Measurement and Dynamic Analysis of the Efficiency of Public Service Expenditure in Heilongjiang Province

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Abstract: Based on the National Standards for Basic Public Services (2023 Edition), this article constructs an efficiency evaluation index system for public education, health, public culture, and social security. The three-stage DEA model is selected to measure the efficiency of basic public services in cities and prefectures inilongjiang Province. The real efficiency of basic public service output after excluding environmental factors and random interference is obtained to help achieve high-quality supply of public services.

Keywords: Basic Public Services; Public Finance; Expenditure Efficiency;Tax Policy

1. Introduction

Basic public services are the basic rights enjoyed by every citizen equally and an important criterion to measure the governance capacity of the government. The report of the20th National Congress of the Communist Party of China proposes to achieve the equalization of basic public services by 2035. The Government Work Report of long jiang Province in 2025 proposes to continuously guarantee and improve people's livelihood, continuously promote high-quality employment, improve the level of social, provide satisfactory education to the people, promote the development of health, and old-age care, and let the people share the achievements of high-quality revitalization development.

2. Efficiency of Initial Public Services - Analysis of the First Stage Traditional Dea Model

2.1 Analysis of the First Stage Efficiency Value

(1)Comprehensive technical efficiency(TE). When the comprehensive technical efficiency is 1, it indicates that the input-output of basic public services in the region is comprehensive and effective; otherwise, indicates that there is input redundancy or output insufficiency.See Table 1:

Table 1. Measurement Results of the Efficiency of Basic Public Service Expenditure in Heilongjiang Province in the First Stage

Region	Region 2022 Efficiency Value				13-Year Average		
	Production overall technical efficiency(TE)	Pure technical efficiency (PTE)	Scale efficiency (SE)	SCALE	Production overall technical efficiency(TE)	Pure technical efficiency (PTE)	Scale efficiency (SE)
Harbin City	0.907	1	0.907	drs	0.881	0.993	0.887
Qiqihar City	0.912	0.912	0.999	drs	0.891	0.898	0.992
Mudanjiang City	0.752	1	0.752	drs	0.805	0.857	0.941
Jiamusi City	0.646	0.653	0.990	drs	0.659	0.670	0.984
Jixi City	0.639	0.643	0.994	drs	0.741	0.749	0.989
Hegang City	0.481	0.499	0.963	drs	0.579	0.590	0.981
Shuangyashan City	0.830	1	0.83	drs	0.687	0.829	0.844
Qitaihe City	0.748	1	0.748	drs	0.807	0.857	0.948
Heihe City	0.447	0.564	0.793	drs	0.584	0.654	0.892
Yichun City	0.936	1	0.936	drs	0.870	0.961	0.907
Daqing City	0.510	0.512	0.995	drs	0.589	0.599	0.982

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Suihua City	0.771	0.776	0.994	irs	0.804	0.808	0.995
Average	0.715	0.797	0.908		0.741	0.789	0.945

In the first stage without considering environmental factors and random noise, it can be found from Table 1 that the average value of comprehensive technical efficiency of output 13 years from 2010 to 2022 in various cities of Heilongjiang Province is 0.741, that there is a large room for improvement in the efficiency of basic public services in Heilongjiang Province.In Harbin, Qiqihar and Yichun, the average value of this index is about 0.88. Without considering other factors, the efficiency of public services in these areas is relatively effective compared to the above regions; while the value of this index in Hegang is the lowest only 0.579, which has a certain gap compared with other cities, indicating that there is still a lot of room for improvement in this city.

(2)Pure technical efficiency(PTE).When the pure technical efficiency is 1, it indicates that the management and technical level of the local government is effective in the investment and output of basic services; otherwise, it indicates that there are problems in the government's management capacity and technical level.It can be seen from Table 1 that the average value from 2010 to 2022 is 0.79, but the average value of Harbin City, Mudanjiang City, Shuangyashan City, Qitaihe City and Yich City in 2022 is 1, reaching DEA efficiency. Compared with Hegang, Heihe and Daqing, it shows that the government management level is relatively good, and the gap is about 0.5, which also shows that there is a big difference in pure technical efficiency of basic public among different cities, and the management level and technical ability of local governments are uneven, so it is necessary to continuously improve the management level and technological innovation.

(3)Scale efficiency(SE).When the scale efficiency is 1, it indicates that the overall basic public services of the region are scale efficient; otherwise, it indicates that there are such as excessive scale or unreasonable scale construction.From the value of the mean over the 13 years, the overall level of scale efficiency is high, reaching 0.945, the scale of public services is relatively reasonable.Among them, the lowest average scale efficiency is 0.844 in Shuang Yashan City, indicating that implementing the optimal for regions with low scale efficiency is an important way to improve the scale efficiency and comprehensive technical efficiency of the region.

