Mathematical Model and Decision Gap of Resource Allocation in Urban and Rural Compulsory Education--Based on the Empirical Study of 16 Regions in Yunnan province

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Abstract. The influencing factors of the unbalanced allocation of compulsory education resources, the corresponding relationship between the three elements of regional educational resource scale demand, educational resource supply level and educational resource allocation state forms a set of supply, demand and configuration relationship. This mathematical model is used to quantify this correspondence between 12 regions in Yunnan. The difference in the level of supply and demand of educational resources determines the priority level of regulation among regions and the priority level of urban and rural compulsory education and education resources allocation.

Introduction

The level of social and economic development in Yunnan, China is not only far lower than the national average, but the gap between regions is growing, which will seriously affect the realization of a comprehensive well-off society and a precise poverty alleviation strategy. Scientific understanding of the regional differences in the level of social development between urban and rural areas, through the rational regulation of the spatial allocation of basic education resources between urban and rural areas to achieve regional gaps between urban and rural development, is a major task that must be resolved to achieve regional coordinated development[1].

Problems And main Ideas

From the perspective of systemic cognition, education is subordinate to the social system and is the subsystem that constitutes the social system. The issue of equality in kindergarten education is a sub-problem of social equity. Its problem identification, problem diagnosis and problem decision-making should be included in the comprehensive research of the complex system of society. In the process of regional education development, the following basic development characteristics exist: (1) The development of regional education and related issues are not a single educational issue, but a comprehensive issue of regional development. The resolution of educational issues requires integrated regulation of the elements of education and the environmental elements of educational development. (2) The development of education and regional economic and social development remain relatively consistent to a certain extent, and the level of regional education investment is moderately ahead of the level of regional economic and social development, and can play a leverage role in the development of regional coordination gaps in education coordination. (3) The internal structure of education is in the process of constant change with the improvement of educational development level and the development stage, and this change gradually shifts from passive adjustment to active optimization[2-4].

Theoretical Model

The research focuses on the correspondence between educational resource demand, educational resource allocation and educational resource supply in the development of urban and rural compulsory education in the study area. Starting from the scientific identification of the gap between

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urban and rural compulsory education, systematically identify the urban gap, township gap and urban-rural gap of educational resources.

Through the factor analysis method, the gap can be diagnosed, and the gap between the components of urban and rural compulsory education resources and the combination characteristics of these gap can also be measured.

Based on the identification and systematic diagnosis of the gap problem, based on the satisfaction and regional regulation of the compulsory education resources in the comprehensive relationship of supply, demand and ratio, a regulation model for reducing the allocation of compulsory education resources in urban and rural areas in Yunnan is proposed.

Identification Model of Urban and Rural Compulsory Education Gap. The diversity of expressions of urban-rural compulsory education gap determines the selectivity of its identification. Based on the perspective of resource allocation, the identification of urban-rural compulsory education gap is mainly based on the following models:

$$У_t=f[(\chi_1, \psi_1),(\chi_2,\psi_2),t,\lambda] \quad (1)$$

In the formula, y is the recognition degree of the gap between urban and rural compulsory education resources allocation, and $f_{(\chi)}$ is the identification system of the gap between urban and rural compulsory education resources allocation, χ_1, χ_2 are the stock and growth rate of urban and rural compulsory education resources[6].

It can be concluded that: (1) the gap between the urban and rural compulsory education resources is χ_1, the gap of stocks is the historical continuation of the past state, and under the influence of the t-variable, the status quo of regional compulsory education development and gaps y is determined. (2) The gap between the growth rate of urban and rural compulsory education resources is χ_2, the gap between the growth rate is the beginning of the change of the future state, and the future development of the regional compulsory education and the future pattern of the gap yt under the influence of the t variable. (3) The gap between the types of urban and rural compulsory education resources is ψ_1, and the gap between stock types is the functional manifestation of the factor structure.The gap between urban and rural compulsory education resource growth rate type ψ_2, the gap of growth rate type is the embodiment of functional changes caused by changes in factor structure, and the two influence the development characteristics of regional compulsory education and its inter-domain relationship under the influence of t-variable.

