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RESEARCH ARTICLE

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# Regional Inequality of Higher Education Resources in China



**Abstract** With the expansion of the higher education system in China since the late 1990s, questions on the distribution of higher education opportunities and resources have attracted increasing attention from academics, policymakers, and the general public. While there have been an increasing studies on the development of higher education opportunity equality in China, quantitative, systematic research on the distribution of higher education resources across China is still rather limited. This paper aims at filling this gap. It provides quantitative and comprehensive evidence on the development of the distribution of higher education resources across Chinese provinces. The analysis is based on a provincial panel dataset and uses a generalized Theil index to measure inequality. Results show that higher education resources have been far from equally provided in relation to the size of provincial student populations in China. The unequal distribution has become even more pronounced over the past decade. In other words, even if high school students have an increasingly equal access to higher education in China (Bickenbach & Liu, 2013b), the increasingly unequal distribution of higher education resources makes it difficult for university students to equally benefit from higher education.

**Keywords** education resources, China, higher education, regional inequality, Theil index

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## Introduction

China's rise to become the second largest economic power in the world is an amazing success story of the recent past. Its rapid economy development has been gradually challenged since 2012, however, with its annual growth rate decreasing from an on average two-digit level to about 7 % in the past few years. Thus, China's President Xi Jinping made it clear in 2014 that China needs to adapt and get used to the "new normal" of Chinese economy. Under the "new normal," the Chinese economy will grow at lower rates than before, but the quality should be enhanced. To achieve it, Chinese government is turning to encourage key innovation activities more strongly than ever. Innovation should help Chinese industries to climb up global value chains and foster economic growth (CCCPC & SC, 2016). In addition to innovation, Chinese government also emphasises that structural reforms are required to support the quality of growth in China. One aspect of these reforms relates to regional disparity in the economic structure and development (Chen, 2015). Regional policies should continuously support the realisation of a more balanced economic development across regions in China. Against this background, promoting innovation and at the same time supporting a more balanced regional economic development becomes a crucial challenge for China.

As highlighted in Nelson and Phelps (1966), one essential determinant of innovation is human capital. A highly qualified labour force is required to carry out complicated innovation activities in established firms. Such skilled persons are also advantageous for producing new ideas and initiating more sophisticated innovation and upgrading activities that go beyond the boundary of existing firms (Acs, Braunerhjelm, Audretsch, & Carlsson, 2009; Acs, Audretsch, & Lehmann, 2013; Aghion et al., 2009). To promote innovation and encourage a more equal regional economic development, expanding the pool of human resources with advanced knowledge and skills in all provinces of China can thus be considered a highly relevant policy instrument. Due to the crucial role of universities in human capital development, it is to be expected that such policies should lead to a more equal access to the higher education system across provinces in China.[1] Before any policy evaluation in this regard can be carried

[1] This paper does not argue that a more equal distribution of human resources—compared to a more concentrated distribution of human resources—is more advantageous for innovation. Instead, this paper expects that a more equal distribution of higher education resources in China is advantageous for expanding human capital bases in all provinces. This expansion in turn is then advantageous for all provinces to achieve a more quality-oriented growth model.

out in the future, one needs to have a better overview of the distribution of higher education opportunities and resources and its development over time. While there has been for some time an increasing research on the distribution of higher education opportunities in China, quantitative and systematic research on the distribution of higher education resources is still rather limited. This paper thus aims at filling this gap by providing quantitative and comprehensive evidence on the development of the distribution of different types of higher education resources over time. The evidence is obtained by using a generalised Theil index as an inequality measure to analyse a pertinent province-level panel dataset for the years 2003 to 2013.

The remainder of the paper is organised as follows. A brief literature review is provided in the second section. Building on the previous literature, our research concept, including the methodology applied and data used for the analysis, is introduced in the third section. The results of the analysis are presented in the fourth section, and the fifth section concludes with policy implications.

## Literature Review

Inequality in education in China has been a long-lasting hot topic for academics, policymakers, and the general public over the years. As education in general and higher education in particular have become one of the central policy foci of Chinese government since the late 1990s, the research and discussions on the topic have been further intensified and extended (Hawkins, Jacob, & Li, 2009).

Many studies in this area focus on selected research regions to obtain detailed knowledge of potential sources of inequality in accessing education in China. Among others, individuals' or families' economic background, gender, location, and ethnic background etc. are the often focused-on sources of unequal education access in these studies (Jacob & Holsinger, 2009). The studies are mainly based on qualitative research methods such as interviews, field experiments, and case studies. Cross-section regression analysis has been sometimes carried out for few selected research years depending strongly on the availability of the relevant data. These studies are highly important, since they provide detailed and down-to-earth evidence explaining whether and why the abovementioned sources of education discrimination may matter. Some key findings can be summarised as follows.

