

# Research on the performance evaluation method of the theil index in supplying equilibrium of basic public service

JIANGUO ZHAO<sup>1</sup>, ZANGYI LIAO<sup>3,4</sup>

**Abstract.** Objective: To measure the problem for the non-equalization of basic public service supply. Methods: We constructed the performance evaluation index systems, and used the Theil index to evaluate the performance of basic public service supply in China's provinces. Results: This paper takes these aspects as the first index, such as the infrastructure construction, basic education services, public employment services, public health service and social security service. At the same time, it cooperates with 16 indexes as the second index to construct the performance evaluation systems, and then use the Theil Index to evaluate the performance in China's provinces that using the panel data from the year 2000 to 2012. Conclusion: The non-equalization of basic public service supply among the provinces in China is serious. There are significant differences in the status quo and trends of non-equalization among the different basic public service supply projects. Either the difference of economic development and fiscal capacity beyond provinces or the ruling idea is the inherent causes of non-equalization of supply.

**Key words.** Basic public services, equalization of supply, theil index, performance evaluation

## 1. Introduction

Recently, the equalization of basic public services has become an important strategic goal of the national macroeconomic regulation. The eighteen major report clearly

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<sup>2</sup>Workshop 1 - School of Public Administration, Dongbei University of Finance and Economics, China, 116025

<sup>3</sup>Workshop 2 - Institute for Hospital Management, Tsinghua University, China, 518055

<sup>4</sup>Corresponding author: Zangyi Liao; e-mail: [liaozyangyi@163.com](mailto:liaozyangyi@163.com)

pointed out that the equalization of basic public services will become the primary goal that people's life get the overall improvement [1]. In 2012, the State Council promulgated the "National Basic Public Service System in 12th Five-Year Plan". This plan defined the government's fiscal responsibility of basic public service supply, and put forward to eliminate the difference of basic public service supply among the provinces [2]. Therefore, the spatial allocation of basic public services, should give full consideration to the efficiency and justice problems, coordinating quality and level of basic public service among the different provinces, and ensuring the equalization of basic public services in space allocation. But it is undeniable that there are still some problems such as imbalance in the structure of supply among the provinces in the field of education, employment, medical care, health and other public services in China at present, which leads to unfair treatment situation in the construction of basic public service [3]. Therefore, determining scientifically the supply of basic public service and analyzing its spatial pattern the spatial variation mechanism, which can provide scientific and necessary decision for China to formulate and implement the policy on regional equalization of basic public services.

For the problems about regional equalization of basic public services supply, many scholars have conducted beneficial exploration. Grand [4] and World Bank [5] pointed out the regional non-equalization of basic public services is the universal problem. Because of development and income gap in urban and rural areas, regions, groups and personal aspects at the present stage in China, Liu S.X. [6] said that it was mainly caused by the system reason, which was unable to eliminate to rely on a single region, groups and individuals. Li Z.H. and Ren Z.Z. [7] pointed that the western region between urban and rural areas and among different regions are all in the state of imbalance in education, health, social security and cultural infrastructure, human resources, and technical conditions and financial investment at present. Pan X.G. [8] thought that the problem about the non-equalization of basic public service supply was mainly originated from local government insufficient supply capacity, the single supply object, the lack of unified clear supply standards. Xiang J.Q. [9] gives a general induction to the reason of non-equalization of basic public services among regions in China: the unequal possession of resources; the service consumption inequality; the dualization and legal rights imbalanced in service system. Yu J.X. [10], Tian F. and Zhou C.Y. [11], Li A.M. [12], Tian Y.P. [13] respectively makes deep researches on the problem of non-equalization of basic public services among regions from the regional, provincial, urban and rural perspectives.

How to measure the non-equalization of basic public service supply, Powell & Boyne [14] argued that it was about equal that the ratio of the expenditure of public services and local demand were equal in different areas. Warner Mildred & Hefetz Amir [15] thought that the per capita indicators, such as per capita public service quantity, per capita local expenditure and per capita budget allocation were not appropriate but it was worth using to measure space equal or area justice. Combined with the per capita tax contribution index, Boyle & Jacobs [16] measured the equalization of public service distribution from tax contribution in different regions. Zang N.K. [17] analyzed the equalization of basic public service from the aspects of the government performance obstacle. He thought that it was the cause of equal-

ization process of appraisal obstacle that fair value lost, the frame system of general index failed to meet the requirements of basic public service, and a single governance structure was formed. However, the key to eliminate obstacle is to clarify the value of equalization performance evaluation, construct the index system, and promote the diversification of main performance evaluation. Moreover, Zhang F. [18] analyzed on the selection of the measurable indicators of basic public services equalization. Yu J. [19] constructed a supply and demand analysis framework of equalization evaluation. Xie F. and Xiao Y.C. [20] measured basic public service from the perspective of the fiscal decentralization. Song J. [21] carried on the empirical analysis on the supply equalization of basic public service on the local government.

