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EVALUATION OF URBANIZATION EFFICIENCY IN SHANDONG PROVINCE

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ABSTRACT

Efficiency evaluation is helpful to find the problem in urbanization construction process and can provide reference to make scientific urbanization development strategy. This article carries on efficiency evaluation of urbanization construction in 31 county-level cities of Shandong Province based on the data envelope analysis (DEA) model. The results indicate that 20 cities are non-DEA effective, among which 7 cities are at the stage of increasing returns to scale and 13 cities are at the stage of decreasing returns to scale. The projection analysis of DEA model indicate that each input and output factor of non-DEA effective city has input redundancy and output insufficiency at different degree, and non-intensive degree of input factors is quite high, which shows that the present urbanization advancement is mainly pushed by extension growth of input factors.

KEYWORDS:

Urbanization, Efficiency, DEA model, Evaluation

1. INTRODUCTION

Urbanization is the process during which non-agricultural production elements migrating or clustering to the cities. It is the inevitable trend of social economy development, and meantime it has huge impetus function to social economy development. Since the reform and open policy, China's urbanization level has enhanced unceasingly. The urbanization rate increased from 17.92% in 1978 to 45.68% in 2008. The average yearly growth rate is 9.3%. The research of Chinese Academy of Social Sciences pointed out that the way of China's economy growth has changed from single engine impetus of industrialization to double engines impetus of industrialization and urbanization. In recent years, local governments have taken urbanization as the important path to develop local economy and are making their best to advance urbanization construction vigorously. However because of the difference of economic basis, resource talent and management ability, urbanization efficiency has obvious difference. Some local urbanization construction still relays on extension growth. Resources pressure on city development becomes heavier and sustainable development ability is facing challenge. This article will use data envelop analysis model to make quantitative analysis about the urbanization construction efficiency in Shandong Province in order to discover the problem during urbanization construction, and help government to make scientific urbanization strategy.

2. PRINCIPLE OF DEA MODEL

DEA model was found in 1978 by famous operation scientists A.Charnes and W.Cooper. It is a kind of system analysis method used to compare the relative efficiency among decision making units (DMU) through establishment linear programming model. Its basic theory is to take each appraised unit as DMU, then make general analysis of input and output factors of each DMU and estimate their weight. According to the weight calculate the efficiency value and determine the production frontier. And then decide each DMU is effective or not based on the distance between DMU and its production frontier. The DMU who is not on the frontier is called non-DEA efficiency. Simultaneously it can use projection method to point out the reason why the DMU is in inefficient state and how to improve.

The reason why this article chooses DEA model is that urbanization efficiency evaluation involves more than one input and output factors, while it is very convenient to deal with multi-input and output situation by DEA model. Also it is not necessary to know the concrete functional relation among the factors, so the evaluation result is quite objective.

The basic principle of DEA model is: Suppose the number of DMU is n. T j-th DMU is represented as DMU_j (j=l,2,…n). The input vector of DMU_j is $X_j=(X_{1j}, X_{2j}…X_{mj})T$, and the output vector is $Y_j= (Y_{1j}, Y_{2j}…Y_{rj})$ T. Here, m is the number of input, r is the number of output. The corresponding weight coefficient is $V=(V_1, V_2…V_{m)}$ and $U=(U_1, U_2…Ur)$ respectively. Also suppose X_{ij} is the i-th input value of the j-th DMU, Y_{kj} is the k-th output value of the j-th DMU. V_i, U_k is the weight coefficient of the i-th and the k-th index respectively. Then the corresponding evaluation efficiency index of the j-th DMU is:

$h_j = \frac{U^T Y_j}{V^T X_j} = \sum_{k=1}^{s} U_k Y_{kj} / \sum_{i=1}^{m} V_i X_{ij}$ ÿ Choosing the suitable weight coefficient V and U to let $h_j \leq 1$. High h_j indicates that DMU can use relative less input to obtain relative more outputs. DEA model has several dozens

methods, CCR BCC model are used generally. CCR model can measure technical efficiency of DMU. Introducing the convexity supposition in the CCR model can obtain BCC model, whose effective frontier is a convex set. it can appraise the pure technical efficiency, which means the efficiency without considering the scale factor and the factor handling ability change. CCR and BCC model are shown as the following:

Take the j_0 decision-making unit efficiency index as a goal, take all policy-making unit efficiency index as the restraint, but structure following CCR model and BCC model:

$$\begin{cases} \min \bar{} - £ (\sum_{i=1}^{m} s_i^- + \sum_{k=1}^{s} s_k^+) \\ st \\ \sum_{j=1}^{n} ª_j X_{ij} + s_i^- = \bar{} X_{ij_0}, i = 1,2,3 \cdots m \\ \sum_{j=1}^{n} ª_j Y_{kj} - s_i^+ = Y_{kj_0}, k = 1,2,3 \cdots s \\ ª_j, s_i^-, s_k^+ \geq 0, \ j = 1,2,3 \cdots n \end{cases} \qquad \begin{cases} \min ¤ - £ (\sum_{i=1}^{m} s_i^- + \sum_{k=1}^{s} s_k^+) \\ st \\ \sum_{j=1}^{n} ª_j X_{ij} + s_i^- = ¤ X_{ij_0}, i = 1,2,3 \cdots m \\ \sum_{j=1}^{n} ª_j Y_{kj} - s_i^+ = Y_{kj_0}, k = 1,2,3 \cdots s \\ \sum_{j=1}^{n} ª_j = 1 \\ ª_j, s_i^-, s_k^+ \geq 0, \ j = 1,2,3 \cdots n \end{cases}$$

（1） (2)

（1）describes CCR model, (2)describes BCC model.

3. POSITIVE ANALYSIS ON URBANIZATION CONSTRUCTION EFFICIENCY IN SHANDONG PROVINCE

3.1 DMU selection

County-level city is the bridge between big city and countryside. It is the important carrier to develop county territory economy. The advancement of county territory urbanization is useful to eradicate the dual structure between city and countryside and realize economic integration development. Therefore this article chooses 31 county-level cities in Shandong Province as DMU.

3.2 Input and output factors selection

DEA is a evaluation model which can deal with multi-input and output factors. The selection of index is very important to evaluation result. This article selects the index according to the following principle: (1) Simplification principle. The selected index must be able to reflect the main input and output in the urbanization construction, but shouldn't be too many, otherwise we can't distinguish the different urbanization efficiency among local cities. Generally speaking, index quantity should not surpass half of the DMU quantity. (2) Uniform principle. The computation caliber, the calculation content, the computing time, the measuring unit and so on for each selected index should maintain consistent. (3) Easy operation principle.The selection index must be able to gain the corresponding data material. In addition, the input and output facors shouldn't have strong linear relations.

Based on above consideration, the input indexes this article selects include: (1) Population urbanization rate, namely the proportion of urban population accounts for the region entire population, which is in the essential resource of input factor in urban economy construction, indicated by X_1; (2) The proportion of urban construction fund accounts for regional GDP, which can refelect government's input in urbanization construction, indicated by X_2; (3) Local financial budget expendenture, which can reflect government aggregate input in urbanization process, indicated by X_3; (4)Total quantity of energy consume, which can reflect the resource input, indicated by X_4. The output indexes this article selects include: (1) Area GDP, which can reflect the economy level of development, indicated by Y_1; (2) Value-added of secondary and tertiary industry, which can reflect the industrial structure, indicated by Y_2; (3) The balance of savings deposits of urban and rural residents, which can reflect the urban inhabitant's living standard, indicated by Y_3. The sample data comes from 2009 "Shandong Province Statistics Yearbook" and "Shandong Province Urbanization Development Report".

3.3 Analysis result

This article chooses CCR and BCC model to survey the technical efficiency and the pure technical efficiency of 31county-level cities, and further calculates scale efficiency. Result as shown in Table 1.

Tab. 1 The DEA evaluation result of urbanization efficiency in 31 county-level cities in Shandong Province

CITY	TE	PTE	SE	RS	CITY	TE	PTE	SE	RS
Zhangqiu	0.687	0.784	0.877	drs	Shouguang	0.677	0.682	0.992	drs
Jiaozhou	1.000	1.000	1.000	-	Anqiu	0.673	0.696	0.967	irs
Jimo	0.864	1.000	0.864	drs	Gaomi	0.598	0.609	0.982	irs
Pingdu	0.920	1.000	0.920	drs	Changyi	1.000	1.000	1.000	-
Jiaonan	0.776	0.782	0.993	drs	Qufu	0.694	0.772	0.898	irs
Laixi	0.937	0.959	0.977	irs	Yanzhou	0.680	0.715	0.951	irs
Tengzhou	0.735	0.950	0.773	drs	Zoucheng	0.809	0.846	0.956	drs
Longkou	1.000	1.000	1.000	-	Xintai	0.669	0.813	0.823	drs
Laiyang	1.000	1.000	1.000	-	Feicheng	0.763	0.793	0.962	drs
Laizhou	1.000	1.000	1.000	-	Wendeng	0.948	0.982	0.965	drs
Laiwu	1.000	1.000	1.000	-	Rongcheng	1.000	1.000	1.000	-
Zhaoyuan	1.000	1.000	1.000	-	Rushan	0.904	0.908	0.996	irs
Qixia	1.000	1.000	1.000	-	Laoling	1.000	1.000	1.000	-
Haiyang	1.000	1.000	1.000	-	Yucheng	0.901	1.000	0.901	irs
Qingzhou	0.659	0.701	0.940	drs	Linqing	0.670	0.809	0.828	drs
Zhucheng	0.645	0.684	0.943	drs					