The analysis of Yu and Hannum (2006) shows that families' economic

background plays a key role in determining whether children may or may not be able to go to schools. Families with bad economic backgrounds may also be less capable of caring for their children's health. As a result, even if these children may go to schools, their health conditions may make it more difficult for them to complete all courses with high levels of concentration and energy. They may thus not be able to achieve comparable school outcomes as their healthy schoolmates. Families' economic background may also determine how they evaluate their investment in their children's education both in terms of time and financial resources. Parents are more motivated to send their children to school if the expected benefits obtained, for example, through a better employment prospect after school are larger than the financial loss they experience while children go to school and thus cannot work and help earn money for their families (Wu, 2009). However, going to school does not necessarily guarantee a higher employability after graduation. Xiao's analysis (2006) for Yunnan province shows, for example, that what children learn from their rural classrooms does not seem to match the labour skills required by local firms. In this case, whether education can help students find better-paid jobs in local firms is doubtful. Similar doubts on the potential benefits of education for future employment are documented in the analysis by Postiglione, Jiao, and Gyatso (2006) of Tibet as well. Such doubts would reduce the expected benefits of education investments that the families make for their children. As a result, families may become less motivated to send their children to school or may ask their children not to complete their studies but to drop out of school earlier.

Families' economic background also matters for high-school students' probabilities of accessing university education. Hawkins et al. (2009) argue that students from families with higher incomes tend to have a higher probability of entering national universities, which tend to be located in the eastern region of China and to be equipped with better higher education resources, while those from poor families tend to go to local universities with lower education quality.[2]

[2] The authors use a survey dataset for their analysis. What is missing in the analysis is, however, a consideration of reference values for the distribution of students by family income. The finding that students from wealthier families tend to go to national universities which tend to be located in the eastern region of China can be derived from the fact that wealthier families tend to be more prevalent in the same region as well. The generalised Theil index used for our analysis makes it possible to consider provincial characteristics as references.

Families' economic background is, of course, not the only source of unequal access to education in China. Children from the same economically disadvantaged family may also have different probabilities of going to school. Gender can play an important role in this regard. If families are financially incapable of sending all their children to school, they may tend to send sons to schools rather than daughters, for example. This may be due to cultural reasons as sons are traditionally more responsible in China for taking care of their parents and grandparents (Hansen, 2004). Thus, the investment in sons' education may be more worthwhile than investment in daughters' education. The role of gender in education inequality in China is expected to become more complicated with the economic development in China over time on the one hand and with the one-child policy and the rising boy-biased sex-at-birth ratio in China on the other hand (Jacob, 2007).

Jacob (2007) also looks at ethnic affiliation as a source of inequality in education in China. He particularly emphasises the role of language in this regard. Even if ethnic minority students may obtain support from the government in terms of, preferential treatment for entrance exams and financial resources to cover tuition fees, for example, their lack of Mandarin fluency may be a substantial disadvantage for them at school or university. They may also face integration problems in schools or universities attributable to their minority background and the unfamiliarity of non-minority students with minority cultures. Together with the language problem, the integration problems may make it more difficult for the minority students to interact effectively with their classmates to exchange knowledge, carry out group work and achieve good study outcomes. Their benefits from education may therefore be limited.

Such integration problems are not limited to ethnic minority students only. Kwong (2006) argues that migrant children living and going to schools in urban areas are also faced with such integration challenges. Migrant children may feel isolated due to their geographic origin and social status that may limit the potential education benefits that they otherwise may obtain. Different from minority students, the government's support for migrant students has been very limited. Their families may thus be forced to cover the generally higher tuition fees of schools in the urban areas on their own. The financial burden and integration problems may induce some migrant families to send their children to migrant children's schools instead, where both the tuition fees and the

heterogeneity among students regarding their migration background are generally lower. The education quality of these schools is, however, lower as well. In short, migrant children are generally also disadvantaged with respect to both education access opportunities and education quality.

All in all, as argued by Postiglione (2006), "… it is the rural poor, ethnic minorities, girls and migrants that have the monopoly on low enrolment and high dropout rates" (p. 5). These factors may not always come alone but are possibly jointly relevant in some families which belong to minority groups and originally come from geographically remote areas with low income on average and low employment possibilities. They need to move to urban coastal areas for work. The disadvantages the children of these families face may thus reinforce each other, making it all the more difficult to gain comparable and adequate access to education.

All these studies are important. They provide detailed and generally qualitative information about the education inequality faced at a highly disaggregated level, namely individuals, families, and households, in China. The findings, however, are usually specific to certain regions where the research is done, e.g., certain counties or cities in specific provinces, and to limited years for which they have data for the analysis. More aggregate analyses, covering a wider range of regions and years, are required to complement the existing research findings and provide a more general overview of the topic for China.

Regarding education inequality in China, with focus on higher education, there is another strand of research trying to provide quantitative evidence in this regard at a much more aggregated level. These analyses can supplement the studies introduced above, providing insights into how higher education opportunities and/or resources are distributed across Chinese provinces, abstracting from the abovementioned discrimination factors. While this abstraction is required to enable a large-scale quantitative analysis for the whole China, it also means that the results of these analyses need to be interpreted with caution. Even with a finding showing a strong improvement in inequality in accessing higher education in China over time, it does not mean that every student irrespective of her/his gender, and economic, locational, ethnic and migrant background, may benefit from the improvement in the same way. For overall policy directions such an overview of the developing trends in education inequality is, however, necessary. The findings will not be over- or underestimated if one can keep the

role of the typical discrimination factors at the household level in mind. Findings from both strands of research are thus supplementary, enabling an appropriate combination of policies for general education development and measures for dealing with more specific or idiosyncratic challenges.

