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# The Equality of Distribution of Education Resources—The Case of 96 Universities in the US

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## Abstract

This study uses Gini coefficient and the different decomposition of Gini coefficient to investigate the equality of distribution of human capital and endowment. The result shows that neither the amount of endowment nor the number of teachers indeed causes a great deal of inequality in different schools. The contribution from full-time teachers is more than the contribution from the part-time teachers to the inequal distribution of teachers. For the inequal distribution of endowment, the contribution from the between-group is greater than the contribution from with-group.

## Keywords

Equality, Human Capital, Endowment, Education Resource, Gini Coefficient, Material Capital

## 1. Introduction

In 1999, the Chinese government made decision to expand the scale of enrollment in Colleges and universities, and in the subsequent years of continuous expansion, the size of enrollment is unprecedented. The expansion of enrollment in colleges and universities increases the opportunity for higher education and the higher education transform from elite education to mass education. According to 1996-2008 panel date, Jun's [1] study acquires that due to the implementation of education enrollment policy, the education opportunity inequality is greatly reduced and increased the chance for higher education. But it brings a series of problems, such as the shortage of college education resources. As the scale of Chinese colleges and universities has been expanded rapidly, and the conditions for running schools have been greatly improved. The quality of

school education becomes a prominent problem. So the education department requires each university to focus on the next phase of work, to improve the quality and equality of College education. Teachers and funds are the core of academic quality in Colleges and universities, in the past decades, as many scholar studies agree. Belfield and Fielding (2001) [2] proved that the teaching resources (students, teachers, equipment and daily expenses) directly affect the graduates' education. Ding and Zeng (2015) [3] reported the ranking of Chinese undergraduate universities for the recent 10 years, based on the great effect on human capital and physical capital. And every student should be treated equally as the theory of horizontal equality was proposed by Berne and Stiefel (1984) [4].

Since 1999, 72 Chinese universities belonging to the Ministry of Education (MOE) were selected as "985 Project" and "211 Project" universities; it aims to develop some outstanding universities to set a good example in teaching, research, and service to society for other. These MOE universities are distributed in 18 provinces, among which, Beijing, Shanghai, Jiangsu and Hubei have the largest amount. Till 2013, though accounting for only 8.5% of all Chinese universities (879 undergraduate universities), MOE universities occupy nearly total resources of Chinese higher education. In addition, since 2011, no more other universities were permitted to join in "985 Project" and "211 Project" by the ministry of education universities in China.

In this paper, we will study the distribution of endowment and teachers' equality in the US, as the United States is the world's most developed countries. The total investment in higher education and its diversified financing channels are in the world's leading position. The practice of higher education funding in the United States is known as the typical model of the western countries, and the source of higher education investment can basically points into four major blocks: one is government investment, including federal, state, and local government investment; second, personal and family involvement, namely, colleges and universities, the tuition and fees; the third is from the social investment, mainly including donation income; the fourth is the sales and service income. Due to the lack of date, we use the endowment in each school. In the US, the teachers are divided into part-time teachers and full-time teachers. The main difference between full-time teachers and part-time teachers is that full-time teachers have a job security, enjoy the basic benefits of the school, only to participate in teaching management, not to participate in other management work. Part time teachers have no job security, do not enjoy the benefits of the school, do not participate in any management work, and have been paid remuneration according to the course. According to China's terms, they are "temporary workers". At present, these "temporary workers" have accounted for 50% of the teaching staff of American University.

With regard to the consumption of special consumer goods, A. Druckman (2008) [5] estimates the inequalities between neighborhoods using Gini coefficient. Jiandong Chena and Jiantao Chena (2015) [6] use Gini coefficient to study the unbalanced development of Chinese inter-provincial high-grade highway from 1997 to 2013, the Gini coefficient is widely used to study the problem of

resource allocation. In this paper, we also use the Gini coefficient to study the resource distribution in the US higher education.

The rest of the paper is organized as follows. In Section 2, we review the earlier literatures. Section 3 presents the method of Gini coefficient, and also the Gini coefficient decomposition data are presented in Section 3. We discuss our empirical results in Section 4, and Section 5 concludes.