Diagnostic model of urban-rural compulsory education gap. The key to the diagnosis of the gap between urban and rural compulsory education lies in the definition of the relationship between the three links of demand, supply and allocation of educational resources. The specific diagnostic models are as follows:

$$У_i=f\ (d_i, p_i, k_i) \quad (2)$$

In the formula, y_i is the i-class or i-group urban and rural compulsory education resource allocation gap, d_i is the i or i group urban and rural compulsory education resource demand level, p_i is the i or i group urban and rural compulsory education resource supply level, k_i is i class or i The state of urban and rural compulsory education resources allocation.

The red line of the urban-rural compulsory education resource allocation gap is 0, and the regional average value of urban and rural compulsory education resource demand, supply level and configuration status is 0. When $У_i>0$, it can be concluded: (1) if $d_i>0$ and $p_i>0$, or $d_i<0$ and $P_i<0$, then $k_i>0$, the state of urban and rural compulsory education resources is poor. (2) if $d_i>0$ and $k_i>0$, or $d_i<0$ and $k_i<0$, then $p_i<0$, the allocation level of urban and rural compulsory education resources is insufficient. When $У_i<0$, it can be concluded: (1) If $d_i>0$ and $p_i<0$, then $k_i>0$, the urban and rural compulsory education resource allocation state is excellent; (2) if $d_i>0$ and $k_i<0$, then $p_i>0$, the urban and rural compulsory education resource allocation level is higher[8].

Urban and Rural Compulsory Education Gap Decision Model. The key to the decision-making gap between urban and rural compulsory education resources allocation is to regulate the relationship between compulsory education allocation among regions. As shown in Figure 1,

according to the regional system theory of human-land relationship [12], in the process of adjusting the gap between urban and rural compulsory education resources, when the urban-rural gap between the sub-regions R_{31}, R_{32}, and R_{33} of the regional R_3 is greater than that the urban-rural gap between the sub-region R_1, R_2, and R_3 of the regional R. It is necessary to coordinate the order of compulsory education resource allocation, and implement a gradient allocation of limited compulsory education resources between R_{31}, R_{32} and R_{33}, and prioritize the urban-rural gap between R_{31}, R_{32} and R_{33}.When the allocation of urban and rural compulsory education resources between sub-regions R_1, R_2 and R_3 of region R is not large, but the structure of compulsory education resources is chaotic and disorderly, and the gap between different types of compulsory education resources is too large, the resource allocation structure of urban and rural compulsory education in the balanced region should be the key point of regulation and control, and the factor resources should be invested in the region. When the sub-regions R_1, R_2 and R_3 of the region R tend to have homogeneous demand for compulsory education resources, the contradiction of resource demand should be transformed by changing the state of educational resource allocation, and the inter-regional competition relationship should be transformed into a complementary relationship[5,7,9].

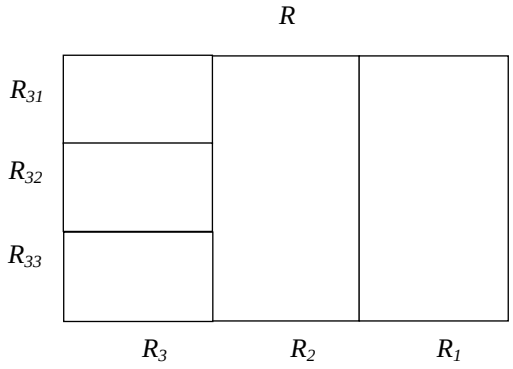

Fig. 1 Schematic diagram of urban and rural compulsory education resource allocation decision model

Research Data And Indicators

Data Sources. Unless otherwise stated, the data used in this study are mainly derived from:

(a) Development Planning Department of Yunnan Provincial Department of Education. Statistical Reports of Various Educational Undertakings in Yunnan (2013, 2015).

(b) Yunnan provincial bureau of statistics. Yunnan Statistical Yearbook (2014, 2016).

(c) Yunnan provincial bureau of statistics. Statistical Communique on National Economic and Social Development of Yunnan Province (2013, 2015).

(d) Yunnan Provincial Department of Education. Statistical Communique on the Development of Education in Yunnan Province in 2015.

(e) Yunnan Yearbook Association. Yunnan Yearbook (2013, 2015).

Indicator selection. According to the theoretical model of the research, the research selects the education scale demand index, the education supply level index and the education allocation state index to quantify the educational resources difference and spatial allocation of the compulsory education primary school section in the study area.

