ICIC Express Letters ICIC International ©2020 ISSN 1881-803X
Volume **14**, Number **1**, January **2020** pp. **53–65**

DETECTING THE EQUALITY OF RESOURCE ALLOCATION FOR PRE-SCHOOL EDUCATION BASED ON GINI COEFFICIENTS OF CHINA'S PROVINCES

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Received July 2019; accepted October 2019

Abstract. *This study aims to detect the equality of resource allocation of pre-school education in China. The resource allocation includes human resources, material resources, and financial resources domains. A self-designed fuzzy questionnaire with 20 proposed indicators was used to determine their importance from 15 experts. There are 12 indicators selected as the fitted research tool to review the equality of resource allocation in pre-schools, including four indicators in human resources, four indicators in material resources, and four indicators in financial resources. We considered Gini coefficient to transform the data related to pre-school education collected from 31 provinces in China. The results reveal unequal distribution or extreme unequal distribution of specific indicators, which provides useful information for further efforts to remodel pre-school education.*

Keywords: Equality of education, Gini coefficient, Fuzzy statistics, Pre-school education, Resource allocation

1. **Introduction.** Resource allocation is used to assign the available resources in an economic way. It refers to decision makers dealing with equitable distribution of available resources. Resource allocation is a part of resource management and has become a crucial topic in various fields [1]. Recently, the equality of resource allocation for different levels of education has become a new consensus to achieve quality and equity [2,3]. In this sense, the pre-school education plays a key role in the process of education for all. The educational resource allocation is directly related to the level and quality of pre-school education. Excellent and sufficient educational resources will effectively promote the growth of young children, while lack of educational resources may threaten the opportunities, processes and results of equal access to education, even become a gap in the long-term development of children.

Previous studies focusing on resource allocation in pre-school education have found that the regional disparity of educational resource allocation in pre-school education remains a persistent issue [4]. Since 2016, China has officially implemented the "one couple with two children" policy (hereinafter referred to as the "comprehensive two-child" policy), which poses new challenges to the demand for pre-school education and compulsory education. Research on the impact of the basic educational resource allocation with school-age population change has become a hot issue [5]. Based on different data set (including national

DOI: 10.24507/icicel.14.01.53

data and provincial data), researchers forecast and analyze the number of pre-school age population and the demand for educational resources by using various statistical methods. Studies show that government and market should play respective roles to affect resource allocation in preschool education, meaning government playing a leading role in alleviating the status of insufficient investment and disparity of resource allocation in pre-school education, and market participating in development of pre-school education, which could optimize resource allocation structure to achieve a balance between supply and demand of educational resources in pre-school education [5-7].

The population change brought about by policy implementation will affect re-allocation of educational resources. On the contrary, the educational resource allocation will also affect the change of population size and structure [8]. The rapid development of urbanization has led to the differential educational resource allocation which forces families to adopt the strategy of "replacing quantity with quality" in order to concentrate more resources to obtain high-quality educational resources. That is to say, the differential educational resource allocation affects women's fertility desire and keeps it at a low level. To some extent, the differential educational resource allocation also has the effect of "family planning", which is one reason affecting the fertility rate [9]. Based on current studies, redefining the equality of resource allocation is an important and necessary task for researchers or educators in current pre-school settings.

During these years, China has initiated couple plans for improving pre-school education. For example, "The 13th Five-Year Plan for National Economic and Social Development of the People's Republic of China" (2016-2020) (hereinafter referred to as "13th Five-Year Plan") proposes to increase the gross entrance ratio (GER) to 85% in 3 years pre-school education [10]. In order to accelerate the modernization of education, according to the "13th Five-Year Plan" and "National Medium and Long-Term Education Reform and Development Plan (2010-2020)", the State Council issued the "13th Five-Year Plan for the Development of National Education" in 2017, proposing to more specific development goals and the actions that will be taken [11]. China's pre-school education has made remarkable achievements. In 2018, there are 46 million and 564 thousand children enrolled in 260 thousand kindergartens, which implies 81.7% GER counted in 3 years pre-school education [12]. While it still confronts various challenges. The effect of implementing the Plans to achieve the equality of pre-school education is still unclear. Whether implementing the resource allocation in different provinces might result in inequity of pre-school education? How serious the inequality existed in the system? It needs more work to detect the issue. Gini coefficient is the most commonly used quantity to examine the degree of equality, which could consider all the observed values and verify the degree of equality by a certain number of variables. Gini coefficient is easy to operate just by using Excel software to describe formulas and transform the collected data. With clear explanation, Gini coefficient can be used not only to examine the equality of educational resource allocation, but also to show the development trend to see if the inequality issue of resource allocation in preschool education has been alleviated for several consecutive years. Based on the questions, the purposes of this study are listed as follows:

a) To explore the connotation and scope of China's pre-school resource allocation indicators to detect the equality issue;

b) To detect the equality of resource allocation in different provinces and different domains.