## 2. Literature Review

Equity and efficiency are two obviously important consideration in the analysis of the education sector all the time. Jill Johnes and Li Yu (2008) [7] uses data envelopment analysis (DEA) to examine the relative efficiency in the production of research of 109 Chinese regular universities in 2003 and 2004. Ding (2012) [8] study the basic factor that influence the production efficiency using 68 Chinese university belonging to the Ministry of Education (MOE) from 2001 to 2008. Maja Mihaljevic Kosor (2013) [9] summarize the concepts, method and perspective of efficiency in Higher Education, pointing out that efficiency is a suitable and needed goal for any educational system.

As for equity, Many researchers in the field of education (Bottani & Benadusi, 2006 [10]; Giancola, 2009 [11]) agree on the fact that the issue of equity is a crucial topic for the study of education systems. There are many ways to define equity in education, Benadusi (2006) [10] effectively summarizes the possible interpretations of equity into six different ideas: pure meritocracy, equal treatment, inter-individual equality, minimum threshold, equality between social groups (or of opportunities) and advantages for the disadvantaged. In the field of equity a few studies have already considered the equal opportunity. For example, evidence from many countries indicates a global, long-term trend of girls' access to schooling catching up with boys'. Moreover, the household register system which divides city and country, as well as increasing income inequality is deepening institutional barriers and stratum differentiation to influence the opportunity to school. Though gender and regional gaps have been reduced significantly, the population residing in economically disadvantaged areas, especially females, still warrants social concern (Jun Yang, Xiao Huang 2015 [6]).

Besides, Hong (2009) [12] takes the teacher and student ratio as an index to study the regional distribution of higher education resources, the result shows that the distribution of higher education resources in our country is not in equilibrium, and the imbalance in the distribution of the human population is higher than that of the income distribution. Our paper studies the distribution human capital as many researches agree that every student should be treated equally, also, human capital is important to the development of school.

## 3. Analysing Education Resource Inequality Using Gini Coefficient

### 3.1. Data Resource

How can measure education resource equality? Prior to the study of human capital

and material capital have an important impact on the education results, we select the human capital and material capital to study the distribution of the unfair. Schultz founded the theory of human capital, and defined the human capital is the knowledge, skills, experience, creativity and health status of the economic value of the human capital. In Colleges and universities, teachers and researchers are the most important human capital, in particular, the professor (Senior Teachers) with a wealth of knowledge, skills and experience; young teachers (senior and intermediate teachers) have a very strong innovation. Material capital refers to the form of long-term production, is the material basis of human capital. In Colleges and universities, material capital is all kinds of educational resources and facilities. Among them, laboratory, library, the library and the classrooms (Teaching Department of education, 2009) and school covers an area, laboratory equipment and teaching etc. is an important place for teaching and research activities and the basic conditions; and according to the fixed assets management system, buildings, vegetation, electronic equipment, medical, office equipment, sports goods of fixed assets in Colleges and universities are also indispensable for the development of the elements; in particular, education and scientific research funds is an important component of the material capital.

Due to the limitation of data, we just analyze the full-time teachers and part-time teachers separately as for the human capital and the endowment as for the material capital. The endowment data are from the National Association of College and University Business Officers (NACUBO), which consist of those gathered from 832 U.S. colleges and universities for the 2014 NACUBO-Commonfund Study of Endowments. Eliminating five schools belonged to Canad and the two that the data was defected. We just choose the top 100 schools, which listed in Table 1. The data on students and teacher are from IPEDS, and the data are from 2014. The teachers include both full-time and part-time teachers.

### 3.2. Method

There are multiple ways to measure degrees of inequality, such as the Theil-L Index, the coefficient of variation,, and the Gini index. The main reasons this study chooses the Gini coefficient as the measurement are that, first, the Gini index is used widely to measure multiple types of distribution difference (Sen, 1997) [13], and second, with the advancement of Gini coefficient decomposition methods, we can apply more dimensions to find out the causes of the unbalanced development.