This second strand of research has generally focused on analysing the development of the distribution of higher education opportunities across Chinese provinces over time. By using different inequality measures and different (short-period) datasets, previous analyses obtain empirical evidence that indicates different developing trends of the distribution of higher education opportunities in China over time. For example, Shen (2007b) uses the coefficient of variation to calculate regional inequality in terms of the number of universities over selected years between 1949 and 2003, and finds a decreasing trend over the research period. In contrast, Shen (2007a) cannot identify a clear developing trend, when the analysis is carried out based on provincial statistics of new university students from 1989 to 2000 and on both the coefficient of variation and the Gini index for inequality measurement. Different from Shen (2007a), the analysis of Liu, Zhao, and Sun (2009) based on various inequality measures such as the coefficient of variation, the Gini index, and the traditional Theil index provide evidence rather suggesting that the regional inequality of university students decreased in relation to the provincial population size over the years 2004 to 2006. One more comprehensive study on this topic is provided by Liu (2007). By applying both Gini and Theil indices to analyse a dataset for the years 1998 to 2006, Liu (2007) suggests a decreasing trend of inequality of higher education proxied by the number of university students in relation to the provincial young population size. A rebound of inequality could be observed in 2006, however. The analysis of Liu (2007) is extended by Bickenbach and Liu (2013b) in various aspects. Bickenbach and Liu (2013b) use a provincial panel dataset for a period from 1997 to 2008. They consider a larger variety of variables to proxy the higher education opportunities and take into account the provincial heterogeneity. For measuring inequality, Bickenbach and Liu (2013b) apply a more generalised inequality measure, namely the generalised Theil index, and carry out decomposition analyses to search for (regional) sources of inequality. Their analysis shows a decreasing trend of regional inequality of higher education opportunities in relation to the provincial size of the (young) population over the research period. The poorer provinces are found to benefit

relatively more from the development trend than the richer ones.

Bickenbach and Liu (2013b) focus, however, on general aspects of access to higher education only, i.e., on the number of universities and the number of university places. They leave the quality aspect of the analysis, namely the distribution of higher education resources, for future research. The fact that universities in China differ widely in their quality is well evidenced by Zhong (2011). Wang (2016) also indicates that Chinese universities can be classified into ten ranks in the national bureaucratic system. Universities with higher ranks generally benefit more from government education and research funds. This affects the higher education quality that universities can provide to their students. Relying on the number of universities and university places to investigate the issue of higher education inequality over time would thus be not sufficient. Hence it is of high relevance to consider the quality aspect proxied by higher education resources while investigating the issue of equal access to higher education in China.

The current paper thus aims at filling the gap left by Bickenbach and Liu (2013b). More concretely, we take Bickenbach and Liu (2013b) as the base for our analysis aiming at investigating the development of inequality of higher education resources across provinces in China. As Bickenbach and Liu (2013b) do, we use the generalised Theil index particularly for its feature of "additive decomposability" that is important for our analysis here.[3] We analyse a provincial panel dataset for a more recent time period, 2003–2013, covering various variables to proxy higher education resources spanning from teaching

[3] See F. A. Cowell (2011). *Measuring inequality* (3rd ed.). Oxford, England: Oxford University Press, for more information. The additive decomposability feature "makes it possible to trace the overall changes in the inequality of higher education opportunities [here: resources] between provinces to changes in the corresponding inequality within and between meaningfully defined subgroups of provinces (e.g., larger geographic regions)" (Bickenbach & Liu, 2013b, p. 276). The Gini index may also be used to calculate the inequality levels of the of higher education resources across provinces in general. But due to its lack of the additive decomposability feature, no decomposition analysis can be done. Such an analysis is, however, crucial for our research purpose here. The regional Gini index mentioned here should not be confused with the Education Gini used in education literature. While both the regional Gini index and the Education Gini share the same technical concept, the Education Gini is calculated to measure the inequality in educational attainment for countries or regions (e.g., V. Thomas, Y. Wang, & X. B. Fan (2001). Measuring education inequality: Gini coefficients of education (Research Working Paper no. 2525. Washington, DC: World Bank). Since the focus of the paper is not to gain insights into the distribution of population with different educational attainment across provinces in China but to provide evidence on the distribution of higher education resources available to university students as a determinant of higher education quality, no traditional Education Gini is calculated here.

personnel to physical assets and to related financial investment. The findings are expected to provide additional insights into higher education inequality in China, because inequality is not just a matter of getting access to a university but also relates to resources that university students from different provinces may enjoy for their studies.[4]

## Research Concept and Research Data

### Research Concept

As mentioned above, the current paper takes Bickenbach and Liu (2013b) as its base and aims at filling the gap left by them to investigate the development of the distribution of higher education resources over the last decade.[5] Thus, we apply the same inequality measure as Bickenbach and Liu (2013b) for our analysis. Since our focus is on higher education quality instead of higher education access, we consider variables different from theirs to proxy the higher education resources.