Given the two purposes, this study applies a self-designed fuzzy questionnaire to modifying the indicators to fit the importance of resource allocation. Then, collect data based on 31 provinces and calculate the Gini coefficients to tackle the equality issues.

The structure of this research includes the following components. First, we address how the fuzzy questionnaire was built and how the Gini coefficient was used to examine the equality issues in pre-school education. Second, demonstrate the current status of resource allocation and detect the serious inequality indicators to provide suggestions for policy makers. Finally, conclusions are presented to address implications of this research.

2. **Method.** In this section, we will demonstrate how the study is designed, indicators were selected, data were collected, and the Gini coefficients were conducted to determine the inequality of resource allocation in pre-schools.

2.1. **Research framework.** This study focuses on the equality of pre-school education in China. First, we considered the official data set in China. To tackle this issue, we found the province-base data are much easier to collect and transform. Fuzzy questionnaire has been used to enhance the logic of selecting indicators from human resources, material resources, and financial resources domains. Figure 1 displays that the Gini coefficient has been used to transform and justify the equality of related resource allocation based on the data of 31 provinces.

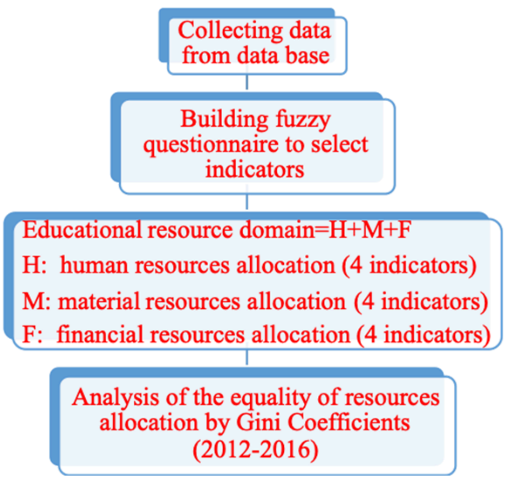

FIGURE 1. Research framework

2.2. **Design of fuzzy questionnaire.** The traditional questionnaire uses some fixed answer patterns to measure subject's preference and is expressed by the scale derived from the integer. However, almost all of human thinking and behavior reflect the ambiguity of things, and the language they display is also vague language [13]. The binary logic of the traditional questionnaire neither conforms to human thinking and behavior pattern, nor reflects the true attitude and cognition of the respondents. By providing a basis for approximate reasoning, a mode of reasoning which is not exact, or very inexact, such logic may offer a more realistic framework for human reasoning than the traditional binary valued logic [14]. With different functions, the fuzzy statistical method's application as a tool allows the capture and accurate reflection of the diversity, subjectivity, and inherent imprecision in human responses to questionnaires [15]. The example of fuzzy questionnaire answer is shown in Figure 2.

Perception of the importance of "Full-time teachers"

1	2	3	(4)	5	(6)	7

FIGURE 2. An example of self-designed fuzzy questionnaire

To get credible opinions from the group consensus, this study invited 15 experts in this pre-school field to participate the process of building questionnaire. The 15 experts' education backgrounds and experiences include college scholars (5), education evaluation scholars (3), pre-school practitioners (4), directors with more than 5 years of pre-school education work experiences (3).

2.3. **Transformation of fuzzy interval data by using fuzzy mean and centroid.** The transformation process has been defined as follows [16-18]. The concept of interval fuzzy data can be defined as a well-distributed membership function with fuzzy numbers. The symbol of "[ ]" means a closed interval. If a, $b \in R$ and $a < b$, then $[a, b]$ is interval fuzzy data. It can be named "a" as the lower bound of $[a, b]$ and "b" as the upper bound of $[a, b]$; if $a = b$, then $[a, b] = [a, a] = [b, b] = a = b$, and it is a real number a (or b). Similarly, a real number k can be defined as $[k, k]$. If $[a, b]$ is an interval fuzzy set, we can define $C_o = (a + b)/2$, $S_o = (b - a)/2$, and they represent the "center" and "radius" or "variance" respectively. This study also defined an interval fuzzy number as the following format: $[C_o; S_o] \Rightarrow [C_o - S_o, C_o + S_o] = [a, b]$. Based on the results of questionnaire verification, this study selected 12 indicators from human resources, material resources and financial resources domains. Table 1 demonstrates the fuzzy interval data transformation including fuzzy mean and fuzzy centroid by calculating the perception of the importance of educational resources with all expert participants.