Gini coefficient of total and different types of teacher

$$G = \frac{1}{2n^2\eta}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|y_{\text{end-stu}}^{i} - y_{\text{end-stu}}^{j}\right| \tag{1}$$

$$G = \frac{1}{2n^2\eta}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|y_{\text{tea-stu}}^{i} - y_{\text{tea-stu}}^{j}\right| \tag{2}$$

$$G_{\text{full-stu}} = \frac{1}{2n^2\eta}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|y_{\text{full-stu}}^{i} - y_{\text{full-sti}}^{j}\right| \tag{3}$$

Table 1. The names of the schools.

| The name of university | The name of university |
|---|---|
| University of Tennessee System | University of Wisconsin Foundation |
| The University of Georgia Foundation | University of Missouri System |
| University of Florida Foundation, Inc. | University of Illinois and Foundation |
| Texas Tech University System | University of Nebraska |
| University of Alabama System | University of Oklahoma |
| University of Arkansas-Fayetteville | University of Cincinnati |
| University of Kentucky | Purdue University |
| Virginia Commonwealth University | Michigan State University |
| Baylor University | University of Minnesota and Foundation |
| Georgetown University | The Kansas University Endowment Association |
| Tulane University | Saint Louis University |
| Southern Methodist University | Indiana University and Foundation |
| University of Texas System | University of Michigan |
| Texas Christian University | Case western Reserve University |
| Wake Forest University | The University of Tulsa |
| University of Virginia | Washington University in St. Louis |
| Vanderbilt University | Northwestern University |
| Duke University | University of Chicago |
| Emory University | University of Notre Dame |
| Trinity University (Texas) | Swarthmore College |
| University of Richmond | University of Colorado Foundation |
| Baylor College of Medicine | University of California |
| Washington & Lee University | The UCLA Foundation |
| Rice University | University of California, Berkeley Foundation |
| Berea College | University of Washington |
| University of Lowa and Foundation | The George Washington University |
| Boston University | University of Southern California |
| Tufts College | The Rockefeller University |
| Boston College | California Institute of Technology |
| Brown University | Stanford University |
| Middlebury College | Pomona College |
| Smith College | University of Pennsylvania |
| Dartmouth College | Rutgers, the State University of New Jersey |
| Bowdoin College | Carnegie Mellon University |
| Wellesley College | Johns Hopkins University |
| William College | University of Pittsburgh |
| Grinnell College | Yeshiva University |
| Amherst College | University of Rochester |
| Harvard University | Cornell University |
| Yale University | Columbia University |
| Massachusetts Institute of Technology | University of Delaware |
| Princeton Theological Seminary | Syracuse University |
| University of California-San Francisco Foundation | New York University |
| The Texas A&M University System and Foundations | Lehigh University |
| The University System of Maryland Foundation, Inc. | Vassar College |
| Georgia Institute of Technology and Related Foundations | Princeton University |
| University of North Carolina at Chapel Hill and Foundation | |

$$G_{\text{part-stu}} = \frac{1}{2n^2\eta}\sum_{i=1}^{n}\sum_{j=1}^{n}\left|y_{\text{part-stu}}^{i} - y_{\text{part-stu}}^{j}\right| \tag{4}$$

where, in formula (1), $y^i$ and $y^j$ are the numbers of total endowment per unit of students in the $i$th and $j$th school. $\eta$ is average numbers and there are n schools. similar to formula (1), formula (2) is the calculation equation for the Gini coefficient of the total teachers per units of students. Formula (3) is the calculation equation for the Gini coefficient of the full-time teachers per units of students. (4) is the calculation equation for the Gini coefficient of the part-time teachers per units of students.