3.3.1 Technical efficiency analysis

From Table 1, we can see that the technical efficiency value of Jiaozhou, Longkou, Laiyang, Laizhou, Laiwu, Zhaoyuan, Qixia, Haiyang, Rongcheng, Changyi, Laoling is 1, also their slack variable $s^- = 0$, $s^+ = 0$, which indicate these 11 cities are the DEA effective units. Jimo, Yucheng, Rushan, Pingdu, Laixi, Wendeng's technical efficiency value is between 0.864-0.948, which is higher than the average value 0.845, show that their urbanization construction efficiency is higher. Tengzhou, Feicheng, Jiaonan, Zoucheng's technical efficiency value is between 0.735-0.809, which indicate their urbanization construction efficiency is ordinary. Other city's technical efficiency value is somewhat low, which indicate their urbanization construction efficiency is bad.

To the DEA effective cities, we can further analyze their relative efficiency through the reference time. The so-called reference time refers that in the evaluation process, the number of times effective DMUs are taken by non-effective DMU as reference object and improvement goal. The number of times is higher, the stronger the steadiness of DMU relatively effective is. According to the DEAP2.1 output result, the reference times of different cities is as follows:

Tab. 2 The reference times of DEA efficency city

CITY	Jiaozhou	Longkou	Laiyang	Laizhou	Laiwu	Rongcheng
Reference times	7	8	14	5	6	4
CITY	Zhaoyuan	Qixia	Haiyang	Changyi	Laoling	
Reference times	4	3	0	0	1	

Laiyang, Longkou, Jiaozhou's reference times place on top three, therefore the relatively effective stability of these cities is stronger; Haiyang, Changyi, Leling's reference times place on bottom three, which show the relatively effective stability of these cities is weak.

3.3.2 Pure technical efficiency analysis

Table 1 indicates that the PTE of those cities whose TE is effective is also effective. In addition, Jimo, Pingdu, Yucheng's PTE is 1, while their slacks is 0, namely in the current input and output condition, the technical is effective. The reason why their TE is non-DEA is that their scale is not fit.Their scale should be changed to improve allocation efficency.

3.3.3 Return to scale analysis

The fourth column in table 1 indicates that, the 11 cities which are DEA effective are at the stage of constant return to scale, which means the growth rate of output keeps the same speed with that of input. Laixi, Anqiu, Gaomi, Qufu, Yanzhou, Rushan, Yucheng are at the stage of increasing return to scale, which means scale expantion can enhance the urbanization construction efficiency. The other 13 cities are at the stage of decreasing return to scale, which means under the present technical level, the growth rate of output is smaller than that of input. For these cities, it is difficult to enhance urbanization efficiency only by depending on the increase of manpower, fund and resources. Their economic structure and resources allocation way must be adjusted and technical level should be improved.

3.3.4 non-DEA effective projection analysis

Because the projection on production frontier of DMU is effective, input and output combination of non-DEA effective could be adjusted according to projection analysis by DEA model in order to achieve DEA effective. This kind of approach to change non-DEA effective to DEA effective has indicated the improvement direction for the policy-maker.We can calculate the target value of input and output index through CCR model. Then compare the target value and the actual value can get the improvement value.Table 2 is the improvement value calculated by projection analysis.