Table 1. Transformation of fuzzy interval data by using fuzzy mean and centroid

Domain	**Indicator**	**Fuzzy mean**	**Centroid**
Human resources	H1: Full-time teachers per kindergarten	$[4.56, 6.22]$	$[5.39]$
	H2: Health physicians per kindergarten	$[3.56, 5.22]$	$[4.39]$
	H3: Caretakers per kindergarten	$[3.89, 5.56]$	$[4.72]$
	H4: Proportion of leaders and teachers with undergraduate degree and above	$[4.78, 6.44]$	$[5.61]$
Material resources	M1: Average living space	$[3.67, 5.22]$	$[4.44]$
	M2: Average green area	$[3.89, 5.78]$	$[4.83]$
	M3: Average book	$[5.00, 6.67]$	$[5.83]$
	M4: Average digital resource	$[3.44, 5.33]$	$[4.39]$
Financial resources	F1: Average educational expenditure	$[5.11, 6.56]$	$[5.83]$
	F2: Average public finance budget education expenditure	$[5.11, 6.33]$	$[5.72]$
	F3: Average public expenditure	$[4.78, 6.33]$	$[5.56]$
	F4: Ratio of per capita public expenditures on education to per capita GDP	$[4.89, 6.67]$	$[5.78]$

2.4. **Data collection.** The study selected China as a target to detect her pre-school educational resource allocation issues. Based on the Planning Department of the Ministry of Education of China [19,20] and China Educational Finance Statistical Yearbook (2013-2017) [21], we collected the original data within the five years (2012-2016) from 31 provinces. The data were classified into 12 indicators by human resources, material resources, and financial resources domains based on experts' opinions. The selected indicators based on province data are defined as follows.

a) In human resources domain, full-time teachers (or health physicians or caretakers) per kindergarten means total number of teachers (or health physicians or caretakers) divided by number of kindergartens each province.

b) In material resources domain, average living space (or average green area or average book or average digital resource) means the total living space (or average green area or average book or average digital resource) divided by the number of children each province.

c) In financial resources domain, average educational expenditure (or average public finance budget education expenditure or average public expenditure) means ratio of expenditure on kindergarten education (or total public finance budget education expenditure or total public expenditure of the kindergarten) to the number of children each province.

2.5. **Transformation of Gini coefficient.** The Gini coefficient is a summary statistic of the Lorenz curve [22] and is commonly used to measure the inequality of income distribution among residents in a country or region [23]. Table 2 shows that the Gini coefficient can be defined or interpreted in many ways [24].

Table 2. The equations and interpretations in transformation of Gini coefficient

Equations	Interpretations
$G = A/(A+B)$	Gini coefficient refers to the arc area formed by Lorenz curve and 45 degree angle equal line formed by the observed value of educational resource allocation indicators, divided by the triangular area formed by the complete equal line and vertical coordinate and horizontal coordinate, as shown in Figure 3.
$Gini = 1 - \sum_{i=1}^{n}(X_i - X_{i-1})(Y_i + Y_{i-1})$ [25]	X_i is the cumulative share of population and Y_i is the cumulative share of household related distribution.
$G = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}\lvert x_i - x_j\rvert}{2n^2\bar{x}}$ [26]	x is an observed value, n is the number of values observed, and x bar ($\bar{x}$) is the mean value.
$G = 1 - 2\sum_{i=1}^{I} L_i = 1 - \sum_{i=1}^{I}(\omega_i + \omega_{i-1})(\rho_i - \rho_{i-1})$ [27]	The equation is from a research of water allocation problem. i is the name of the administrative district; L_i is the area under the Lorenz curve generated by the administrative district i; ω_i is the cumulative share of water volume allocated to administrative district i, where $\omega_0 = 0$; ρ_i is the cumulative share of population in the administrative district i, where $\rho_0 = 0$.

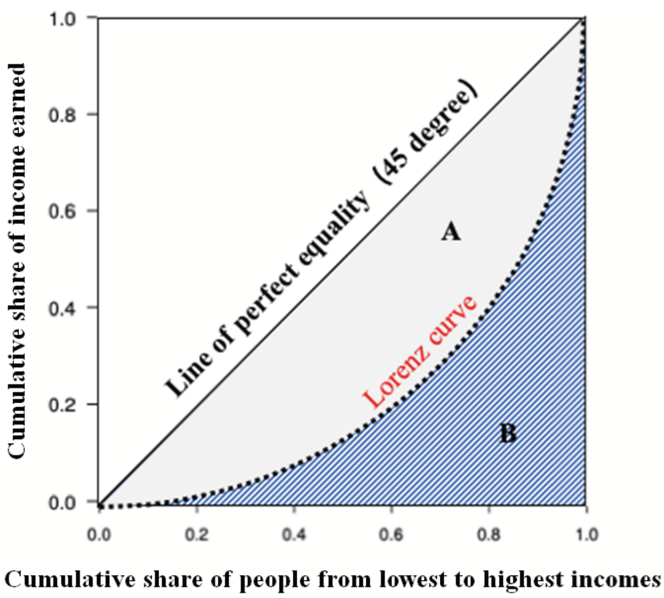

Figure 3. The transformation of Gini coefficient

In this study we use the original equation $G = A/(A+B)$ and expand the basic concept of the "income" Gini coefficient to measure the "resource allocation inequality" between resource-rich regions and resource-poor regions, getting the "resource allocation" Gini coefficient. This study transformed the original data from 31 provinces in China to analyze the Gini coefficients of human resources, financial resources and material resources. Take the calculating process of one indicator's Gini coefficient in human resources (H4: Proportion of leaders and teachers with undergraduate degree and above) in year 2012 as an example in Table 3.