As our general inequality measure we apply the generalised Theil index[6]

[4] While there are, in fact, some studies which also analyse the regional distribution of higher education resources in China, e.g., Y. P. Cui (2010). 省域高等教育实力的分类评价 [Classification and evaluation of China's regional strength of higher education]. 清华大学教育研究 [*Tsinghua Journal of Education*], *31*(1), 45–50; L. L. Hou & L. Xue (2008). 我国高等教育资源区域分布的变化及其政策含义 [Changes in the distribution of higher education institutions in China and its policy implications]. 清华大学教育研究 [*Tsinghua Journal of Education*], *29*(6), 56–61), these studies do not provide a systematic and comprehensive analysis for a longer time period as provided in this paper.

[5] The terms "universities" and "higher education institutions" used in this paper refer to "regular higher education institutions" in China. Education resources and students considered in this paper are the education resources provided by and students studying in these institutions.

[6] The Theil index has been widely used to measure the income inequality among (groups of) individuals. It is not restricted to that purpose, however. The Theil index belongs to the class of generalised entropy measures, and can be interpreted as a disproportionality measure of concentration, specialisation, and localisation. As such it can be used to measure the regional concentration and specialisation of resources or activities of focus, if the research units are geographic units instead of individuals (see F. Bickenbach & E. Bode (2008). Disproportionality measures of concentration, specialization, and localization. *International Regional Science Review*, *31*(4), 259–288. doi: 10.1177/0160017608319589, for more technical information). The generalised version of the Theil index used here enables us to make decisions on the province-specific weights and references, depending on our research purpose. This is an advantage over the traditional Theil index where no references and no province-specific weights are considered.

which is defined as follows:

$$T^{wr} = \sum_{i=1}^{I} w_i \frac{\frac{X_i}{\Pi_I}}{\sum_{i=1}^{I} w_i \frac{X_i}{\Pi_i}} \ln\left(\frac{\frac{X_i}{\Pi_i}}{\sum_{i=1}^{I} w_i \frac{X_i}{\Pi_i}}\right), \quad (1)$$

where $I$ is the number of observations (provinces) for the analysis and $X_i$ ($i$ = 1, …, $I$) is the variable used to proxy higher education resources of the province $i$. The inequality measure is calculated for each year of the research period for the analysis. While the traditional Theil index (or unweighted absolute Theil index) does not consider provincial differences (neither as reference nor as weight), here we consider $\Pi_i$ as province-specific reference and $w_i$ as province-specific weight. If the ratio of higher education resources (e.g., university teachers) and reference (e.g., university students) is the same across all provinces (perfect equality) the Theil index will be zero. Otherwise it will be positive with an increasingly positive value signalling increasing inequality.

In the following analysis three different sets of references and weights will be considered leading to three types of Theil indices: the unweighted absolute Theil index, the unweighted relative Theil index, and the weighted relative Theil index (Table 1).

We also carry out decomposition analyses which break down the generalised Theil index into within-group and between-group inequality components[7]:

$$\begin{aligned} T^{wr} &= T^{wr}_{within} + T^{wr}_{between} \\ &= \sum_{r=1}^{R} w_r \frac{\sum_{i\in I_r} \frac{w_i}{w_r}\frac{X_i}{\Pi_i}}{\sum_{i=1}^{I} w_i \frac{X_i}{\Pi_i}} \sum_{i\in I_r} \frac{w_i}{w_r} \frac{\frac{X_i}{\Pi_i}}{\sum_{i\in I_r} \frac{w_i}{w_r}\frac{X_i}{\Pi_i}} \ln\left(\frac{\frac{X_i}{\Pi_i}}{\sum_{i\in I_r} \frac{w_i}{w_r}\frac{X_i}{\Pi_i}}\right) \\ &\quad + \sum_{r=1}^{R} w_r \frac{\sum_{i\in I_r} \frac{w_i}{w_r}\frac{X_i}{\Pi_i}}{\sum_{i=1}^{I} w_i \frac{X_i}{\Pi_i}} \ln\left(\frac{\sum_{i\in I_r} \frac{w_i}{w_r}\frac{X_i}{\Pi_i}}{\sum_{i=1}^{I} w_i \frac{X_i}{\Pi_i}}\right), \end{aligned} \quad (2)$$

[7] For more technical details see Bickenbach and Liu (2013b), and F. Bickenbach & E. Bode (2008). Disproportionality measures of concentration, specialization, and localization. *International Regional Science Review*, *31*(4), 259–288. doi: 10.1177/0160017608319589.

