, globalization is an unavoidable tendency. Urban is taking an important role in the world, and the competition among urban becomes severer. The ability of competing with other cities have drawn more and more attention. Based on a brief description of literature review, a method based on stakeholders' perspective is proposed to solve the competitiveness evaluation problem. First of all, the evaluation problem and fundamental definitions are proposed. In addition, the evaluation index and model are given. Finally, the effectiveness of the proposed method is illustrated by the example as Liaoning province.

Introduction

Under the background of scientific development, the competition between cities no longer just focuses on the speed and the size of economic development. Many evaluation models for urban economic competitiveness have been proposed by scholars. Li et al. (2014) developed an urban competitiveness evaluation index system, and proposed a model to evaluate the competitiveness of the 14 coastal cities based on entropy method [1]. In order to avoid the shortage of single method, Xu et al. (2015) constructed a fussy combination evaluation method to evaluate cities' comprehensive competitiveness in the main areas of Heilongjiang province [2]. Liu et al. (2015) constructed an index system based on development level, economic growth, economic structure and economic efficiency, and proposed a method to evaluate the economic competitiveness of main cities in Huaihe river basin based on analytic hierarchy process and variation coefficient method. Above mentioned methods have each superiority, but evaluated objects' voice is seldom discussed in the existing research, and evaluated objects are an important part of comprehensive evaluation problems. To improve the democracy of an evaluation, many scholars proposed new methods [4, 5]. Yi (2007) proposed a multi-attribute decision-making method indicating self-determination, which is based on weights non-dictatorship and competitive view optimization principle [6]. Dong et al. (2012) regarded every alternative as an intelligent agent with self-determination, and proposed a self-determination method based on the co-opetition perspective [7]. Based on the models above, a method based on stakeholders' perspective is proposed to solve urban economic competitiveness evaluation problem of Liaoning province.

Evaluation Model

The classic bargaining evaluation method is based on a multi-index evaluation system with evaluation object $O = (o_1, o_2,\ldots, o_n)$ and evaluation index $X = (x_1, x_2,\ldots, x_m)$. The index observed value $x_{ij} = x_j (o_i)$ ($i = 1, 2,\ldots, n; j = 1, 2,\ldots, m$) is objective existence, and an $n \times m$ observed value

matrix A can be constructed as $A = [x_{ij}]_{n \times m} = \begin{bmatrix} x_{11} & x_{12} & L & x_{1m} \\ x_{21} & x_{22} & L & x_{2m} \\ M & M & M & M \\ x_{n1} & x_{n2} & L & x_{nm} \end{bmatrix}$. Let y_i be the evaluation value of o_i.

We know that if one row vector is close in value to another one in evaluation matrix A, then the two evaluated objects could have more common interests. Based on this analysis, we define the benefit correlation coefficient with respect to vector proximity.

Definition 1: Let $r_{ii'}$ be the benefit correlation coefficient between evaluated objects o_i and $o_{i'}$, given by

$$r_{ii'} = x_i \cdot x_{i'} / \|x_i\| \cdot \|x_{i'}\|, \quad i, i' = 1, 2, \ldots, n \tag{1}$$

where $x_i = (x_{i1}, x_{i2}, \ldots, x_{im})$ is a row vector of matrix A, and $\|x_i\|$ is the norm of x_i. If the data of matrix A has been normalized, then $r_{ii'} \in [0,1]$. By Definition 1, we know that the bigger $r_{ii'}$ is, the more benefits evaluated objects obtain from cooperation.

Definition 2: Let $c_{ii'}$ be the net benefit coefficient between evaluated object o_i and evaluated object $o_{i'}$, given by

$$c_{ii'} = r_{ii'} - (1 - r_{ii'}) = 2r_{ii'} - 1. \tag{2}$$

The Eq. 2 represents net benefit between evaluated object o_i and evaluated object $o_{i'}$ if they cooperate with each other. Obviously, $c_{ii'} \in [0,1]$. When $c_{ii'} > 0$, cooperation between evaluated object o_i and evaluated object $o_{i'}$ does not more harm than good. When $c_{ii'} = 0$, cooperation brings same pros and cons. When $c_{ii'} < 0$, cooperation does more harm than good, and evaluated object o_i is a competitor for evaluated object $o_{i'}$.

Suppose each evaluated object is an independent agent. In this case, each object would like to highlight its own advantages and maximize its own interests as much as possible. In general, each stakeholder has some similar advantages; thus, when an evaluated object highlights the advantages of stakeholders, it also highlights its own advantages. Hence, we suppose that each evaluation subject not only tries to highlight its own inherent advantages, but also to take advantage of the stakeholders to expand their advantages as much as possible.