The Gini coefficient is a number varied from 0 to 1, where 0 corresponds with absolute equality and 1 corresponds with absolute inequality. The Gini coefficient below 0.2 means high equality; the Gini coefficient between 0.2-0.3 means moderate equality; the Gini coefficient between 0.3-0.4 means bearable; the Gini coefficient between 0.4-0.6 means moderate inequality; the Gini coefficient above 0.6 means high inequality. Generally, 0.4 is used as the warning line of the Gini coefficient indicating the critical point of the unequal status [28]. When the Gini coefficient increased above 0.6, society may be turbulent due to competition for power or wealth [29].

3. **Results.**

The results are mainly based on the analysis and discussion of the educational resource allocation equality indicators and related literature to verify the research purposes.

TABLE 3. The calculating process of Gini coefficient of indicator H4

Process	Description
Step 1: Calculating the relevant indicators according to the original data.	(table below)

Province	Human Resources							
			Education background of kindergarten leaders and full-time teachers					
	Kindergarten Heads	Full-time Teachers	total	Graduate	Under-graduate	Associate Bachelor	High School Graduate	Below High School Graduate
Beijing	1892	26330	28222	296	9022	13913	4803	188
Tianjin	1336	11286	12622	168	4836	5103	2137	378
Hebei	9189	67120	76309	113	12925	42771	18845	1655
Shanxi	4935	38194	43129	74	8043	22966	11247	799
Inner Mongolia	3199	25807	29006	80	7573	15168	5593	592
Liaoning	7425	45493	52918	181	7601	28115	15152	1869
Jilin	4061	23487	27548	145	6948	14047	5736	672
Heilongjiang	4978	25427	30405	51	5654	17190	6500	1010
Shanghai	1838	31289	33127	174	18864	12228	1801	60
Jiangsu	6824	94660	101484	195	28842	55538	16101	808
Zhejiang	9754	107289	117043	181	19276	59504	36887	1195
Anhui	6208	42959	49167	58	6159	30589	11169	1192
Fujian	7772	59163	66935	31	7801	27612	29058	2433
Jiangxi	11147	57338	68485	81	4885	27640	30015	5864
Shandong	17267	116408	133675	257	19283	62341	47379	4415
Henan	15143	112551	127694	147	13883	68215	40594	4855
Hubei	7011	49153	56164	105	6834	26425	20583	2217
Hunan	11849	65413	77262	87	6282	42992	26051	1850
Guangdong	18751	168842	187593	385	13931	87572	78569	7136
Guangxi	8344	44857	53201	77	4977	27885	17281	2981
Hainan	1856	11473	13329	11	860	7491	4418	549
Chongqing	4729	26735	31464	49	3923	16635	10136	721
Sichuan	11260	65403	76663	119	7451	40931	27369	793
Guizhou	3458	23846	27304	17	3290	14764	8512	721
Yunnan	5093	35581	40674	79	7436	19706	11889	1564
Tibet	174	1593	1767	2	270	1050	373	72
Shaanxi	6746	49462	56208	123	8301	32138	14266	1380
Gansu	2157	17086	19243	45	4394	10288	4115	401
Qinghai	722	4361	5083	13	780	2252	1853	185
Ningxia	681	6145	6826	20	1050	4343	1320	93
Xinjiang	2439	24486	26925	29	4654	16602	5373	267

(continued)

Step 2: Automatically sorting the transformed data from small to large in EXCEL to form the second column of data.

	A	B
1	Province	the proportion of kindergarten leaders and teachers with undergraduate degree and above
2	Hainan	0.065346238
3	Jiangxi	0.072512229
4	Guangdong	0.076314148
5	Hunan	0.082433797
6	Guangxi	0.094998214
7	Sichuan	0.098743853
8	Henan	0.109872038
9	Fujian	0.117009039
10	Guizhou	0.121117785
11	Hubei	0.123548893
12	Chongqing	0.126239512
13	Anhui	0.1264466
14	Shandong	0.146175425
15	Liaoning	0.147057712
16	Shaanxi	0.149871904
17	Tibet	0.15393322
18	Qinghai	0.15601023
19	Ningxia	0.156753589
20	Zhejiang	0.166238049
21	Hebei	0.170857959
22	Xinjiang	0.173927577
23	Yunnan	0.184761764
24	Heilongjiang	0.187633613
25	Shanxi	0.188202833
26	Gansu	0.230681287
27	Jilin	0.257477857
28	Inner Mongolia	0.263841964
29	Jiangsu	0.286123921
30	Beijing	0.330167954
31	Tianjin	0.396450642
32	Shanghai	0.574697377

Step 3: Calculating the "province cumulative" data with the equation "$= \mathrm{B}n/\$\mathrm{B}\$32$" ($n = 2, 3, \ldots, 32$) to form the third column of data.