**Table 1** Three Types of Theil Indices for the Analysis

| Theil Index | Weight | Reference | Equation Presentation | Notes for Interpretation |
|---|---|---|---|---|
| Unweighted absolute Theil Index | No province-specific weight considered (i.e., $w_i = 1/I$) | No reference considered (i.e., $\Pi_i = 1$) | $T^{ua} = \frac{1}{I}\sum_{i=1}^{I}\frac{X_i}{\bar{X}}\ln\left(\frac{X_i}{\bar{X}}\right)$ | Completely ignore provincial differences (e.g., population size and student size), when analysing the distribution of resources |
| Unweighted relative Theil Index | No province-specific weight considered (i.e., $w_i = 1/I$) | Province-specific reference considered (i.e., university student size at the province level as reference) | $T = \sum_{i=1}^{I}\frac{\frac{X_i}{\Pi_i}}{\sum_{i=1}^{I}\frac{X_i}{\Pi_i}}\ln\left(I\frac{\frac{X_i}{\Pi_i}}{\sum_{i=1}^{I}\frac{X_i}{\Pi_i}}\right)$, | Consider provincial difference as reference (student size), thus focusing on resources per student instead of absolute amount of resources; Ignore the provincial difference in population size, thus giving all provinces the same weight to the contribution of province-level inequality to the overall inequality for China |
| Weighted relative Theil Index | Province-specific weight considered: $w_i = \mathrm{POP}_i / \sum_i \mathrm{POP}_i$ pop for population size | Province-specific reference considered (i.e., university student size at the province level as reference) | $T = \sum_{i=1}^{I}\mathrm{w}_i\frac{\frac{X_i}{\Pi_i}}{\sum_{i=1}^{I}w_i\frac{X_i}{\Pi_i}}\ln\left(\frac{\frac{X_i}{\Pi_i}}{\sum_{i=1}^{I}\mathrm{w}_i\frac{X_i}{\Pi_i}}\right)$ | Consider both province-specific reference and weight, thus focusing on resources per student for analysis and also giving provinces different weights (based on population size) to adequately consider province-level contribution to the overall inequality (see Section "Teaching Personnel" and Footnote 6) |

where $r = 1,\ldots, R$ refers to the mutually exclusive groups of provinces and $I_r$ represents the set of provinces $i$ belonging to the region $r$. The region-specific weight $w_r$ is equal to the sum of province-specific weights ($w_i$) of all provinces $i$ belonging to the region $r$. All other variables are defined as in Equation *1*. The decomposition analysis enables us to gain additional insights into the sources of inequality, whether the development in inequality is mainly attributable to changes in inequality "within" and/or "between" pre-defined groups of provinces.

The strategy of the empirical analysis is as follows. It begins with investigating the development of the distribution of various higher education resources, using the generalised inequality measure introduced above (Section "Inequality Development of Higher Education Resources"). Firstly, we analyse the development of the distribution of teaching personnel of universities due to their key role as transmitters of knowledge to university students. Taking this analysis as our baseline, we additionally take into account the heterogeneity of teaching personnel with respect to their education experience and qualifications (Section "Teaching Personnel"). The higher education quality is, however, not determined by the quality of teaching personnel alone. Whether there are sufficient teaching resources to support an efficient learning process is a crucial determinant of education quality as well. Thus, we move to analyse the development of the distribution of teaching resources in the section, "Teaching Resources." There we begin with considering two basic types of resources, namely books and computers, for the analysis. Besides, we consider universities' educational expenditures and fixed assets to proxy their potential financial capacity in expanding and improving teaching resources for university education. Finally, we move to the decomposition analysis with a focus on the teaching resources (Section "Development of Within- and Between-Group Inequality of Teaching Resources").

**Research Data**

The empirical analysis to be presented in the section, "Empirical Results," is

based on a provincial panel dataset for China from 2003 to 2013.[8] It mainly covers variables used to proxy higher education resources, including (senior) teaching personnel and teaching resources like books, computers, fixed assets, and educational expenditures.[9] Moreover, it covers data such as the number of students and the population size of provinces which we consider as base statistics for the reference variable and the weight variable for the analysis, respectively. We collected these data from three different statistical yearbooks from China: *Educational Statistics Yearbook of China* (MOE, 2003–2013), *China Educational Finance Statistical Yearbook* (MOE & NBSC, 2004–2014), and *China Statistical Yearbook* (NBSC, 2004–2014). The distribution of higher education resources by region in 2003 and 2013 is presented in Table 2.[10] It can be observed that higher education resources of all kinds in the whole of China have increased substantially from 2003 to 2013. While the total number of teaching personnel in the universities doubled from 2003 to 2013, the expansion of financial resources (fixed assets and educational expenditures) in the higher education system in China was even more pronounced over the same period. The amount of financial resources was more than four times higher in 2013 than ten years ago. The increase in higher education resources was reflected in the regional statistics as well. While growth rates differ across regions, the changes in shares over time seem insubstantial, with the Eastern region being the one enjoying the largest shares in all kinds of higher education resources in both 2003 and 2013, followed by the Central region and the Western region. The Northeastern region which consists of only three provinces in China accounted for the smallest share of

[8] The key data used for the analysis are collected in an easier and more accurate way by statistical bureaus than many macroeconomic statistics such as GDP. The number of university teachers should be clear to each university. Books and computers can be counted while doing inventory management. The financial data should be clearly traceable through investigating corresponding documentation in university financial/budget sheets.

[9] Since data for educational expenditure in 2012 is missing, we used the average values of the corresponding values for 2011 and 2013 for the missing data in order to have a balanced panel dataset for the analysis.