Decomposition contribution rate and its increment according to different types of teacher

In this subsection, we study further the contribution of different types of teacher to the degree of unbalanced of teachers in different universities. The study uses formulas 5 - 6 to decompose the Gini coefficient of teachers of per students according to the different types of teacher, as follows:

$$G = \sum_{n=1}^{4} E_n G_n' = \sum_{n=1}^{4} R_n E_n G_n \tag{5}$$

where $G$ represents the Gini coefficient of summed numbers of teacher of per student; En represents the proportion of the number of teachers of type $n$ to the total teachers; $G_n$ represent the Gini index of type $n$; and $G_n'$ represents the concentration index (also called the pseudo Gini coefficient) of type $n$. when the total number of teacher are ranked from lowest to highest, a rank of teachers of type $n$ is possible not strictly from lowest to highest; in this situation, $G_n'$ is called the pseudo Gini coefficient, and $G_n'$ does not equal $G_n$. because there are 96 schools involved in this study, $q = (1, 2, \cdots, 96)$, and then, the teacher of type n in unit $q$ is $x_{qn}$.

$$R_n = \frac{\sum_{q=1}^{96}\left(q - \frac{96+1}{2}\right)x_{qn}}{\sum_{q'=1}^{96}\left(q' - \frac{96+1}{2}\right)x_{qn}} = \frac{\operatorname{cov}\left(x_n, q\right)}{\operatorname{cov}\left(x_n, q'\right)}$$

is the Gini correlation coefficient between type n numbers of teachers and total number of teachers (Larman and Yitzhaki, 1985 [14]).

Then, the contribution of type n teacher's imbalance to overall unbalanced teacher can be expressed as $\frac{E_n G_n'}{G}$.

Then, we can obtain the dynamic results of the decomposition:

$$\Delta G = G^{t_1} - G^{t_0} = \sum_{n=1}^{2} G_n^{t_0}\Delta E_n + \sum_{n=1}^{2} E_n^{t_0}\Delta G_n + \sum_{n=1}^{2}\Delta E_n \Delta G_n \tag{6}$$

where $\Delta E_n = E_n^{t_1} - E_n^{t_0}$ represents the change of the proportion of type n teacher's number to the total number of teacher from the base period to the current period. $\Delta G_n = G_n^{t_1} - G_n^{t_0}$ represents the change of the concentration index (pseudo Gini coefficient) of the numbers of teacher per student from the base period to current period. Thus, the change of the Gini coefficient of summed

teachers per student can be decomposed into three parts: first, the construction effect caused by the structural changes of teachers per students of all types of teachers; second, the concentration effect caused by the change of the concentration index of teachers per students of all types of teachers; and third, the comprehensive effect of these two effects.

Decomposing Gini coefficient according different regions

In this section, we study the impact of different regions on the distribution of endowment. There are diverse way to decompose Gini coefficient, such as the method putted forward by Zhang and Li (2002) [15], Yitzhaki and Lerman (1991) [16]. In this paper, we use the decomposing Gini coefficient proposed by Anthony Shorrocks (2005) [17] because of the reasonable interpretation of $R$ to avoid the existence of overlapping data and a biased result. The specific contents are described below. Let G be the Gini coefficient and let the population subgroups be indexed by $k = 1, 2, \cdots, m$. The decomposition takes the form:

$$\begin{aligned} G = G\left(y^1, y^2, \cdots, y^m\right) &= \frac{2}{n^2\mu}\sum_{k=1}^{m}\sum_{j\in N_k} r_i\left(y_i - \mu\right) \\ &= \frac{2}{n^2\mu}\sum_{k=1}^{m}\left\{\sum_{i\in N_k} i\left(y_i - \mu_k\right) + \sum_{i\in N_k} i\left(\mu_k - \mu\right) + \sum_{i\in N_k}\left(r_i - i\right)y_i\right\} \\ &= W + B + R \end{aligned} \tag{7}$$

where

$$W = \frac{2}{n^2\mu}\sum_{k=1}^{m}\sum_{i\in N_k} i\left(y_i - \mu_k\right) = \sum_{k=1}^{m} v_k^2 b_k G\left(y^k\right) \tag{8}$$

$$\begin{aligned} B &= \frac{2}{n^2\mu}\sum_{k=1}^{m}\sum_{i\in N_k} i\left(\mu_k - \mu\right) = \sum_{k=1}^{m} b_k v_k\left[\sum_{j=1}^{k} v_j - \sum_{j=k}^{m} v_j\right] \\ &= G\left(y^{\bar{1}}, \cdots, y^{\bar{m}}\right) \end{aligned} \tag{9}$$