	A	B	C
1	Province	the proportion of kindergarten leaders and teachers with undergraduate degree and above	province cumulative
2	Hainan	0.065346238	0.113705474
3	Jiangxi	0.072512229	0.12617463
4	Guangdong	0.076314148	0.132790145
5	Hunan	0.082433797	0.143438617
6	Guangxi	0.094998214	0.165301284
7	Sichuan	0.098743853	0.171818868
8	Henan	0.109872038	0.191182424
9	Fujian	0.117009039	0.203601136
10	Guizhou	0.121117785	0.210750544
11	Hubei	0.123548893	0.214980784
12	Chongqing	0.126239512	0.219662586
13	Anhui	0.1264466	0.220022929
14	Shandong	0.146175425	0.254351997
15	Liaoning	0.147057712	0.255887216
16	Shaanxi	0.149871904	0.260784041
17	Tibet	0.15393322	0.267850918
18	Qinghai	0.15601023	0.271465012
19	Ningxia	0.156753589	0.272758491
20	Zhejiang	0.166238049	0.28926189
21	Hebei	0.170857959	0.297300746
22	Xinjiang	0.173927577	0.302642023
23	Yunnan	0.184761764	0.32149401
24	Heilongjiang	0.187633613	0.326491159
25	Shanxi	0.188202833	0.327481629
26	Gansu	0.230681287	0.401396102
27	Jilin	0.257477857	0.448023372
28	Inner Mongolia	0.263841964	0.459097213
29	Jiangsu	0.286123921	0.497868848
30	Beijing	0.330167954	0.574507502
31	Tianjin	0.396450642	0.689842442
32	Shanghai	0.574697377	1

(continued)

Step 4: Calculating all the "area" data with Formula for calculating trapezoidal area except for D2 with Formula for calculating triangle area one by one. Then sum up the area of each province as area of B.

	A	B	C	D
1	Province	the proportion of kindergarten leaders and teachers with undergraduate degree and above	province cumulative	area of every province
2	Hainan	0.065346238	0.113705474	0.001833959
3	Jiangxi	0.072512229	0.12617463	0.003869034
4	Guangdong	0.076314148	0.132790145	0.004176851
5	Hunan	0.082433797	0.143438617	0.004455303
6	Guangxi	0.094998214	0.165301284	0.004979676
7	Sichuan	0.098743853	0.171818868	0.005437422
8	Henan	0.109872038	0.191182424	0.00585486
9	Fujian	0.117009039	0.203601136	0.006367477
10	Guizhou	0.121117785	0.210750544	0.006683092
11	Hubei	0.123548893	0.214980784	0.006866634
12	Chongqing	0.126239512	0.219662586	0.007010377
13	Anhui	0.1264466	0.220022929	0.007091702
14	Shandong	0.146175425	0.254351997	0.007651208
15	Liaoning	0.147057712	0.255887216	0.008229665
16	Shaanxi	0.149871904	0.260784041	0.008333407
17	Tibet	0.15393322	0.267850918	0.00852637
18	Qinghai	0.15601023	0.271465012	0.008698644
19	Ningxia	0.156753589	0.272758491	0.008777798
20	Zhejiang	0.166238049	0.28926189	0.009064845
21	Hebei	0.170857959	0.297300746	0.009460688
22	Xinjiang	0.173927577	0.302642023	0.009676496
23	Yunnan	0.184761764	0.32149401	0.01006671
24	Heilongjiang	0.187633613	0.326491159	0.010451374
25	Shanxi	0.188202833	0.327481629	0.010547948
26	Gansu	0.230681287	0.401396102	0.011756092
27	Jilin	0.257477857	0.448023372	0.013700314
28	Inner Mongolia	0.263841964	0.459097213	0.014630977
29	Jiangsu	0.286123921	0.497868848	0.015434936
30	Beijing	0.330167954	0.574507502	0.017296393
31	Tianjin	0.396450642	0.689842442	0.020392741
32	Shanghai	0.574697377	1	0.027255523
33				0.294578517

Step 5: The area of the right triangle minus the area of B is equal to the area of A. The Gini coefficient is available, that is $G = A/(A + B)$.