Table 1 Indicator set for the study of urban and rural compulsory education resource allocation

Total index	First-level index	Second-level index	third-level index
Compulsory education resource supply and demand allocation indexcopy （E）	Education Scale Demand Index (E_1)	Number of students in school (E_{11})	
		School-age population (E_{12})	
	Education Supply Level Index (E_2)	Infrastructure Index (E_{21})	Average School Building Area Index (E_{211})
			Average Fixed Asset Index (E_{212})

Total index	First-level index	Second-level index	third-level index
			Average School Books Index (E_{213})
		Educator Index (E_{22})	Teacher-student ratio index (E_{221})
			Teacher Education Index (E_{222})
			Teacher Training Index (E_{223})
		Educational Finance Fund (E_{23})	Education expenditure (E_{231})
			Expenditure on education within the budget (E_{232})
			Expenditure on education expenses within the budget (E_{233})
	Education Configuration Status Index (E_3)	School Placement Index (E_{31})	
		Class placement index (E_{32})	
		Configuration Environment Index (E_{33})	

Empirical Analysis

The gap between supply and demand of education resources in various regions of Yunnan. The ratio of the three-element structure of the city, town and township of the compulsory education resource supply and demand index in primary school in Yunnan was 1.7030, 1.0804 and 0.8019 respectively in 2013. By 2015, this proportion changed to 1.4790, 1.0661 and 0.8509, of which the township structure resources The supply and demand index has increased, and the city and town scale supply and demand index has declined. During this period, the city-town, town-township and city-township gaps in the supply and demand index of compulsory education resources in primary schools in Yunnan Province showed a narrowing trend (as shown in Table 1).

Table 2 The gap between the supply and demand index of compulsory education resources in urban and rural primary schools in Yunnan Province and the trend of the city layout

Year / Region	2013			2015			Changing Trend		
	City-town	*town-township*	*city-township*	*City-town*	*town-township*	*city-township*	*City-town*	*town-township*	*city-township*
Yunnan	**0.6226**	**0.2785**	**0.9011**	**0.4129**	**0.2152**	**0.6281**	**-0.2100**	**-0.0630**	**-0.2730**
Kunming	0.4157	0.5227	0.9384	0.4340	0.5069	0.9409	0.0180	-0.0160	0.0020
Qujing	0.0997	0.0183	0.1180	0.0777	0.0326	0.0451	-0.0220	0.0140	-0.0730
Yuxi	0.6793	0.4677	0.2116	0.4068	0.5616	0.1548	-0.2720	0.0940	-0.0570
Baoshan	0.0661	0.3723	0.4384	0.0787	0.2295	0.3082	0.0130	-0.1430	-0.1300
Zhaotong	0.3838	0.0616	0.4454	0.2411	0.0025	0.2385	-0.1430	-0.0590	-0.2070
Lijiang	0.2240	0.0398	0.1842	0.0641	0.1736	0.1094	-0.1600	0.1340	-0.0750
Pu'er	1.1020	0.1422	0.9598	0.7357	1.0232	0.2874	-0.3660	0.8810	-0.6720
Lincang	0.7538	0.1768	0.9305	0.8177	0.2242	1.0419	0.0640	0.0470	0.1110
Chuxiong	0.2420	0.1338	0.1082	0.3370	0.3685	0.0315	0.0950	0.2350	-0.0770
Honghe	0.2677	0.0288	0.2965	0.0419	0.0647	0.0228	-0.2260	0.0360	-0.2740
Wenshan	0.2061	0.1010	0.3071	0.3480	0.0072	0.3553	0.1420	-0.0940	0.0480
Xishuang banna	0.4245	0.4275	0.0030	0.3038	0.7574	0.4536	-0.1210	0.3300	0.4510
Dali	0.5778	0.0508	0.5271	0.4377	0.0395	0.3983	-0.1400	-0.0110	-0.1290
Dehong	0.4097	0.2087	0.2010	0.1444	0.1907	0.3351	-0.2650	-0.0180	0.1340
Nujiang	*	0.0329	*	*	0.2594	*	*	0.2270	*
Diqing	*	*	*	*	*	*	*	*	*

