ATLANTIS PRESS
Advances in Social Science, Education and Humanities Research, volume 347
3rd International Conference on Economic Development and Education Management (ICEDEM 2019)

Empirical Research on Urbanization Efficiency of National Central Cities

Zhao Wang
Big Data Research Center
Jianghan University
Wuhan, China

Mengjie Wang
Big Data Research Center
Jianghan University
Wuhan, China

Wenqiang Bao*
YiBen Investment Fund
New York, United States

***Abstract*—From both dynamic and static perspectives, this paper conducts a comprehensive analysis research on the urbanization efficiency of nine Chinese central cities from 2005 to 2017. The dynamic analysis of this research shows that the urbanization efficiency of China's central cities is generally raising its volatility. The invalid change of technology is the main threats to the improvement of urbanization efficiency. The static analysis shows that there are surplus resources allocation in some national central cities. In particular, labor resources are the most over-invested. Therefore, in the process of urbanization, the development of science and technology should be placed in an important position. China should choose the road of high-quality urbanization and intensive development.**

Keywords—urbanization; national central city; (Data Envelopment Analysis) DEA; intensification efficiency

I. INTRODUCTION

Up to July 2019, nine cities−Beijing, Tianjin, Shanghai, Guangzhou, Chongqing, Chengdu, Wuhan, Zhengzhou and Xi'an−were successively rated as China' national central cities. According to statistics, the average urbanization rate of these nine cities is 77.11% which is 1.32 times of the national average rate. The total population of those national central cities accounts for 10.1% of the country. The total GDP of the national central cities is 18.42%, and the per capital GDP of the national central city is 1.89 times of the country GDP. The GDP growth rate of them is 1.26 times of the national average level. The national central cities are large-scale cities that lead the development of the region, rank among the international competition, and represent the national image of China. They are the important strategic platform and strategic fulcrum for national development. Therefore, taking the national central city as the research object, through exploring the urbanization efficiency of the national central city, it is hoped to explore a higher quality, more efficient, fairer and more sustainable development path of urbanization.

II. RESEARCH METHODS

A. DEA model

Data Envelopment Analysis (DEA) is a linear programming model that evaluates the relative effectiveness between departments or units which also called the decision-making unit (DMU), with multiple inputs and multiple outputs (called DEA effective). From the perspective of relative effectiveness, this model evaluates the relative efficiency of each unit and department by studying the input and output indicator data of the production decision-making unit.

B. Malmquist model

The Malmquist model, based on DEA model, can dynamically analyze the urbanization efficiency of national central cities. The non-parametric Malmquist productivity index constructs the optimal production frontier in a non-parametric way. This rate compares the production of each decision-making unit with this optimal frontier, and analyzes the technical and efficiency changes of each DMU.

III. INDICATOR SELECTION

This paper refers to Wang Jiating's (2009) index selection method. We consider urbanization rate and non-agricultural production value as output indicators from the perspective of social and economic benefits of urbanization, respectively. Fiscal expenditure, urban fixed-asset investment, urban employment and built-up area are selected as input indicators, from the perspective of the three major input factors – capital, labor and land [3].

IV. INTERPRETATION

We apply the input indicators and output indicators of the national center cities published by China City Statistical Yearbook - 2018 and each city's statistical yearbooks.

The urbanization rate is calculated using the ratio of the general urban population to the resident population. The urbanization rate = urban permanent population / (urban permanent population + rural resident population); non-

agricultural GDP (non-agricultural value) is the sum of the secondary industry and the third industrial production value, non-agricultural output value = output value of secondary industry + output value of tertiary industry.

V. DYNAMIC ANALYSIS OF URBANIZATION EFFICIENCY

A. *Analysis of Malmquist efficiency index from the perspective of time series*

The Deap 2.1 software is used to analyze the urbanization efficiency of the nine national central cities from 2005 to 2017. The Malmquist index of each city every year and its variation decomposition results are obtained (see Table I).