[10] The 31 provinces (including municipalities and autonomous regions) in China are classified into four regions following the geographic classification of regions officially used for regional policy in China: East, Central, West, and Northeast. The Eastern region comprises Beijing, Fujian, Guangdong, Hainan, Hebei, Jiangsu, Shandong, Shanghai, Tianjin, and Zhejiang; the Central region consists of Anhui, Henan, Hubei, Hunan, Jiangxi, and Shanxi; and the Western region consists of Chongqing, Gansu, Guangxi, Guizhou, Inner Mongolia, Ningxia, Qinghai, Shaanxi, Sichuan, Tibet, Xinjiang, and Yunnan. There are only three provinces in the Northeastern region: Heilongjiang, Jilin, and Liaoning (NBSC, 2005).

higher education resources. Against this background one might easily conclude that the regional inequality of higher education resources may not have changed much over time, irrespective of the specific higher education resource variable considered in the analysis. However, even against this background a positive or negative development in relative regional inequality of higher education resources may be possible due to, for example, the different development in student sizes in different regions over time. To provide more insights in this regard, a systematic analysis using the generalised Theil indices introduced above is carried out in the section, "Empirical Results."

**Table 2** Distribution of Higher Education Resources by Region (2003 and 2013)

(a) Teaching Personnel

| | Teachers (thousand persons) | | Senior Teachers (thousand persons) | |
|---|---|---|---|---|
| | 2003 | 2013 | 2003 | 2013 |
| East | 296.8 | 610.3 | 123.1 | 266.1 |
| | (41.0 %) | (40.8 %) | (43.0 %) | (43.3 %) |
| Central | 180.4 | 384.7 | 67.5 | 144.4 |
| | (24.9 %) | (25.7 %) | (23.6 %) | (23.5 %) |
| West | 159.0 | 354.9 | 57.4 | 136.2 |
| | (21.9 %) | (23.7 %) | (20.0 %) | (22.2 %) |
| Northeast | 88.4 | 146.9 | 38.2 | 67.2 |
| | (12.2 %) | (9.8 %) | (13.4 %) | (11.0 %) |
| Total | 724.7 | 1496.9 | 286.2 | 613.9 |
| | (100 %) | (100 %) | (100 %) | (100 %) |

(b) Teaching Resources

| | Books (million) | | PCs (thousand) | | FA (billion RMB) | | Eduexp (billion RMB) | |
|---|---|---|---|---|---|---|---|---|
| | 2003 | 2013 | 2003 | 2013 | 2003 | 2013 | 2003 | 2013 |
| East | 350.2 | 938.2 | 969.7 | 3 327.0 | 173.7 | 717.8 | 89.8 | 375.0 |
| | (41.9 %) | (42.4 %) | (44.9 %) | (45.9 %) | (48.5 %) | (48.0 %) | (52.5 %) | (49.7 %) |
| Central | 204.4 | 564.2 | 508.6 | 1 691.8 | 75.6 | 306.8 | 35.1 | 153.5 |
| | (24.4 %) | (25.5 %) | (23.6 %) | (23.3 %) | (21.1 %) | (20.5 %) | (20.5 %) | (20.3 %) |
| West | 187.6 | 501.1 | 434.4 | 1 510.6 | 64.8 | 322.9 | 29.4 | 158.2 |
| | (22.4 %) | (22.6 %) | (20.1 %) | (20.8 %) | (18.1 %) | (21.6 %) | (17.1 %) | (21.0 %) |
| Northeast | 94.3 | 209.5 | 245.4 | 717.7 | 43.9 | 148.8 | 17.0 | 68.0 |
| | (11.3 %) | (9.5 %) | (11.4 %) | (9.9 %) | (12.3 %) | (9.9 %) | (9.9 %) | (9.0 %) |

(*To be continued*)

(*Continued*)

| | Books (million) | | PCs (thousand) | | FA (billion RMB) | | Eduexp (billion RMB) | |
|---|---|---|---|---|---|---|---|---|
| | 2003 | 2013 | 2003 | 2013 | 2003 | 2013 | 2003 | 2013 |
| Total | 836.5 | 2 213.0 | 2 158.2 | 7 247.1 | 358.0 | 1 496.4 | 171.2 | 754.7 |
| | (100 %) | (100 %) | (100 %) | (100 %) | (100 %) | (100 %) | (100 %) | (100 %) |

*Note*. (1) "Teachers," "Senior Teachers," "Books," "PCs," "FA," and "Eduexp" refer to total full-time teachers, full-time teaching personnel with senior positions, books, computers, fixed assets, and educational expenditures, respectively; (2) The value in bracket is the share of each region in national totals.

Sources: MOE (2003 and 2013); MOE & NBSC (2004 and 2014); NBSC (2004 and 2014).

## Empirical Results

### Inequality Development of Higher Education Resources

*Teaching Personnel*

We begin by considering full-time teaching personnel for our analysis. Full-time teaching personnel play a key role as knowledge transmitters in universities. As presented in Table 1, we use three versions of the Theil index based on three different sets of references and weights here: unweighted absolute (i.e., traditional), unweighted relative, and weighted relative.

While for the relative Theil indices, provincial differences in the number of university students are considered as reference, the absolute Theil index does not take such differences into account. It implies that an equal distribution of teaching personnel in case of relative Theil indices is realised if the distribution of teaching personnel across provinces is in line with the cross-provincial distribution of university students. In contrast, for the absolute Theil index an equal distribution of teaching personnel means that the absolute number of teaching personnel is the same for all provinces independent of the need for teachers as reflected in the number of students.