The research divides the supply-demand index of compulsory education resources in primary schools in various regions of Yunnan from 2013 to 2015. The changes of city-town, town-township and city-township are divided into four regional types according to their actual growth: Significantly reduced (Class I), reduced (Class II), expanded (Class III), and significantly expanded (Class IV). Among them, the areas where the city-town gap has been significantly reduced are the five regions of Yuxi, Zhaotong, Pu'er, Honghe and Dehong. The areas where the city-town gap has narrowed are Qujing, Lijiang, Xishuangbanna and Dali. The urban-town gap has expanded into two regions: Kunming and Baoshan. The areas where the city-town gap has expanded significantly are Lincang, Chuxiong and Wenshan. The areas where the gap between town and township has been significantly reduced are Baoshan, Zhaotong and Wenshan. The areas where the gap between town and township has narrowed are three regions: Kunming, Dali and Dehong. Where the gap between town and township has expanded are Qujing, Yuxi, Linyi and Honghe. The areas where the gap between town and township is significantly expanded are Lijiang, Pu'er, Chuxiong, Xishuangbanna and Nujiang. The areas where the city-township gap has been significantly reduced are the three cities of Zhaotong, Pu'er and Honghe. The areas where the city-township gap has narrowed are the six cities of Qujing, Yuxi, Baoshan, Lijiang, Chuxiong and Dali. The areas where the gap in the township has expanded are four regions of Kunming, Lincang, Wenshan and Dehong. The area where the gap between city-township is significantly expanded is Xishuangbanna.

Differences in the Regional Structure Types of the Supply-Requirement-Configuration of Educational Resources in Yunnan. The supply-demand-distribution structure of urban and rural compulsory education resources reflects the interrelationship between regional education resource supply, educational resource demand and educational resource allocation. This mutual relationship reflects the configuration structure of inter-regional compulsory education resources including the balance between the resource supply side, the demand side and the configuration end, and the difference between the source supply side, the demand side and the configuration side of each area. According to the relationship between supply and demand of regional compulsory education resources, the regional supply and demand index can be determined. According to the relationship between configuration and demand of regional compulsory education resources, the regional allocation index can be determined, according to supply and demand. Index and configuration index, which can divide different areas into the following four types of area types: Type I, areas with high levels of educational resources and better configuration, type II, areas with high levels of educational resources and poorly deployed status, type III, areas where the supply of educational resources is low and the allocation status is good, and type IV, areas with low levels of educational resources and poorly deployed status.

Table 3 Differences in the Regional Structure Types of the supply-demand-distribution of compulsory education resources in primary schools (2013, 2015)

Year / Region	2013			2015		
	Supply and demand index	***configuration index***	***structure type***	***Supply and demand index***	***configuration index***	***structure type***
Kunming	0.8333	1.0209	Ⅲ	0.8986	0.9769	Ⅳ
Qujing	0.7160	0.7379	Ⅳ	0.8105	0.7801	Ⅳ
Yuxi	1.3333	1.7962	Ⅰ	1.3914	1.8279	Ⅰ
Baoshan	1.2501	1.4696	Ⅰ	1.4105	1.3918	Ⅰ
Zhaotong	0.6410	0.9246	Ⅳ	0.7020	0.9144	Ⅳ
Lijiang	1.6533	0.9954	Ⅱ	1.9427	1.0408	Ⅰ
Pu’er	1.5713	0.5349	Ⅱ	1.6614	0.5107	Ⅱ
Lincang	1.6919	1.2261	Ⅰ	1.8984	1.1804	Ⅰ
Chuxiong	1.1931	0.9567	Ⅱ	1.3995	0.9945	Ⅱ
Honghe	0.8729	0.8144	Ⅳ	0.9806	0.7799	Ⅳ
Wenshan	0.8221	0.9752	Ⅳ	0.9275	0.8929	Ⅳ

Year Region	2013			2015		
	Supply and demand index	*configuration index*	*structure type*	*Supply and demand index*	*configuration index*	*structure type*
Xishuangbanna	1.5025	1.3142	Ⅰ	1.6377	1.1913	Ⅰ
Dali	1.0272	0.7397	Ⅱ	1.2342	0.7736	Ⅱ
Dehong	1.4996	2.2089	Ⅰ	1.4648	2.0366	Ⅰ
Nujiang	2.0817	0.9182	Ⅱ	2.2281	0.8570	Ⅱ
Diqing	2.3837	0.4684	Ⅱ	2.7878	0.4596	Ⅱ

IN THE URBAN PATTERN OF THE COMPULSORY EDUCATION RESOURCE ALLOCATION INDEX OF THE URBAN AND RURAL PRIMARY SCHOOLS IN YUNNAN IN 2013, THE REGIONS WITH RESOURCE ALLOCATION LEVEL HIGHER THAN THE RESOURCE DEMAND LEVEL ARE DEHONG, YUXI, BAOSHAN, XISHUANGBANNA, LINYI AND KUNMING.