In conclusion, from the existing research, the equalization of basic public service supply has become the key point of scholars at home and abroad. The problem on inter regional non-equalization of basic public service supply is prevalent in both at home and abroad. "The equalization", as a principle and value orientation, has been recognized by many experts and scholars and has become a goal of the governments' policy. The problem of non-equalization supply of inter-provincial basic public services in China is very prominent. But the existing research on the ideas behind the phenomena of non-equalization and empirical analysis on the non-equalization of difference measure is still not fully and deeply. Furthermore, the existing research results on the spatial scale and scope of provincial differences in basic public services also has limitations. The selection of evaluation index is not reasonable and the calculation method also exists problems and is not standard. Based on these, this paper will try to construct an evaluation index system of the equalization of basic public service supply. By using the Theil index to measure the quality and level of inter-provincial supply of basic public services in China, we explore spatial difference characteristics in the supply of basic public services in space, analyze internal mechanism, and put forward the improvement suggestions on the problem of inter-provincial basic public services supply non-equalization in order to provide useful reference for decision-making of relevant department.

## **2. Index system, evaluation methods and data description**

### ***2.1. The content of equalization of basic public services and the structure of index evaluation system***

Researching equalization performance of basic public services supply, defining and understanding "public services", "basic public services" and "equalization" are the logical starting point for the research. In this regard, domestic scholars have conducted many researches according to the Chinese situation, but they do not get consensus about these concepts currently, even exists big divergence [22]. The scope of equalization of basic public services should not be too much broad or constrictive, but should maintain the principle of proportionality, so it should include the most basic livelihood-class public services, such as, infrastructure, basic education, public employment services, public health services and social security services, When evaluate the regional equalization performance of basic public services supply, we

believe that it should be measured by the perspective on equalization of supply. In general, the so-called equalization is a reflection of the fairness, which means the non-discriminatory basic public services for different provinces. Thus, this paper evaluates the equalization of basic public services supply from the level of investment performance.

Based on the previous researches, the paper designs Indicator system, like Table 1 that contains 5 primary indicators and 16 secondary indicators that can measure and evaluate the basic public services supplies situation of Chinese provinces' equalization, according to the connotation of basic public services, systematisms, integrity, selection of cross data, statistics data availability, and index system reliability into account.

## 2.2. Measurement methods-Theil index

Theil index is an analysis method that commonly measures the income disparities of inter-individual or inter-regional, or that the degree of inequality analysis method. Because evaluating the regional equalization of basic public services supplies contains with no significant values, but equally regard basic public service provision levels of regions or provinces as a unified index [23]. So, this paper gives the same weight to the different provinces, choosing Theil index to evaluate the regional equalization of basic public services supplies levels.

Theil index is derived from the entropy concept in information theory. Entropy is known as the average information rate in information theory, assume that a particular event  $E$  will occur with a certain probability  $P$ , and receive a confirmation message to confirm the occurrence of the event  $E$ . So, this message can be expressed as the amount of information contained in formula:

$$H(p) = \ln\left(\frac{1}{p}\right) \quad (1)$$

Suppose that a complete event group is constituted by the probability  $p_1$  to  $p_n$ , and then:

$$\sum_{i=1}^n p_i = 1 \quad (2)$$

The entropy or the expected amount of information is equal to the amount of information of each event multiplied by the product of the corresponding probability. Formula is as follows:

$$Hx = \sum_{i=1}^n p_i h(p_i) = \sum_{i=1}^n p_i \log\left(\frac{1}{p_i}\right) = - \sum_{i=1}^n p_i \log(p_i) \quad (3)$$

In general, the Theil index is calculated as

$$E(y) = \frac{1}{n} \sum_{i \in 1} \frac{y_i}{\mu} \ln \frac{y_i}{\mu} \quad (4)$$

Where  $n$  represents the number of samples, which means the number of provinces;  $y_i$  represents income of  $i$  the province that ranged from low to high;  $\mu$  is the mean of  $y$ . the range of Theil index is  $[0, \infty)$ , 0 means complete equality, and the higher the value, the greater the degree becomes inequality. The most important feature of Theil index is that can measure the contribution of internal group gaps.