Another difference between the three indices used is the different weights considered in the index calculation. For the unweighted Theil indices it is assumed that the contribution of each province to overall inequality is determined by its deviation from the average level of teaching personnel (relative

to the size of university students) only. For the weighted Theil index, provinces' population sizes are used to additionally weigh the contribution that each province makes to overall inequality. For the latter case this implies that two provinces where the level of teaching personnel (relative to the size of university students) deviates by the same relative amount from the overall average, the province with the larger population is contributing more to overall inequality of teaching personnel in China than the province with a smaller population.

From Fig. 1 it can be observed that all three indices were largely constant over time, suggesting a relatively constant degree of (absolute and relative) inequality of teaching personnel across regions over the observation period. The major difference between the absolute and relative measures is that the unweighted absolute inequality of teaching personnel was much higher (almost 0.2) throughout the observation period than the unweighted relative inequality (0.008–0.013) and the weighted relative inequality (0.005–0.008).[11] These level differences between the absolute inequality and relative inequalities simply

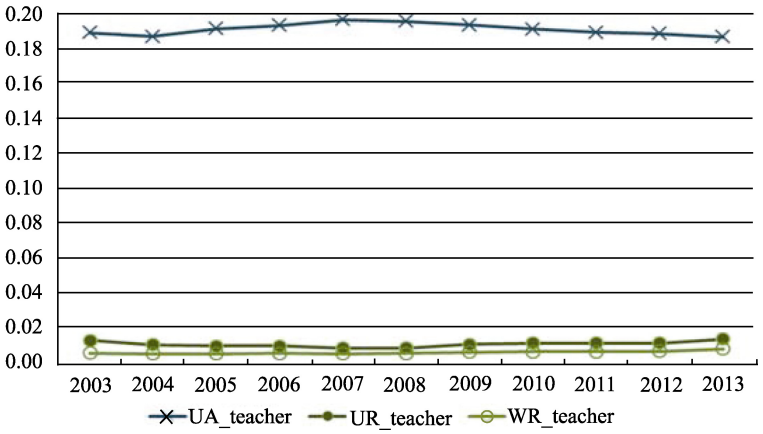


**Fig. 1** Regional Inequality of Full-Time Teaching Personnel

*Note*. "UA_teacher," "UR_teacher," and "WR_teacher" refer to the unweighted absolute, unweighted relative, and population-weighted relative Theil indices based on the statistics for full-time teaching personnel, respectively.

Sources: MOE (2003–2013); NBSC (2004–2014).

[11] While the inequality measures suggest a relatively constant developing trend in terms of teaching personnel in China, the number of teaching personnel in China has more than doubled from almost 725,000 persons in 2003 to 1.5 million persons in 2013.

suggest that (absolute) teaching personnel differed much more across provinces than teaching personnel per student. The low values of the relative indices suggest that inequality in teaching personnel across provinces does not seem to be a severe problem once differences in the number of students are taken into account. This finding is hardly surprising given policies that take the size of student populations as one of the main criteria considered in determining the size of the teaching personnel (MOE, 1986a).

Another finding is a (slight) level difference between the unweighted and weighted relative indices with the latter one being lower. This suggests that provinces with larger deviations from the average level in terms of the teacher-student ratio tend to be smaller than average in terms of population size.[12]

As mentioned above, one of the key observations from Fig. 1 is the low levels of relative inequalities of teaching personnel in China. This, however, does not rule out quality differences in teaching personnel. Even if students can access the same number of teaching personnel for education, the quality of knowledge that they would obtain depends strongly on the quality of the teaching personnel, which is determined, inter alia, by their teaching experience and their own education. In other words, one needs to consider the quality heterogeneity of teaching personnel for the inequality analysis as well.

One possible way to differentiate teaching staff by quality is to consider their job titles. There are officially four different job titles for university teachers in China: Assistant, Lecturer, Associate Professor, and Professor. These titles are awarded based on individual evaluation processes that take into account teachers' scientific research quality, competence and qualifications, as well as teaching quality. Senior positions (Associate Professor and Professor) are generally characterised by stronger records in these three evaluation aspects (MOE, 1986a; SCNPC, 1998).

University students with access to a larger number of senior teaching personnel are expected to have access to more academic knowledge. It should also be easier for them to learn from their teachers, given senior teaching personnel's generally more abundant teaching experience. We, therefore,

[12] For example, the largest deviations from the average level of teacher-student ratio in 2013 were found for Beijing, Shanghai, and Hainan which account for only about 1.56 %, 1.78 %, and 0.66 % of the total populations of China, respectively.

recalculate the relative inequality indices focusing on the teaching staff with senior positions only. Results are presented in Fig. 2. For comparison, the two corresponding indices considering total teaching staff from Fig. 1 are also shown in Fig. 2.[13]