Tab. 3 Improvement value of input and output index

City	Redundancy of input				Insufficiency of output		
	X_1	X_2	X_3	X_4	Y_1	Y_2	Y_3
Zhangqiu	-10.69	-3.129	-3.865	-265.122	0	6.425	617.328
Jiaozhou	0	0	0	0	0	0	0
Jimo	0	0	0	0	0	0	0
Pingdu	0	0	0	0	0	0	0
Jiaonan	-8.941	-0.144	-5.121	-70.602	0.931	0	10468.18
Laixi	-1.291	-0.014	-0.511	-8.256	0	4.848	5204.684
Tengzhou	-10.853	-0.17	-0.97	-227.116	0	0.588	5659.795
Longkou	0	0	0	0	0	0	0
Laiyang	0	0	0	0	0	0	0
Laizhou	0	0	0	0	0	0	0
Laiwu	0	0	0	0	0	0	0
Zhaoyuan	0	0	0	0	0	0	0
Qixia	0	0	0	0	0	0	0
Haiyang	0	0	0	0	0	0	0
Qingzhou	-17.491	-0.591	-3.519	-125.309	0	0.375	0
Zhucheng	-22.065	-1.143	-6.455	-68.764	0	10.908	8118.634
Shouguang	-15.775	-0.361	-6.676	-242.683	0	21.72	0
Anqiu	-18.197	-0.28	-1.317	-42.434	0.76	0	1907.762
Gaomi	-15.963	-0.493	-4.603	-75.011	0	6.49	2524.893
Changyi	0	0	0	0	0	0	0
Qufu	-7.008	-0.116	-1.867	-88.076	4.277	0	1593.903
Yanzhou	-9.313	-0.234	-4.459	-170.296	0	5.455	2638.72
Zoucheng	-17.08	-0.049	-3.413	-972.655	10.864	0	12067.9
Xintai	-27.487	-0.191	-3.671	-278.962	0	0	4405.527
Feicheng	-10.637	-0.132	-3.187	-307.585	0	0	2728.641
Wendeng	-0.682	-0.579	-0.346	-6.715	0	3.815	0
Rongcheng	0	0	0	0	0	0	0
Rushan	-1.805	-0.385	-1.189	-92.126	0	4.224	6388.789
Laoling	0	0	0	0	0	0	0
Yucheng	0	0	0	0	0	0	0
Linqing	-12.281	-1.81	-0.995	-22.308	8.089	0	0

From X_1 column, we can see the population urbanization rate of all non-DEA effective cities exists redundancy, among which Xintai has the biggest redundant value(27.487%), Zhu Cheng, Anqiu, Qingzhou, Gaomi's redundant value is also quite high (above 15%). This phenomina shows the population urbanization in these cities does not adapt to their economy development, the increase of urban population has not transformed to corresponding productivity. X_2 column demonstrates the redundant situation of the proportion of urban construction fund account for the GDP. Under the present scale, The urban construction fund disbursement in Zhangqiu is too much, expenditures should be cut and fund efficiency should be enhanced. The next is Linqing and Zhucheng. Other cities' urban construction fund disbursement scale also should be reduced suitably. X_3 column reflectes the disparity between fanicial expenditure and the target value. Data shows Zhucheng, Shouguang, Jiaonan, Gaomi, Yanzhou's expenditure redundancy is big, so they should reduce fanicial expenditure scale. X4 column reflects the redundant value of energy input. Zoucheng's redundancy occupies about 3/4 of its energy input. Feicheng, Xintai, Zhangqiu, Shouguang, Tengzhou have big energy conservation space in energy input aspect.

From insufficiency of output data, we can see the cities except Jiaonan, Anqiu, Qufu, Zoucheng, Linqing have achieved their area GDP target value. To the aspect of industry structure, Shouguang, Zhucheng, Zhangqiu, Gaomi, Yanzhou, Rushan and so on still have big promotion space to improve their value-added of the secondary and tertiary. The balance of savings deposits of urban and rural residents is somewhat low in Zoucheng, Jiaonan, Zhucheng, Rushan and should be enhanced to achieve DEA effective; Laixi, Tengzhou, Xintai, Feicheng also should take measure to increase the income of inhabitants.

4. CONCLUSION

DEA analysis indicates that in the urbanization construction process in Shandong Province, there are 11 DEA effective cities, all of which are at the stage of constant return to scale. The other 20 cities are non-DEA effective, among which, Laixi, Anqiu, Gaomi, Qufu, Yanzhou, Rushan, Yucheng are at the stage of increasing return to scale, the others are at the stage of decreasing return to scale. The projection analysis of DEA model indicates that each input and output factor of non-DEA effective city has input redundancy and output insufficiency at different degree, and non-intensive degree of input factors is quite high, which shows that the present urbanization advancement is mainly pushed by extension growth of input factors. Urban population input, financial input, resources input in some cities present strong non-intensive characteristic. Therefore, urbanization construction shouldn't pursue the growth of urban population quantity and financial resource increasement. The growth way should be transformed. The industry layout and structure should be optimized in order to enhance urbanization efficiency.

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