	A	B	C	D
1	Province	the proportion of kindergarten leaders and teachers with undergraduate degree and above	province cumulative	area of every province
2	Hainan	0.065346238	0.113705474	0.001833959
3	Jiangxi	0.072512229	0.12617463	0.003869034
4	Guangdong	0.076314148	0.132790145	0.004176851
5	Hunan	0.082433797	0.143438617	0.004455303
6	Guangxi	0.094998214	0.165301284	0.004979676
7	Sichuan	0.098743853	0.171818868	0.005437422
8	Henan	0.109872038	0.191182424	0.00585486
9	Fujian	0.117009039	0.203601136	0.006367477
10	Guizhou	0.121117785	0.210750544	0.006683092
11	Hubei	0.123548893	0.214980784	0.006866634
12	Chongqing	0.126239512	0.219662586	0.007010377
13	Anhui	0.1264466	0.220022929	0.007091702
14	Shandong	0.146175425	0.254351997	0.007651208
15	Liaoning	0.147057712	0.255887216	0.008229665
16	Shaanxi	0.149871904	0.260784041	0.008333407
17	Tibet	0.15393322	0.267850918	0.00852637
18	Qinghai	0.15601023	0.271465012	0.008698644
19	Ningxia	0.156753589	0.272758491	0.008777798
20	Zhejiang	0.166238049	0.28926189	0.009064845
21	Hebei	0.170857959	0.297300746	0.009460688
22	Xinjiang	0.173927577	0.302642023	0.009676496
23	Yunnan	0.184761764	0.32149401	0.01006671
24	Heilongjiang	0.187633613	0.326491159	0.010451374
25	Shanxi	0.188202833	0.327481629	0.010547948
26	Gansu	0.230681287	0.401396102	0.011756092
27	Jilin	0.257477857	0.448023372	0.013700314
28	Inner Mongolia	0.263841964	0.459097213	0.014630977
29	Jiangsu	0.286123921	0.497868848	0.015434936
30	Beijing	0.330167954	0.574507502	0.017296393
31	Tianjin	0.396450642	0.689842442	0.020392741
32	Shanghai	0.574697377	1	0.027255523
33				0.294578517
34				
35			B=	0.294578517
36			A=	0.205421483
37			Gini=	0.41

3.1. **Gini coefficients of human resources allocation.** Based on experts' opinions, we selected four indicators in human resources domain to tackle the equality issue in pre-school education.

Table 4 displays the Gini coefficients of 31 provinces from 2012 to 2016 in human resources allocation domain. Specifically, H1 has a Gini coefficient below 0.4, showing equal distribution. The Gini coefficient in H2 varied from 0.4 to 0.6, showing unequal distribution and increasing tendency. For H3, the Gini coefficients are from 0.2 to 0.4, except for 0.43 in 2014. Typically, the Gini coefficients of H4 are from 0.2 to 0.4, except for 0.41 in 2012. The declining tendency demonstrates the equal distribution to a certain degree in this domain. The details of the trends with human resource allocation have been displayed in Figure 4.

Table 4. The result of Gini coefficients in human resources allocation

Indicators	Gini coefficients				
	2012	2013	2014	2015	2016
H1: Full-time teachers per kindergarten	0.24	0.24	0.24	0.24	0.23
H2: Health physicians per kindergarten	0.44	0.45	0.49	0.51	0.51
H3: Caretakers per kindergarten	0.33	0.38	0.43	0.28	0.29
H4: Proportion of leaders and teachers with undergraduate degree and above	0.41	0.40	0.39	0.37	0.35