TABLE I. 2005-2017 AVERAGE MALMQUIST EFFICIENCY INDEX EVERY YEAR AND ITS DECOMPOSITION

Year	effch [a]	techch [b]	pech [c]	sech [d]	tfpch [e]
2005-2006	0.994	1.048	0.976	1.018	1.042
2006-2007	1.048	0.955	1.031	1.017	1.001
2007-2008	0.999	1.034	1.001	0.999	1.033
2008-2009	0.975	1.093	0.972	1.003	1.065
2009-2010	1.013	0.972	1.007	1.006	0.985
2010-2011	1.012	0.985	1.02	0.993	0.997
2011-2012	0.985	1	0.981	1.004	0.985
2012-2013	0.995	0.961	1.016	0.98	0.956
2013-2014	1.032	0.946	1.008	1.024	0.977
2014-2015	1.021	0.995	1.023	0.997	1.016
2015-2016	0.986	1.039	0.985	1.001	1.024
2016-2017	1.028	0.932	1.021	1.007	0.958
Mean	1.007	0.996	1.003	1.004	1.003

a. effch: technical efficiency change (relative to a CRS technology).
b. techch: technological change.
c. pech: pure technical efficiency change (ie., relative to a VRS technology).
d. sech: scale efficiency change.
e. tfpch: total factor productivity (TFP) change.

As can be seen from Table I, the average value of the Malmquist efficiency index for the national central city in 2005-2017 is 1.003. It shows that the urbanization efficiency of the national central cities is increasing at an annual increasing rate of 0.3%, and the urbanization process is developing steadily.

In the years when urbanization efficiency declined, except for 2011-2012, the decline of urbanization efficiency in other years was caused by the decline in technological change.

Based on the above results, the decline in technological change will directly lead to the decline of urbanization efficiency. The improvement of technical efficiency change can make up for the decline of technological change and promote the overall increase of urbanization efficiency.

B. *Analysis of Malmquist efficiency index from the perspective of cities*

Dynamic analysis for the urbanization efficiency of the nine national central cities during 2005-2017 was obtained, and the Malmquist index and the decomposition results were obtained in Table II.

TABLE II. 2005-2017 NATIONAL CENTRAL CITIES AVERAGE MALMQUIST EFFICIENCY INDEX AND ITS DECOMPOSITION

City	effch	techch	pech	sech	tfpch
Beijing	1.022	1.039	1	1.022	1.061
Tianjin	1.009	1.055	1.008	1.001	1.065
Shanghai	1.015	1.05	1	1.015	1.066
Guangzhou	1	0.986	1	1	0.986
Chongqing	1.017	1.027	1.017	1.001	1.045
Chengdu	1.002	1.016	1.005	0.997	1.018
Wuhan	1	0.972	1	1	0.972
Zhengzhou	1	0.938	1	1	0.938
Xi’an	1	0.89	1	1	0.89
Mean	1.007	0.996	1.003	1.004	1.003

From Table II, it can be found that the Malmquist efficiency indices of the five cities of Beijing, Tianjin, Shanghai, Chongqing and Chengdu are all greater than 1, indicating that during these 13 years, the urbanization efficiency of these five cities has been continuously improved. The technical efficiency change, together with technological change, has been improved, accounting for the development of urbanization efficiency.

The Malmquist efficiency index of four cities - Guangzhou, Wuhan, Zhengzhou and Xi’an - is less than 1, indicating that there is an efficiency loss in urbanization during these 13 years. And the main reason for the loss of efficiency is the ineffective changes in technological change.

VI. STATIC ANALYSIS OF URBANIZATION EFFICIENCY

A. *DEA effectiveness analysis*

Using Deap2.1 software, the urbanization efficiency was measured for 2005 and 2017 respectively. The results show that the urbanization efficiency of the national central city in 2005 is relatively low, the urbanization efficiency value is only 0.887. There are only 5 cities with DEA effective. By 2017, the urbanization efficiency has increased significantly. Urbanization efficiency value is 0.961. And the number of cities that have achieved DEA efficiency has risen to 7. The urbanization scale returns of each city are shown in Table III.

TABLE III. EVALUATION OF ECONOMIES OF SCALE OF URBANIZATION EFFICIENCY

Scale	Increase		Invariant		Decrease	
Year	2005	2017	2005	2017	2005	2017
City	-	Chongqing, Chengdu	Guangzhou, Chengdu, Wuhan, Zhengzhou, Xi'an	Beijing, Tianjin, Guangzhou, Wuhan, Zhengzhou, Xi'an, Shanghai	Beijing, Tianjin, Shanghai, Chongqing	-

B. Intensive analysis under input orientation

Applying the projection analysis, the intensive efficiency analysis of cities which do not reach an effective level in 2017 is carried out. Since only Chongqing and Chengdu did not achieve DEA effective in 2017, the following analysis is only conducted for Chongqing and Chengdu. By running the software Deap2.1, the non-intensive values and non-intensity degree of the four input factors in Chongqing and Chengdu are obtained. The results are shown in Table IV.