In the urban pattern of the compulsory education resource allocation index of the urban and rural primary schools in Yunnan in 2013, the regions with resource allocation level higher than the resource demand level are Dehong, Yuxi, Baoshan, Xishuangbanna, Linyi and Kunming. The allocation level of compulsory education resources in the remaining 10 regions is lower than the resource demand level. By 2015, the regions with resource allocation levels higher than the resource demand levels are Dehong, Yuxi, Baoshan, Xishuangbanna, Linyi and Lijiang. The allocation level of compulsory education resources in the remaining 10 regions is lower than the resource demand level. According to the relative relationship between the supply and demand index of compulsory education resources and the resource allocation index of primary schools in various regions in Yunnan in 2013, the regions can be divided into four different regional structure types: Structural type I includes Yuxi, Baoshan, Linyi, Xishuangbanna and Dehong, structure type II includes Lijiang, Pu'er, Chuxiong, Dali, Nujiang and Diqing, structure type III includes Kunming City, structure type IV includes Qujing, Zhaotong, Honghe and Wenshan. By 2015, in the regional structure type pattern of various regions, Kunming changed from a type III area to a type IV area, and Lijiang changed from a type II area to a type I area, and the regional pattern of the other regions did not change.

Decision Application And Discussion

The Gradient of the Compulsory Education Gap in Urban and Rural Area. The non-equilibrium status of compulsory education in Yunnan shows coexistence in various development levels at the city level. The high-level regions and low-level regions have significant differences and development contradictions. On the urban-rural scale of the region, the internal differences in multi-regional urban and rural areas are manifested. Prominently, the regional differences between the urban, town and township ternary structures are significant.[10,11]

(1) Priority of inter-regional regulation. In the process of compulsory education resource regulation, resources should be preferentially allocated to regions with low supply and demand index to promote the balance of supply and demand of compulsory education resources within the region. Through the supply and demand of compulsory education resources in various cities and counties in Yunnan Province, the priority of compulsory education resource allocation on the city level can be obtained. Level I areas: Zhaotong, Qujing, Wenshan, Kunming and Honghe; Level II areas: Dali, Chuxiong, Baoshan, Yuxi and Dehong; Level III areas: Xishuangbanna, Pu'er, Lijiang Linyi, Nujiang, Diqing. Among them, the priority of regional input is gradually reduced from level I to level III, that is, the level I area is a region where the level of compulsory education resources is poor, and the level of compulsory education resources input needs to be tilted and prioritized.

(2) Priority of regulation within the region. In the process of regulating urban and rural compulsory education resources, it is necessary to prioritize resources to areas where the gap between urban and rural areas is large, and promote the balance between supply and demand of urban and rural compulsory education resources. Through the supply and demand of compulsory education resources in the three-dimensional structure areas of regions, towns and townships in various cities of Yunnan, the priority of compulsory education resources input on urban and rural scales can be obtained. Level I areas: Diqing and Linyi; Level II areas: Pu'er, Kunming,

Xishuangbanna, Yuxi, Dali, Chuxiong, Wenshan, Nujiang, Baoshan, Dehong and Zhaotong; Level III areas: Lijiang, Qujing and Honghe. Among them, the priority of regional input is gradually reduced from Grade I to Grade III, that is, the level of compulsory education resources between urban and rural areas is relatively large. Therefore, these areas should be tilted and prioritized in the process of reducing the level of compulsory education resources input between regions.

Result and Discussion. There are many factors influencing the regional distribution of educational resources. In addition to the influence of the development law of education itself, it is also affected by regional economic and social development factors. How to scientifically understand the impact of these factors on the layout of educational resources and the interaction mechanism between factors requires more follow-up research.

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