Due to the different size of the population of each province, only evaluating the average supplies level of basic public services of each province can cause error. For example, if an average level of basic public services supplies of province is high, but the province only have one person, while the level is low of another province's basic public services supplies, but its population size is 1 million people. So if we only assessing according to the supplies level of basic public services, then the degree of equalization will be high, but the basic public services level of majority residents is equal. In order to avoid such problems, the paper will use population size as frequency weighting during the process of measurement and analysis, which can effectively overcome the impact of the factors to the Theil index.

### ***2.3. Data sources***

The data are from the authoritative materials of National Bureau of Statistics and other departments, which include China Statistical Yearbook, China Population and Employment Statistics Yearbook, Educational Statistics Yearbook of China, China Affairs' Statistics Yearbook, China Health Statistical Yearbook, and National Economic and Social Development Statistics Bulletin of nation and provinces.

Table 1 The evaluation indicator system of equalization of basic public service

Primary Indicators	Secondary Indicators
Infrastructure	Railway mileage per capita (Km/ten thousand people)
	Highway mileage per capita (Km /ten thousand people)
Basic education services	Ordinary primary school student-teacher ratio
	Ordinary junior middle school student-teacher ratio
	Total education funds input per ordinary primary school student
	Total education funds input per junior middle school student
Public employment services	Registered urban unemployment rate (%)
	Employment agencies (Unit / hundred thousand people)
Public health service	Possess number of health institutions (Unit/thousand people)
	Possess number of hygienic personnel (Person/thousand people)
	Possess number of health institutions bed (Unit/thousand people)
Social security services	Urban and rural residents social insurance joining rate(%)
	New rural cooperative medical insurance joining rate (%)
	Urban basic medical insurance joining rate (%)
	Urban minimum living allowance level (Yuan/ per capita)
	Rural minimum living allowance level (Yuan/ per capita)

### 3. Interprovincial equalization performance evaluation results

According to the performance evaluation system that constructed above, this paper calculate Theil index using panel data from 2000 to 2012 years, and evaluating the equalization performance of primary levels of infrastructure construction, basic education, public employment services, public health services and social security respectively. The results of equalization performance evaluation analysis of interprovincial basic public services supplies that measured by Theil index are as follows.

#### *3.1. Infrastructure supply equalization performance evaluation*

From Fig. 1 we can see that the tendency of infrastructure supply differences of Chinese provinces appears increasing first and then decreasing since 2000. Theil index shows significant upward trend from year 2000 to 2003, Theil index of railway mileage per capita and highway mileage per capita reaches 0.2780 and 0.1710, respectively in 2003. But then gradually reduce after 2003, especially after 2005, Theil index of railway mileage per capita and highway mileage per capita reaches 0.0710

and 0.0540, respectively in 2012. The data suggests that the gap of infrastructure equalization of basic public services supply in China is shrinking in recent years, but the reductions of extent are inconsistent in different years.

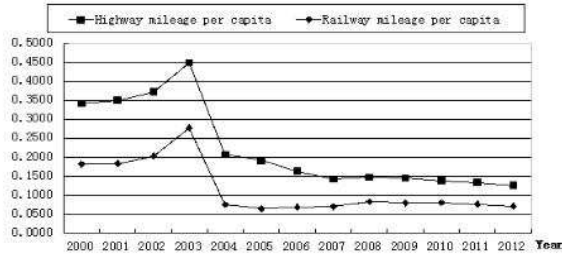


Fig. 1. Theil index tendency of inter-provincial infrastructure construction

Analyzing the reasons for this trend, it probably applied to the implementation of a series of regional development strategies since 2003, such as the developed of the western, central northeast region in China. The country constructs infrastructure, especially increases inputs of railway and highway construction in the less developed central and western provinces, which narrowed the gap between them and the developed eastern provinces. Meanwhile, the nation has implemented "village road", the benefits of agricultural policies, increasing supply services of infrastructure construction in rural areas since 2005, which also plays an important role to narrow the gap between developed provinces and backward provinces.