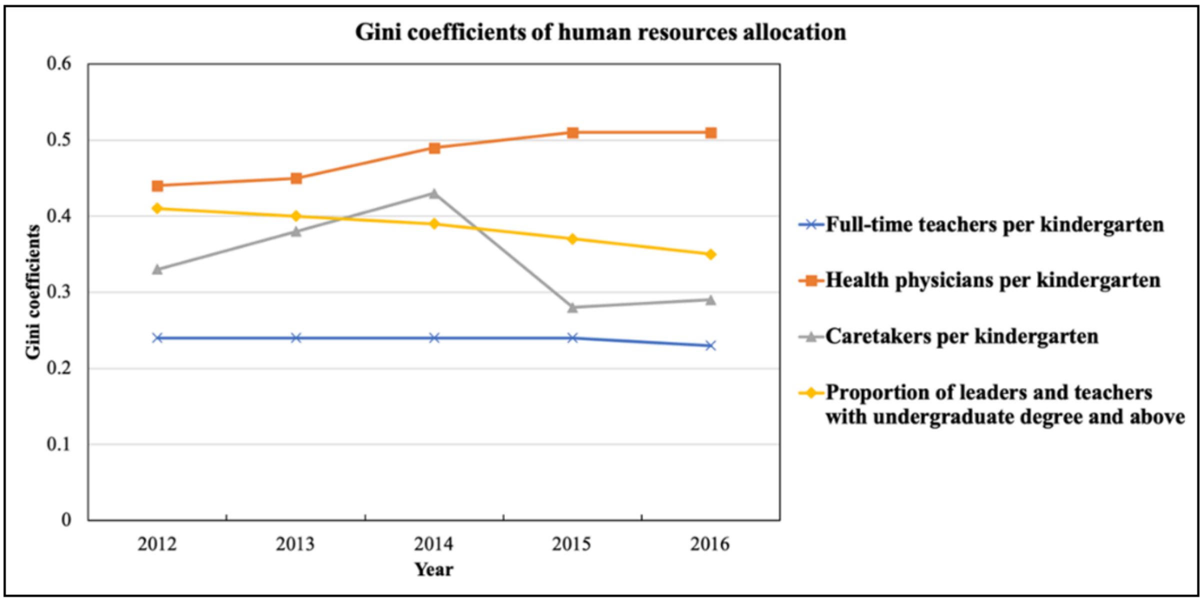

Figure 4. Gini coefficients of human resources allocation

3.2. **Gini coefficients of material resources allocation.** Based on experts' opinions, four indicators were selected as represented the material resources allocation domain.

Table 5 shows the Gini coefficients of average living space, average green area, and average book indicator are all below 0.4. The green area providing and book support for pre-school are quite equal as out results. In this domain, we found M4, indicator of average digital resource, with an increasing Gini coefficient values from 0.6 to 0.95, it demonstrates highly unequal distribution among provinces. The details of the trends with material resource allocation have been displayed in Figure 5.

TABLE 5. The result of Gini coefficients in material resources allocation

Indicators	Gini coefficients				
	2012	2013	2014	2015	2016
M1: Average living space	0.24	0.13	0.05	0.28	0.33
M2: Average green area	0.30	0.21	0.17	0.14	0.08
M3: Average book	0.18	0.10	0.06	0.01	0.02
M4: Average digital resource	0.60	0.63	0.61	0.82	0.94

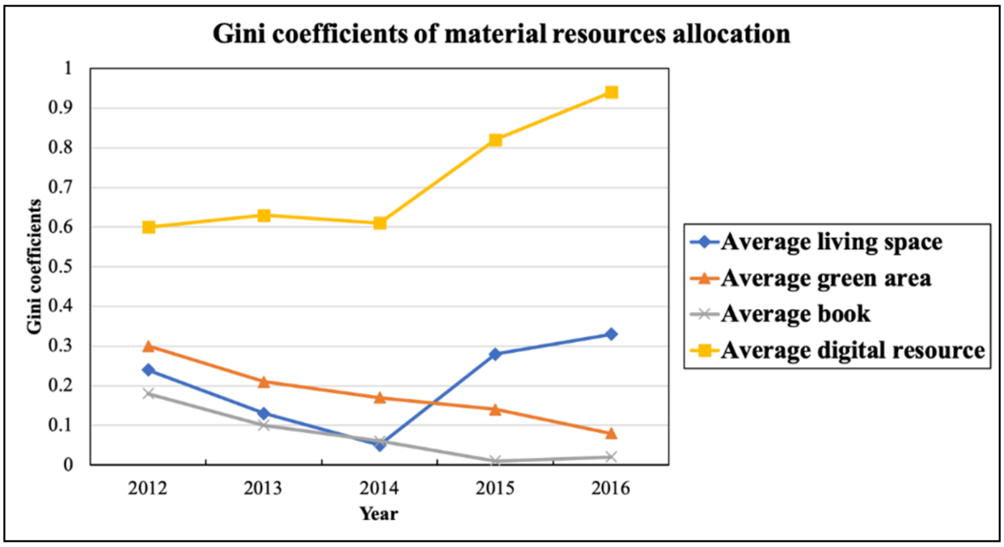

FIGURE 5. Gini coefficients of material resources allocation

3.3. **Gini coefficients of financial resources allocation.** Based on experts' opinions, we selected four indicators to transform Gini coefficients in financial resource allocation domain. The results of Gini coefficients in financial resources allocation are presented in Table 6.

TABLE 6. The result of Gini coefficients in financial resources allocation

Indicators	Gini coefficients				
	2012	2013	2014	2015	2016
F1: Average educational expenditure	0.45	0.53	0.47	0.44	0.42
F2: Average public finance budget education expenditure	0.52	0.51	0.56	0.53	0.59
F3: Average public expenditure	0.35	0.53	0.50	0.45	0.42
F4: Ratio of per capita public expenditures on education to per capita GDP	0.53	0.48	0.61	0.57	0.48

Table 6 demonstrates the Gini coefficients of financial resources allocation with the largest values. During these periods, almost all the indicators are above 0.4, except for the indicator F3 in 2012, which means the extreme unequal distribution in financial resource allocation. The details of the trends with financial resources allocation have been displayed in Figure 6.