2.2 Scale of Returns Analysis

Scale economies reflect the output changes brought about by the changes in the scale of basic public service input in each city of Heilongjiang Province, specifically three cases: increasing returns to scale (irs), decreasing returns to scale (drs), and constant returns to scale (-).It can be seen from Table 1 that the scale of basic public services in Heilongjiang Province in 2022 basically shows a stage, and the pure technical efficiency and scale efficiency in these areas have not reached the optimal level, indicating that the scale factor allocation is not reasonable and cannot bring an proportion of public service output.

2.3 Overall Efficiency Trend Analysis

The results of the mean value calculation of the basic public service expenditure efficiency of various cities and prefectures in Heilongjiang Province show that overall level of basic public service expenditure efficiency in Heilongjiang Province is not high. Among them, the comprehensive technical efficiency in 2015 dropped to 0.6; the scale efficiency of the whole province was higher than the pure technical efficiency in 13 years, indicating that the inefficiency of basic public efficiency did not reach DEA mainly due to the low pure technical efficiency.

3. Deducting Environmental Factors and Random Noise-Second-Stage Sfa Regression Analysis

3.1 Selection and Explanation of Environmental Factor Indicators

Since the efficiency of public service expenditure is affected by different factors, in the second stage, the interference of environmental factors is excluded to obtain the real efficiency of each city, and the above factors are used as environmental variables by referring to the methods of relevant scholars.Such as population density (PD) = total population of the area/administrative area land area index (Xiong Xing [1], 2020),

per-capita GDP (Per-GDP) = gross domestic product of the area/total population of the area (Fan Fzhi [2], 2020; Wang Dong [3], 2022); government size (GS) = local expenditure/gross domestic product of the area (fiscal autonomy (FA) = local fiscal revenue/local fiscal expenditure (Luo Meijuan [4], 2024).

3.2 Analysis of Empirical Results of Sfa Regression

The first stage of the traditional DEA model analysis results obtained four basic public service input indicators of the relaxation variable, which is called input redundancy, its essence is the gap between the actual input and the optimal target input on the production efficiency frontier, which can reflect the shortage and waste of the basic public service input the municipal governments in Heilongjiang Province.Fried (2002) posited that managerial inefficiency, environmental factors, and statistical noise will affect input slack variables.Therefore, the Frontier 4.1 software is used to eliminate environmental factors and statistical noise, and the SFA regression is constructed. The four public service input relaxation variables in the first stage of Heilongjiang Province are selected as the explained variables, and the four environmental factors such as population density, per GDP, government size and financial autonomy are selected as the explanatory variables. The model is constructed as follows:

$$S_{nj}=\beta_0^n+\beta_1^n z_{1j}+\beta_2^n z_{2j}+\beta_3^n z_{3j}+\beta_4^n z_{4j}+p_{nj}+\mu_{nj}$$

$j=1，2，...；n=1，2，3，4$

In the formula,S_{nj}j represents the slack variable of the nth basic public service input in the jth region,$z_j$represent population density, GDP per capita, government size, and fiscal autonomy, respectively, as the four contextual variables，β_0^n is the estimated coefficient of the environmental variable, β_0^n for the constant term,The other parameters are defined as before. The SFA regression results are shown in 2:

Table 2. Second-Stage SFA Regression Results

Indicator	Per capita expenditure on education as a slack variable for input	Per capita expenditure on public culture as a slack variable for input	Per capita expenditure on social security and employment as a slack variable for input	Per capita expenditure on health and medicine as a slack variable for input
Constant term	0.000*	0.047*	-0.026*	0.006*
	(0.003)	(1.164)	(-0.298)	(0.056)
Population density	-0.000**	-0.001*	-0.001*	-0.000*
	(-2.400)	(-1.286)	(-0.365)	(-1.163)
GDP per capita	0.019***	0.002*	0.035***	0. 267***
	(2.602)	(0.139)	(4.185)	(3. 120)
Government size	-0.115*	-0.080***	0. 077*	-0.022*
	(-0.953)	(-2.570)	(0.552)	(-0.082)
Fiscal autonomy	-0.001*	0.013*	-0.357**	-0.383**
	(-0.009)	(-0.791)	(-1.848)	(-1.451)
σ2	0.108***	0. 173***	0. 112***	0.158***
γ	0.991***	0.999***	0.973***	0.995***
LR test	19.628***	83.490***	27.278***	38.701***

Note: t values in parentheses, “***、**、 *” denote the significant level of 1%、 5%、10%.

From the regression results of the SFA model, the model setting form was tested and it was found that all the LR tests of the input relaxation variables significant at the 1% level, thus the SFA model setting was effective.

4. Conclusion

The above analysis shows that after excluding the interference of environmental factors and random noise, the change of scale efficiency in various cities is relatively obvious, and of the scale efficiency conditions have changed from decreasing in the first stage to increasing, which indicates that the scale benefit of overall basic public services in Heilongjiang Province relatively good, and the basic public service system shows a good growth trend. However,

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it also reflects that there is a problem of obvious supply shortage in the basic public of Heilongjiang Province.

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