Although the gap is shrinking, this article does not contain other infrastructure services data into the estimated system because of the limitations of indicators selection, data availability and other reasons, which impact the effectiveness of the equalization analysis. But from the view of the rail and road infrastructure, the gap between these two basic public service provisions are still large, which need all levels of government to promote equality of the road construction.

### ***3.2. Basic education services supply equalization performance evaluation***

Fig. 2 is the Theil index trend of basic education services from year 2004 to 2012, which reflects the degree of equalization changes that primary education supply of Chinese provinces. Four evaluation indicators selected from this point of view since 2004, the inequalities of ordinary primary school student-teacher ratio and Ordinary junior middle school students-teacher ratio have gradually improved. Theil index showed a slight downward trend especially since 2006, which shows the differences between provinces gradually reduced from the school size of ordinary primary schools and ordinary junior middle school, but the absolute values are still great different, it still needs to be worked that narrow differences in resource allocation of ordinary junior middle school conditions.

However, Theil index of basic education funds input has kept rising since 2004, suggesting that exacerbate unequal degree of inter-provincial investment in basic education, which is contrary to the China's equalization strategy of basic education

that deserve government policy makers to pay attention. For the reason, developed provinces increase investment of basic education services caused by the demand of talents and development of basic education, but relatively speaking, because of insufficient financial resources or not enough attention of less developed provinces, funds for basic education in terms of the total the amount or in the growth rate, are not as much as developed provinces, resulting in the gap continues widening. Education is the foundation of a regional economic development, social stability and cultural prosperity, especially in the initial stage of basic education for the nursery of talents, which has significance worth. So, it is worthy for local governments attach great importance to achieve the equalization supply of basic education.

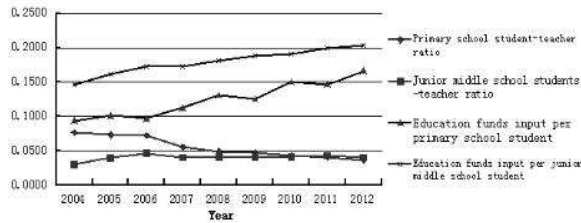


Fig. 2. Theil index tendency of inter-provincial basic education services

### 3.3. Public employment service supply equalization performance evaluation

Employment problem is serious issue that government efforts to solve, and the realization of public employment services can play an important role in guaranteeing employment of residents. In view of the data are not available, the article selects two indicators that are the registered urban unemployment rate and the number of employment agencies per hundred thousand people to measure the Theil index during the equalization performance evaluation process of inter-provincial public employment service. From Fig. 3, the difference between the registered urban unemployment rate is very small. Probably due to the characteristics of the statistical aspects of employment in China, the registered urban unemployment rates of provinces are very low, remained at 4% or less, and thus the Theil index of urban registered unemployment rate is small.

But investigating the number of employment agencies per hundred thousand people, Theil index slightly fluctuated in these 11 years, substantially widening, this inequality was the most evident especially since 2008, Theil index was 0.2647 in 2008, but the Theil index rose to 0.4220 in 2010, it remained at 0.4005 in 2012, which reflects the basic public service provisions in the aspect of employment agencies are great different. This condition may be related to the financial crisis in 2008, the serious problem of unemployment caused by the economic downturn, such as the severe unemployment of economically developed coastal provinces, employment demand increases, prompting the government is committed to put in the public employment service protection, but because the employment situation is different among provinces, this situation exists inequality gap.



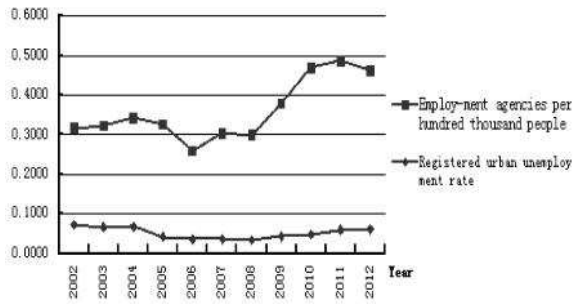


Fig. 3. Theil index tendency of inter-provincial public employment services

### 3.4. Public health services equalization performance evaluation

Used the data in the year 2000-2012, and selected the number of health institutions per thousand people.

