Research on the Efficiency of New Urbanization in 18 Provinces and Cities Along the Belt and Road

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Abstract. Promoting the construction of new urbanization is a strategic choice to expand domestic demand, and it is of great theoretical and practical significance to study the efficiency of new urbanization. In this paper, the input-output index of the new urbanization efficiency is constructed, and the BCC model of DEA is used to study the new urbanization efficiency of 18 provinces and cities along the Belt and Road in 2021. The results show that only five provinces and cities, including Chongqing and Shanghai, have achieved DEA efficiency, while some regions have low efficiency, unreasonable resource allocation and serious waste of resources, which restrict the sustainable development of new urbanization.

Keywords: Efficiency study; New urbanization; DEA model; The Belt and Road

1.Introduction

Urbanization is the inevitable result of the continuous growth of social economy and the rapid development of science and technology. Over the past 40 years of reform and opening-up, China's urbanization process has been accelerating. The urbanization rate has increased from 17.92% in 1978 to 64.72%[1]. However, with the continuous development of urbanization, the problems that hinder urbanization such as excessive consumption of resources and unreasonable allocation of resources have become increasingly apparent and aggravating. In this context, China has put forward the "human-centered" new urbanization, which should pay attention to the development quality and sustainable development of urbanization, in order to create an ecological and livable new urbanization model.

At present, most studies on urbanization efficiency take a province as an example to analyze the differences of urbanization development in different cities, and rarely involve the comparison of new urbanization among different provinces in a specific region. China's the Belt and Road initiative has significantly boosted the economic development of 18 major provinces and cities along its route[2]. Therefore, this paper selects 18 major provinces and cities along the Belt and Road, such as Chongqing, Zhejiang and Heilongjiang, as research subjects to analyze the reasons for their differences in new urbanization efficiency in order to improve the quality of their new urbanization and promote the sustainable development of their economies and the sustainable use of ecological environment.

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2.Evaluation method and selection of new urbanization efficiency index

2.1Research Methods (DEA)

Data Envelopment Analysis (DEA) was first proposed by Charnes, Cooper and Rhodes in 1978[3]and is mainly used to evaluate the validity of decision units. Djordjević, Maitra, and Ghosh[4] used a DEA model to assess the efficiency of ports considering operational, economic and environmental factors. Wu and Lin[5] constructed a model to assess the performance of cultural tourism in Asian destinations using a DEA approach. Xu, Zhang, Cheng, Zhang, and Chen[6] illustrated the application of the DEA model to five years of ecological data in China to provide recommendations for future environmental management.

DEA model includes the CCR model and the BCC model, because the CCR model can only evaluate the technical effectiveness, while the BCC model can evaluate the comprehensive efficiency. Therefore, the input-oriented BCC model is selected to study the efficiency of new urbanization in 18 provinces and cities along the Belt and Road.

Assuming that there are n decision making units DMUs, each with p inputs, denoted as x_i (i=1, 2, …, p) and q outputs, denoted as y_r(r=1, 2, …, q) the evaluation of the k_0 decision making unit is Model (1) as follows:

$$\min \theta, s.t. \begin{Bmatrix} \sum_{k=1}^{n} x_{ik}\lambda_k + s_i^- = \theta x_{ik_0} \\ \sum_{k=1}^{n} y_{rk}\lambda_k - s_r^+ = y_{rk_0} \\ \sum_{k=1}^{n} \lambda_k = 1 \\ \lambda_k \geq 0, s_i^- \geq 0, s_r^+ \geq 0, k = 1, 2, \cdots n \end{Bmatrix} \tag{1}$$

Where λ_k represents the weight vector of the inputs and outputs of each decision unit and θ is the input-output efficiency evaluation value of the k_0 decision unit. The slack variable s^+ represents the number of inputs that have been reduced by the DEA effect and s^- represents the number of outputs that have been increased by the DEA effect.

If θ is equal to 1 and both s^+ and s^- are equal to 0, then the decision unit is DEA valid; if θ is less than 1, then the decision unit is DEA invalid.

2.2Index selection and data sources

At present, many scholars have conducted studies on the evaluation of urbanization efficiency, using the indicator system of multiple inputs and multiple outputs; similarly, the evaluation indicator system of multiple inputs and multiple outputs is still used for the study of the efficiency of new urbanization. According to the definition and connotation of new urbanization, the indicators are based on the existing literatures[7] with more emphasis on the ecological environment aspect.

Input indicators include land, capital, labor, water resource and energy; output indicators are mainly composed of population urbanization, economic urbanization, social urbanization and

ecological urbanization. The data are obtained from the China Statistical Yearbook 2021. Details are shown in **Table 1**:

Table 1. Input-output index system of new urbanization efficiency evaluation

Type of indicator	Selection of indicators	Indicator meaning
Input indicators	Land	Urban built-up area
	Capital	Investment in urban environmental infrastructure
	Labor	Urban employment
	Water Resource	Water consumption
	Energy	Electricity consumption.
Output Indicators	Population urbanization	Proportion of urban population
	Economic urbanization	Per capita disposable income of urban residents
	Social urbanization	Total retail sales of social consumer goods
	Ecological urbanization	Urban green space

3.Analysis of empirical results based on DEA-BCC model

3.1Analysis of empirical results

An input-oriented BCC model was set up to analyze the efficiency of new urbanization in 18 major provinces and cities along the Belt and Road in 2021. The results obtained by running the DEAP software are shown in **Table 2**:

Table 2. Analysis of the efficiency of new urbanization

Regions	Technical efficiency	Pure technical efficiency	Scale efficiency	Returns to scale
Chongqing	1	1	1	Unchanged
Hainan	1	1	1	Unchanged
Jilin	1	1	1	Unchanged
Ningxia	1	1	1	Unchanged
Qinghai	1	1	1	Unchanged
Shanghai	1	1	1	Unchanged
Tibet	1	1	1	Unchanged
Gansu	0.427	0.429	0.995	Increasing
Liaoning	0.869	0.874	0.995	Diminishing
Inner Mongolia	0.528	0.531	0.994	Increasing
Zhejiang	0.975	1	0.975	Diminishing
Guangxi	0.398	0.413	0.964	Increasing
Yunnan	0.601	0.636	0.945	Increasing

Shaanxi	0.674	0.715	0.943	Increasing
Xinjiang	0.522	0.554	0.943	Increasing
Heilongjiang	0.66	0.726	0.909	Diminishing
Fujian	0.878	1	0.878	Diminishing
Guangdong	0.768	1	0.768	Diminishing
average	0.795	0.827	0.962	

Table 2 shows that the scale efficiency, technical efficiency and pure technical efficiency of the 18 provinces and cities along the Belt and Road are 0.962, 0.795 and 0.827. Although overall new urbanization does not reach DEA validity, its overall level of efficiency of new urbanization is good.

In terms of provinces and cities, the new urbanization efficiency of 7 provinces and cities, including Chongqing, Hainan and Jilin, is 1, which is DEA effective, indicating that their input-output ratio has reached the optimum; the new urbanization efficiency of 8 provinces and cities, including Gansu and Liaoning, has not reached DEA effective, indicating that they need to further adjust the quantity of inputs or outputs in the process of new urbanization construction to reach DEA effective; the "pure technical efficiency" of Zhejiang, Fujian and Guangdong provinces is 1, and the "scale efficiency" is less than 1, indicating that their input-output ratio has reached the optimum, and the reason why they are in DEA ineffective is caused by the scale efficiency.

3.2Analysis of the causes of invalid DEA provinces and cities

The redundant slack variables in DEA invalid areas were calculated by the multi-stage method, and the results are shown in **Table 3** and **Table 4** below:

Table 3. Analysis of output deficits in DEA ineffectiveness areas

Insufficient output	Proportion of urban population	Per capita disposable income of urban residents	Total retail sales of social consumer goods	Urban green space
Gansu	0	12465.242	0	6336.603
Guangxi	6.523	21757.044	0	5434.048
Heilongjiang	0	11590.672	0	0
Liaoning	11.508	32338.789	5369.198	0
Inner Mongolia	0	9098.488	1349.972	0
Shaanxi	11.15	14517.743	0	19223.329
Xinjiang	18.038	16953.922	4014.315	0
Yunnan	17.593	24674.621	0	49267.81

Note: For areas not listed, the slack variable is 0 and no improvement is required

As shown in **Table 3**, among the output indicators, firstly, the population urbanization of five provinces, including Guangxi and Liaoning, has not reached DEA validity, and the proportion of urbanized population needs to be increased; secondly, the economic urbanization of eight provinces, including Gansu and Guangxi, has not reached the standard, and the per capita disposable income of urban residents needs to be increased significantly; once again, Liaoning,

Inner Mongolia and Xinjiang also need to be improved in terms of total retail sales of consumer goods; finally, in terms of ecological urbanization, four provinces, including Gansu and Guangxi, need to expand the area of urban green space to achieve effective DEA in ecological urbanization.

Table 4. Input redundancy analysis of DEA ineffective areas

Input redundancy	Urban built-up area	Investment in urban environmental infrastructure	Urban employment	Water consumption	Electricity consumption
Gansu	0	160167.287	133.779	4.799	53.498
Guangxi	0	929522.29	311.356	45.056	58.083
Heilongjiang	346.979	219415.618	118.213	146.953	0
Liaoning	1257.348	0	700.691	22.409	699.541
Inner Mongolia	0	107871.158	0	33.413	1046.085
Shaanxi	0	575445.392	426.617	0	62.712
Xinjiang	41.906	147555.705	0	234.753	465.001
Yunnan	0	114558.874	888.563	28.143	316.246

Note: For areas not listed, the slack variable is 0 and no improvement is required

As shown in **Table 4**, among the input indicators, firstly, in terms of land resources, there is redundancy in land utilization in Heilongjiang, Liaoning and Xinjiang; secondly, in terms of capital investment, except for Liaoning Province, there is a large amount of capital redundancy in the remaining seven provinces and cities; again, Xinjiang has the largest amount of redundancy in water consumption, which is about 48 times that of Gansu province; finally, in terms of energy consumption, except for Heilongjiang Province, the remaining seven provinces and cities have different degrees of redundancy in energy consumption.

In summary, the causes of ineffective DEA of new urbanization in some provinces and cities along the Belt and Road are partly due to the imbalance of input-output ratio and the utilization rate of resources is not maximized; partly because of the unreasonable allocation of resources.

4.Conclusions

This paper constructs a novel new urbanization input-output index system from the aspect of greening, and adopts the input-oriented DEA-BCC model to measure the new urbanization efficiency of 18 major provinces and cities along the Belt and Road, and identifies the regions where the DEA of new urbanization efficiency is invalid. By calculating their slack variables, we analyzed the main reasons for the ineffectiveness of DEA. The aim is to improve the quality of new urbanization in the 18 provinces and cities along the Belt and Road, and to promote the sustainable development of their economies and the sustainable use of ecological environment.

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