$i$ occurs in the $i$th position when the teacher distribution is written $y = (y^1, y^2, \cdots, y^m)$, and in position $r_i$ when all teacher in increasing order. The first term of the right-hand side in Equation (7) is the within-group contribution, while the second term is the between-group component of education inequality. $R$ is a residual, which is zero if the subgroup observation ranges do not overlap. When we aim to analyze inequality caused by school type, schools should be divided into two subgroups. In the other situation, it should be divided into three.

## 4. Empirical Result

In Table 2 we describe summary statistics of key variables used in our study. Note that there are wide differences between the max value and the mix value in every variable. For example, a school can have 23451 full-time teachers, while the other only have 40 full-time teachers. In Table 3, according the endowment, we take it from high to low, then, we sort it into 5 subgroups and calculate the proportion of each subgroup. We notice that the top 25 have the most endowment which accounting for 78%. And the last 16 schools accounted for only 10%. From the summary statistic, we notice that the distribution of endowment

is enormous inequality and we further analyze the issue.

First, we measure and calculate the Gini coefficient of the endowment, full-time, part-time and total teachers per student, using the date in 2014 because of the lack of data for other years, but it is meaningful to measure the trends of the distribution with the change of the time if the data is available.

As we all know that Gene coefficient was initially used to calculate the income inequality which ranges from 0 to 1. When the Gini coefficient is 0, it represent that it is the perfect equity, when the Gini coefficient is 1, it represent complete inequity. And the bigger Gene coefficient, the more unfair. In general, The Gini coefficient is between 0.36 and 0.24 in developed country. In accordance with the provisions of the relevant United Nations organizations, 0.4 is the picket line, which means that when the Gini coefficient beyond 0.4, the distribution is largely inequality. In our paper, the Gini coefficient of endowment per student is 0.682, and the Gini coefficient of total teachers per student is 0.4863 (see Table 4). All of the Gini coefficients beyond 0.4, the result should be arouse our great attention.

In the next section, we analyze the effect of part-time teachers per student and the full-time teachers per student to the total teacher-student. And then we analyze whether the distribution of endowment is affected by regions or not.

Decomposition contribution rate and its increment according to different types of teacher

According to data, the teacher is consisted by two types, the first one is full-

**Table 2.** Summary statistics.

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| Number of students in school | 29046.16 | 38356.18 | 208 | 247534 |
| Number of full time teacher | 2747.677 | 2967.38 | 40 | 23451 |
| Number of part time teacher | 817.6882 | 1079.868 | 20 | 6602 |
| Number of endowment | 3990999 | 5872323 | 916828 | 3.59e+07 |

Source: IPEDS and NACUBO (National Association of College and University Business Officers).

**Table 3.** The proportion of different parts into total resource with decreasing order.

| The number of school | 5 | 6 - 25 | 26 - 50 | 51 - 75 | 76 - 93 |
|---|---|---|---|---|---|
| Endowment-students | 0.398 | 0.389 | 0.156 | 0.0145 | 0.0116 |
| Full-time teachers-students | 0.187 | 0.321 | 0.385 | 0.119 | 0.077 |
| Part-time teachers-students | 0.0875 | 0.367 | 0.039 | 0.208 | 0.121 |
| Total teachers-students | 0.169 | 0.319 | 0.008 | 0.136 | 0.085 |

**Table 4.** Different kinds of gini coefficient.

| Variable | Gini |
|---|---|
| Endowment-students | 0.682 |
| Total teachers-students | 0.4863 |

time teacher and the second one is part-time teachers. The part-time teachers is the one who only need to fulfill the responsibility of teaching, be responsible for teaching, and do not need to participate in all activities of the school.