The number of health workers per thousand people and the number of beds per thousand people health institutions as the measure indicators to calculate Theil index of inter-provincial equalization of public health services, the calculation results are shown in Table 2.

Table 2. Theil index of inter-provincial public health services from 2000 to 2012

Year	Number of health institutions per thousand people	Number of hygienic personnel per thousand people	Number of health institutions bed per thousand people
2000	0.0163	0.2536	0.1271
2001	0.0177	0.2548	0.2090
2002	0.0215	0.1429	0.2128
2003	0.0172	0.1455	0.1328
2004	0.0168	0.1406	0.1293
2005	0.0157	0.1248	0.1170
2006	0.0154	0.1200	0.1031
2007	0.0187	0.1245	0.0847
2008	0.0181	0.2544	0.0612
2009	0.0234	0.0919	0.0484
2010	0.0230	0.0768	0.0391
2011	0.0290	0.0684	0.0325
2012	0.0288	0.0677	0.0317

Overall, the inter-provincial gap for public health services is small, provincial

public health service equalization performance is better. This fully shows that public finances construction has been continuously improved and central government increase the control efforts of the public service investment, including medical. Under such background, the equalization effect of public health services in China achieves good success, public health service gaps between provinces gradually narrowing. On specific indicators, the gaps between the health sectors were narrow from year 2003 to 2008, but inequality trend exacerbated since 2009. Based on the perspective of number of health technology ownership, although the Theil index fluctuated, but on the whole the trend showed a narrow, the gap narrowed significantly especially in recent years. The number of beds from health institutions Theil index, declining inequality in provinces, suggesting that the gap is shrinking each year, Theil index reduced to less than 0.0500 especially since 2009.

The reason may be closely related to Chinese medical system, optimize the allocation of resources for health care and investment increasing in public health services. In 2009, the implementation of the national "new medical reform" policy to open a new round of health care reformed, the introduction of a series of policies to increase the healthcare investment of backward areas and less developed provinces, effectively promoted the construction and development of public health services. All of these make the inter-provincial public health resources optimize configuration and constitute a reasonable medical regional development planning, which contribute to vertical and horizontal equalization produced remarkable results among public health services of rural, provincial, eastern and western areas, large hospitals and primary hospitals. So, after development of years, the gap among the provincial public health services are narrowing, equalization performed better overall.

### ***3.5. Social security services supply equalization performance evaluation***

The paper measures the social security service supply equalization performance and selects 5 index, including urban and rural social endowment insurance rate, new rural cooperative medical insurance rate, urban basic medical insurance rate, the level of the minimum living allowance of urban and rural minimum living allowance to calculate Theil index. The results show that the equalization performance of social security sub-project is obvious different.

From each index Theil index of Table 3, urban and rural social endowment insurance and basic medical insurance for urban social security system are both the largest non-equalization degree among the provinces. At present, social security system is still in the pilot and the process of constantly improvement, for example, the national implementation of the new rural social pension insurance system piloted in 2009 and the national implementation of social pension insurance system for urban residents piloted in 2011, and the country to achieve to merger urban and rural social endowment insurance system in 2014. Based on different historic development of fiscal capacity, economic development level, level of social security benefits and urban and rural social endowment insurance system, it can be understood clearly that inter-provincial inequality of rural residents social pension insurance system. In order to achieve the equalization in the future, development of urban and rural res-

idents' social pension insurance system should focus on the "pavement" and narrow "treatment gap".

Theil index of urban basic medical insurance rate fluctuate frequently, but rise significantly, especially since 2008, this difference significantly expanded. This change of difference should have relationship with the data that the paper selects, 2008 National Bureau of urban merge the basic medical insurance system of urban workers and urban residents for the urban basic medical insurance rate data, which in view of the 2007 pilot implementation of the basic medical insurance system for urban residents, the provincial differences in terms of coverage of basic medical insurance system for urban residents, resulting in Theil index disparities of urban basic medical insurance rate. However, it should be seen, whether it is a single system, or merge system, its Theil index is above 0.1600, which indicates that the construction of medical insurance system for urban has large disparities and high levels of inequality among provinces, it is a heavy task to narrow provincial urban basic medical insurance system construction.