3.4. **The emerging inequality indicators in pre-school education.** According to the results of Gini coefficients, we found there are still some indicators showing unequal or extreme unequal distribution during these five years. The details of the inequality phenomena have been displayed in Table 7.

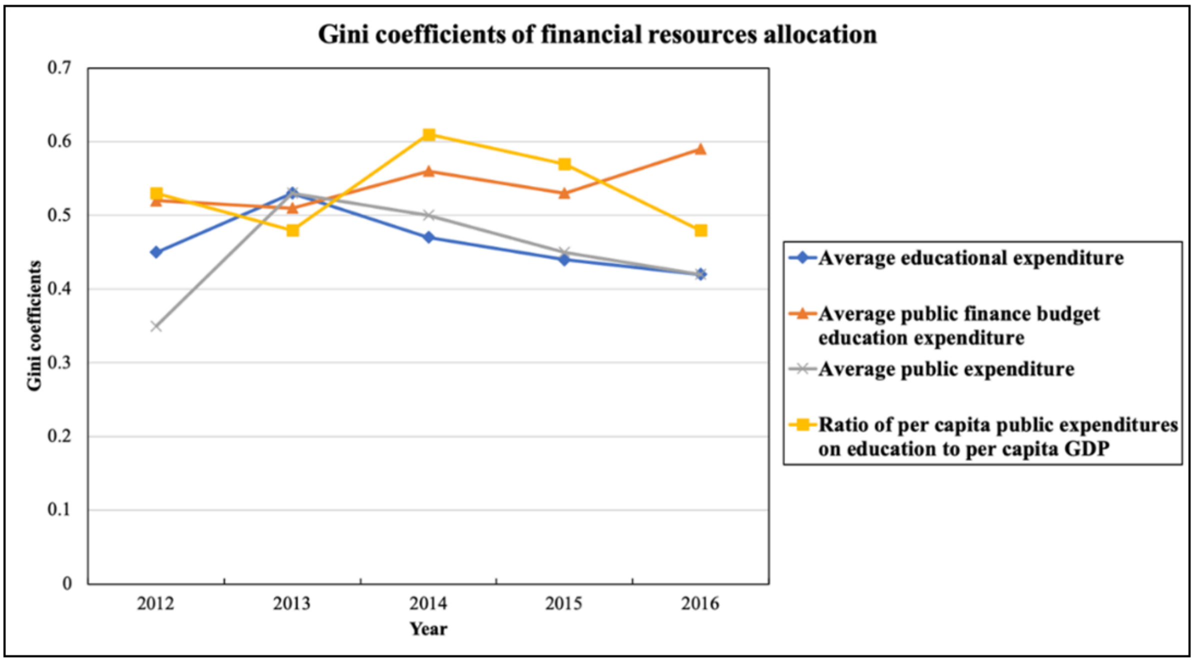

Figure 6. Gini coefficients of financial resources allocation

Table 7. Indicators of Gini coefficients over 0.4

Indicators	Gini coefficients				
	2012	2013	2014	2015	2016
H2: Health physicians per kindergarten	0.44	0.45	0.49	0.51	0.51
M4: Average digital resource	0.60	0.63	0.61	0.82	0.94
F1: Average educational expenditure	0.45	0.53	0.47	0.44	0.42
F2: Average public finance budget education expenditure	0.52	0.51	0.56	0.53	0.59
F3: Average public expenditure	0.35	0.53	0.50	0.45	0.42
F4: Ratio of per capita public expenditures on education to per capita GDP	0.53	0.48	0.61	0.57	0.48

Table 7 shows six indicators with Gini coefficients over 0.4. Following our classification, we can interpret the findings. First, both of the Gini coefficients of indicator H2 and M4 have shown increasing, implying the inequality issues worsen. Second, the inequality of indicator F1 and F3 has been alleviated based on their Gini coefficients. Third, Gini coefficients of F2 and F4 have shown variedly; it means the allocation of these two resources may be affected by some unstable factors. Compared with the inequality of financial resource allocation, it reflects more serious issue among these provinces. Faced with the problems of insufficient investment, unequal distribution of limited resources, and low efficiency, the suggestion goes to the government that it should continue to increase financial investment in pre-school education and effectively improve the resource shortage and quality caused by insufficient funds.

4. **Conclusions.** The Gini coefficient is used to examine the equality of resource allocation of pre-school education, including human resources, material resources and financial resources domains. Some indicators show unequal distribution or extreme unequal distribution, which provides the further efforts of pre-school education, such as referring to educational resource allocation indicators for specific research, establishment of an online database, and the continuous promotion of equal educational opportunities. In order to

develop indicators system to examine the equality issues of resource allocation in pre-school education, the logic of fuzzy questionnaire formation is a practical way to build the research tool. This study provides an example, from indicators selection to data collection and transformation, to tackle equality issues in similar settings for further studies, in which we can extend the indicators to cover more comprehensive contents to deal with issues.

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