We calculate the contribution of different types of teachers per student, the result listed in Table 5 shows that the contribution of full-time teachers per student is 0.867 and the contribution of part-time teachers per student is 0.133.

There are two reasons to interpret the phenomenon. First, according to Table 6, the Gini coefficient of full-time teachers per student is more unfair than the part-time per student. Second, not only the internal distribution of the different types of teachers, but also the number of the type of teachers per student is an important factor. As we can see from Table 7, most teachers are full-time teachers, and it accounting for 0.82 to the total teachers per student.

Besides, if we have the data in other years, we can analyze the change of the Gini efficient and the contribution of different types using the approach mentioned in the section of method.

Decomposing Gini coefficient according different regions

In this section, we study the factor of regions. As we all know, the Chinese is sort into east, west and central. Similarly, the United States is also divided into different regions. Though there are many way to divided the, we use a combination of basic and conventional way, which it was divided into five regions—New England, The central coast of the Atlantic, South, Midwest, West. The schools distributed into different regions, the New England consist 16 schools, the central coast of the Atlantic consist 18 schools while the south, midwest, west include 28 schools, 20 schools, 11 schools respectively, which is listed in Table 8.

Table 5. The contribution of different types of teacher.

| | Full-time teachers-students | Part-time teachers-students | Proportion |
|---|---|---|---|
| Contribution | 0.867 | 0.133 | 6.5 |

Table 6. The Gini coefficient of different types of teacher.

| Variable | Gini coefficient |
|---|---|
| Full-time teachers-students | 0.51 |
| Part-time teachers-students | 0.4624 |

Table 7. The proportion of number of different types of teachers per student to total teachers per student.

| Type of teachers | Full-time teachers per student | Part-time teachers per student | F/P |
|---|---|---|---|
| Percentile | 0.82 | 0.18 | 4.56 |

Table 8. Decomposition by subgroups.

| Subgroups | Within-group Contribution (%) | Between-group Contribution (%) | R(%) | W/B |
|---|---|---|---|---|
| | 17.2 | 49.6 | 35.7 | 2.89 |

Table 9. The number of the school and the ratio of the endowment in each region.

| District | New England | central coast of the Atlantic | South | Midwest | West |
|---|---|---|---|---|---|
| number | 16 | 18 | 28 | 20 | 11 |
| endowment | 0.268 | 0.381 | 0.154 | 0.101 | 0.097 |
| End-stu | 0.293 | 0.370 | 0.096 | 0.088 | 0.154 |

When decomposing for the new England, central coast of the Atlantic, south, midwest and west regions, empirical results show that the contribution rate from within-group components is triple than that of between-group component. The comparison in Table 9 indicates the share of endowment among each region. The first line represent the number of school in each region; the second line represent the proportion of endowment in each region to the total endowment; and the third line represent the proportion of endowment per student in each region to the overall endowment per student. The New England and the central coast of the Atlantic contain 34 schools, received most of the endowments, while the south contain 28 schools just received 15% of endowment. However, the within-group disparity still deserves special attention. The within-group contribution mainly comes from gap between relative advanced and the comparative backward schools in the same region. For example, Harvard University and Grinnell College all belong to New England region but the former trails the latter in education endowment. The implication may lie in that each school has its own characteristics, so more regional appropriate polices should be implemented.

## 5. Conclusions

The purpose of this study is to analyze the situation and the reason of the higher education resource inequality in US. At the beginning, we adopt the Gini coefficient to measure the higher education resource inequality in US. The result shows that neither the amount of endowment nor the number of teachers, there is a great deal of unfairness in different schools.

Next, based on the Gini coefficient decomposition method by different types of teacher, we decomposed education inequality for variables of part-time teachers and full-time teachers. The finding is that the contribution from full-time is so big because the famous schools have more attraction and more ability to apply the position to teachers. Besides, the number of full-time teachers is more than part-time teachers.

Then, we decompose the Gini coefficient of endowment by the variable of regions. The result shows the contribution from between-group is much greater than that from within-group. The New England and the central coast of the Atlantic have more endowment than South, Midwest and West.

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