Non-intensive value = actual input value - target input value.

Non-intensive degree = non-intensive value / actual input value * 100%.

TABLE IV. INPUT FACTOR NON-INTENSIVE DEGREE TABLE

City	Fiscal Expenditure		Urban Fixed Asset Investment		Urban Employment		Built-up Area	
	Non-intensive value	Non-intensive degree	Non-intensive value	Non-intensive degree	Non-intensive value	Non-intensive degree	Non-intensive value	Non-intensive degree
Chongqing	1085.20	25.03	6228.33	35.71	137.95	33.95	226.59	18.68
Chengdu	372.01	12.42	1088.13	11.57	279.11	47.02	93.72	11.57

On the whole, the various factors invested in Chongqing and Chengdu in the process of urbanization are non-intensive. And the factor of the non-intensity of urban employees has reached the highest among all the factors. This result shows that there is extensive growth in urbanization development of those two cities. In other words, it shows that the level of urbanization does not match the input of labor factors well.

VII. CONCLUSION AND SUGGESTION

This paper, using the DEA method, conducts a comprehensive analysis research, from both dynamic and static perspectives, of the urbanization efficiency of nine national central cities in China from the year of 2005 to 2017. The main conclusions are as follows:

Firstly, according to the dynamic analysis of DEA, from the perspective of time series, the urbanization efficiency of national central cities in 2005-2017 is generally raising volatility. The decline in technological change will directly lead to the decline of urbanization efficiency in the short run. The improvement of technical efficiency change can make up for the decline of technological change and promote the overall increase of urbanization efficiency. From the perspective of the national central cities, the improvement of technical efficiency change, together with technological change, have promoted the improvement of urbanization efficiency in most cities. However, there are still a few of cities' urbanization efficiency decreases, caused by the invalid change of technological change. In hence, the ineffective changes in technological change are the main threats to the improvement of urbanization efficiency.

Secondly, according to the static analysis, the national central city has achieved DEA effectiveness in 2017. But there are still non-intensive investment factors in Chongqing and Chengdu, especially labor force factors. Therefore, while attracting a large number of talents, cities should also pay attention to the improvement of urbanization quality and continuously improve the city's carrying capacity.

Based on the above findings, this paper believes that the necessary measures should be taken to improve the current unfavorable situation in the following three aspects.

Firstly, advanced technologies should be vigorously developed. Combined with the specific conditions of different cities, the backward production methods should be eliminated, which can promote the specialized division of labor and supporting cooperation, thereby improving the efficiency of technological change in the process of urbanization and preventing the decline of urbanization efficiency.

Secondly, we should pay attention to improving the urbanization quality, so that there is adequate urban carrying capacity for resources input. The high-quality development of new-type urbanization is to change the mode of urbanization development, taking population urbanization as the core, taking the improvement of city's comprehensive carrying capacity as the support, taking the innovation of system and mechanism as the guarantee, constantly optimizing the urban spatial layout and form. While promoting the urbanization of the rural population, we should also ensure the equalization of basic public services. The quality of urbanization development should be continuously improved to enhance the city' s comprehensive carry capacity.

Finally, the intensive development path should be adhered to. Although extensive urbanization development can improve the level of urbanization in the short term, in the long run, the investment of various factors in China is limited. Extensive development is limited, and taking the intensive road is necessary.

REFERENCES

[1] CHARNES A, COOPER W W, RHODES E. Measuring the efficiency of decision ma king units[J]. European Journal of Operational Research, 1978,2(6):429-444.

[2] BANKER R D,CHARNES A,COOPER W W Some models for estimating technical and scale inefficiencies in data envelopment analysis[J]. Management Science, 1984,30(9):10781092.

[3] Wang Jia-ting, Zhao Liang, The Dynamic Evaluation on the Regional Urbanization Efficiency in China[J]. Soft Science, 2009, vol. 23:92-98.

[4] Tingwei Zhang. Land market forces and government's role in sprawl[J] . Cities. 2000 (2) .

[5] Naghmeh Nazarnia, Christian Schwick, Jochen A.G. Jaeger. Accelerated urban sprawl in Montreal, Quebec City, and Zurich: Investigating the differences using time series 1951‑2011[J]. Ecological Indicators. 2016.

[6] Daniel T. McGrath. More evidence on the spatial scale of cities[J]. Journal of Urban Economics. 2005 (1).