According to the assumption that we can obtain calculation model of index bargaining weight by

$$\max \sum_{i'=1}^{n} c_{ii'} \sum_{j=1}^{m} x_{ij} w_j^{(i)} \tag{3}$$

Where $w_j^{(i)}$ is index weight value from the perspective of evaluated object o_i.

Based on the above ideas, the steps of the proposed method are as follows:

Step 1: Get original data of evaluation index $\{x_{ij}\}$, and uniform index type.

Step 2: Adopt Eq. 4 for non-dimension of indicators, given by

$$x_{ij}^* = (x_{ij} - m_j)/(M_j - x_{ij}) \tag{4}$$

Where mj is the minimum value and Mj is the maximum value that xj may be.

Step 3: Calculate benefit correlation coefficient between evaluated objects by Definition 1.

Step 4: Calculate net benefit coefficient between evaluated objects by Definition 2.

Step 5: In accordance with literature [8], the index weight and evaluation value can be obtained.

Application of the Evaluation Model

According to the literature [9], the evaluation indices and evaluation objects can be determined, and the evaluation index value can be obtained by literature [10]. In this case, there are five evaluation

indices: gross regional domestic product (x_1), total income of public Finance & Budgeting (x_2), gross fixed asset formation (x_3), total retail sales of consumer goods (x_4) and incoming overseas capital in place (x_5). The date unit of x_1, x_2, x_3, x_4 are one hundred million yuan, and the date unit of x_5 is one hundred million dollar. There are fourteen cities: Shenyang (o_1), Dalian (o_2), Anshan (o_3), Fushun (o_4), Benxi (o_5), Dandong (o_6), Jinzhou (o_7), Yingkou (o_8), Fuxin (o_9), Liaoyang (o_{10}), Panjin (o_{11}), Tieling (o_{12}), Chaoyang (o_{13}), Huludao (o_{14}). The index data is shown in Table 1.

Table 1　Related economic data of each city in 2014

	x_1	x_2	x_3	x_4	x_5
o_1	7098.71	610.17	6564.06	3570.11	45.21
o_2	7655.58	615.34	6807.63	2828.42	140.05
o_3	2385.90	159.83	1924.67	897.34	15.90
o_4	1276.58	86.53	919.99	580.98	3.57
o_5	1171.25	95.54	885.20	333.83	6.01
o_6	1023.23	90.16	912.60	478.43	7.27
o_7	1364.00	94.32	970.96	555.00	12.55
o_8	1546.08	121.24	1161.26	436.51	14.01
o_9	606.16	50.19	434.07	258.85	2.51
o_{10}	1014.62	78.35	738.31	361.64	6.00
o_{11}	1304.22	112.01	1171.90	320.96	7.49
o_{12}	867.29	65.98	646.26	391.42	5.59
o_{13}	993.52	73.21	840.00	376.06	2.50
o_{14}	721.55	59.85	544.89	403.59	5.58

According to the evaluation model, the comprehensive evaluation result can be obtained, $\mathbf{y}=[y_1, y_2,\ldots,y_n]$=[0.6577, 0.7152, 0.1647, 0.0589, 0.0514, 0.0461, 0.0687, 0.0867, 0.0000045, 0.0367, 0.0693, 0.0248, 0.0368, 0.0137]. The rank of urban economic competitiveness is shown in Table 2.

Table 2　The rank of urban economic competitiveness

coastal counties	rank	coastal counties	rank
o_1	2	o_8	4
o_2	1	o_9	14
o_3	3	o_{10}	11
o_4	7	o_{11}	5
o_5	8	o_{12}	12
o_6	9	o_{13}	10
o_7	6	o_{14}	13

Conclusion

According to the evaluation results, we can find that the economic-development quality of Dalian is better than other cities in Liaoning, Shenyang takes second place, and the other cities still have resistance to enhance economic power, they urgently need operational measures to improve economic competitiveness. The paper introduced the ideas of self-determining evaluation to urban economic competitiveness evaluation problem, this method has the following features.

First, this method respects evaluated objects as principal status in evaluation process, which emphasizes the democracy of the evaluation, and the evaluation results may gain more acceptance.

Second, this method is based on stakeholders' perspective, the computation process is much easier than the method which is based on co-opetition perspective.

Third, this method is much easier for evaluation demanders to find evaluated objects' advantages and disadvantages than traditional methods, and it can help evaluated objects to strive for their best potential.

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