Look at NCMS, urban and rural subsistence allowances Theil index, the inter-provincial gap is not large and keep downward trend, which has relationship with achieving a full coverage in the country since 2010. NCMS implement system characteristics, such as voluntary insurance, government subsidies, high reimbursement and so on, accessing the trust of rural residential. The system is running effective, which has achieved an equalization result. Meanwhile, after 10-year development of urban and rural subsistence allowances system, the gap between the provinces in terms of benefit levels are reduced, the equalization performance is also good.

Table 3. Theil index of inter-provincial social security services from 2001 to 2012

Year	Urban and rural residents social insurance joining rate	New rural cooperative medical insurance joining rate	Urban basic medical insurance joining rate	Urban minimum living allowance level	Rural minimum living allowance level
2001	-	-	0.1647	-	-
2002	-	-	0.1658	-	-
2003	-	-	0.1712	0.1062	-
2004	-	-	0.1660	0.1108	-
2005	-	-	0.1679	0.1092	-
2006	0.5939	0.0721	0.1703	0.1023	-
2007	0.6221	0.0649	0.1783	0.1070	-
2008	0.4792	0.0354	0.2823	0.1271	-
2009	0.6509	0.0212	0.2928	0.1145	-
2010	0.7960	0.0112	0.2714	0.0999	0.0330
2011	0.5207	0.0097	0.2818	0.0949	0.0328
2012	0.4549	0.0083	0.2893	0.0761	0.0277

## 4. Conclusions and suggestions

### 4.1. *Conclusions*

Based on the regional equalization performance of basic public services supply in China measured by Theil index, the results show that the provincial unequal phenomenon in the supply of basic public services is obvious, and there are significant differences in status and trend of non-equalization of basic public services in different supply.

The reason for the non-equalization of basic public services supply is a dual problem of financial matching degree and organization attention degree. The former is the basic financial security, the latter is a powerful organizational guarantee. Based on the research, the reasons why the non-equalization is below. Firstly, the gap of economic development. Because differences in economic development determine the provincial differences in the construction of basic public services, and the basic public services as a livelihood project is difficult to produce "achievements", so the less developed provinces have no incentive to promote the supply of basic public services. Secondly, inter-provincial fiscal capacity difference is the most important cause of non-equalization of basic public services supply problem. Financial resources is the most basic guarantee, basic public service provision needs strong financial investment. Differences in provincial fiscal capacity lead to differences in basic public services. Thirdly, the governance concepts and administration activities of government decision-makers. In the local government evaluation system that concept is "only for GDP performance", as in the performance evaluation system, the basic public service provision is one of the most indicators that cannot show achievement, which also affects government decision-makers in the bias of governing philosophy and distortion of administrative actions.

### 4.2. *Suggestions*

Firstly, strengthen the government's equalization functions of basic public service delivery. We should adjust the structure of revenue and expenditure. At the same time, we can expand the coverage of basic public services, including more groups into the scope of services. Revenue resolves the imbalances of income among fiscal, corporate and resident. Expenditure solves imbalances that between different projects and between the central and local governments. Maintain public services prices relatively stable. Standardize financial transfer payment, optimize the financial transfer payment system, increase the size and proportion of general transfer payments, enlarge spending on public services, and improve balanced transfer payment. Establishing a sound legal and transparent monitoring mechanism, which include not only effective financial supervision, but also special supervision and judicial oversight within the government, and public press supervision and so on.

Secondly, building diversified regional equalization standards of basic public services supplies. Fully consider the characteristics of each public services and contents, and combined with a specific level of socio-economic development to ensure equal-

ization of public services supply that associated with the most basic livelihood. The form of standard setting can be diversified, establishing the standard system, which combine monetary standard, physical standards and time standard that depend on the characteristics and differences of different service projects. Maintain standard setting dynamic, contents contained basic public services vary in different periods, relative standards should also be changed, which to ensure the compatibility of contents and standards.

Thirdly, building a dynamic monitoring system of basic public service provision. Improve government performance evaluation mechanism, increase the supply of basic public services and the weight of equalization effect. Establish monitoring and evaluation system of basic public services. Under the guidance of the central government, according to the basic public service provision related to the equalization standard, requiring local governments to set up monitoring and evaluation organization, assess with a certain authority, and publish the result as bulletin annually for basic public services supply situation in their areas of jurisdiction. It can provide more valuable reference which shifts the main evaluation criteria of investment to satisfaction and social justice-oriented degree equalization policy of basic public services.

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