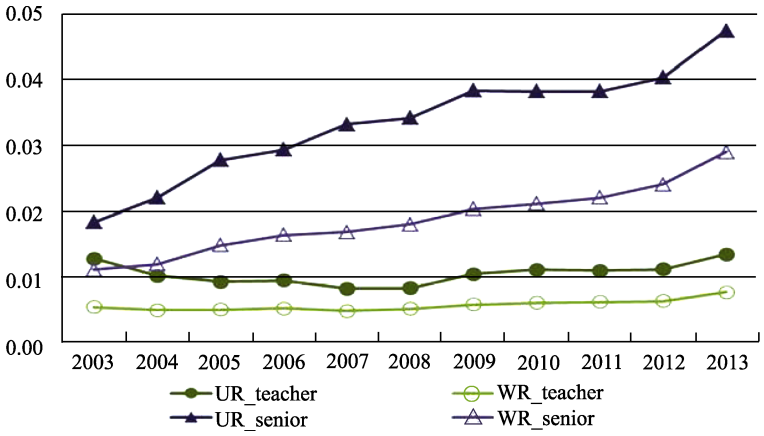


**Fig. 2** Regional Inequality of Full-Time Teaching Personnel with Senior Positions

*Note*. "UR_senior" and "WR_senior" refer to the unweighted relative and population-weighted relative Theil indices of teaching staff with senior positions. For comparison, the unweighted relative (UR_teacher) and population-weighted relative (WR_teacher) Theil indices of full-time teaching personnel as from Fig. 1 are presented in this figure as well.

Sources: MOE (2003–2013); NBSC (2004–2014).

Two observations in Fig. 2 are particularly worth noting. First, regional inequality of considering senior teaching personnel only was higher than in the original case considering all teaching personnel.[14] Second, regional inequality clearly increased over time for the case of senior teaching staff. Such a trend

[13] An average of about 6 % of all teaching personnel in China have no academic job titles at all. They are either responsible for administrative affairs of the universities or are not allowed to participate in evaluation for various reasons. The share of teaching personnel without job titles varied by province over the research period. This implies that even if two provinces have the same total number of teaching staff, one cannot make a direct comparison between these two groups of teaching staff. Students in provinces with a larger share of untitled teaching staff are actually expected to have poorer access to academic knowledge than students in the other provinces. Focusing on teaching personnel with senior titles enables us to avoid this problem.

[14] Similar to the finding above, the weighted relative inequality has again been lower than the unweighted one in the case considering senior staff only, suggesting that the provinces with smaller population sizes are likely to have larger deviations from the average level of senior teaching staff relative to student sizes.

cannot be observed for the case of total teaching personnel, where the development over time was rather constant. In other words, students' access to advanced academic knowledge in China provided by senior teachers seems to be less equal across provinces than their access to academic knowledge in general offered by all teaching staff. Moreover, the unequal access of students to advanced academic knowledge has become even worse over the past decade.

These results are at first glance surprising, given the capacity of the central government to influence not only the general size of teaching personnel but also the number of senior teaching staff in China to support a more balanced knowledge-based development (MOE, 1986a; SCNPC, 1998). The higher inequality for the case of senior teaching staff rather suggests that the number of university students may not be the only criterion considered by the government when deciding on the distribution of senior teaching staff. Other criteria such as policy priorities for supporting some university majors that aid industry development and for promoting the development of a limited number of universities into world-class universities[15] may be responsible for a less equal distribution of senior teaching staff. The unequal distribution is expected to be more in favour of economically more advanced provinces, since top Chinese universities that are considered to be more capable of supporting key industry development and of becoming world-class universities are rather strongly concentrated in select, more advanced provinces (Bickenbach & Liu, 2013a).[16]

The observed (increasingly) unequal access of students to senior teachers and their advanced knowledge may even underestimate the real inequality in terms of access to quality teachers. Although considering job titles accounts for some quality differences between teaching staff, it may still underestimate differences

[15] See MOE (1986a), Ministry of Education of the People's Republic of China (MOE). (1986). 关于"高等学校教师职务试行条例"的实施意见 [Implementation suggestions for "PRC test rules for teaching posts for faculty of higher education"]. Retrieved February 5, 2018, from http://www.moe.gov.cn/s78/A04/s7051/201001/t20100129_180697.html, and Ministry of Education of the People's Republic of China (MOE). (2006). 关于加强国家重点学科建设意见 [Suggestion on strengthening the construction of national key disciplines]. Retrieved February 10, 2018, from http://www.zjkjt.gov.cn/news/node18/detail180202/2007/180202_ 11041.htm, for more information.

[16] Indeed, statistics show, for example, that the senior teacher to student ratio was the highest for Beijing (0.067) in 2013. The ratio for Shanghai (0.040) was ranked high as well. The average senior teacher to student ratio for the economically more advanced Eastern and Northeastern region in 2013 was almost as high as 0.030, compared to 0.021 for the Central and 0.025 for the Western region.

in teacher (and teaching) quality across provinces. In fact, the limited number of senior positions in general and the large supply of qualified university teachers particularly in top universities concentrated in some more advanced provinces result in more severe competition among teaching personnel for senior positions in these provinces.[17] As a consequence it is often argued that the teaching and research quality of university teachers with senior positions has become higher in the few provinces where top universities are more densely located. Thus, university students in more developed provinces may not only have access to a larger number of senior staff but also to better trained and more motivated senior staff.

*Teaching Resources*

Education quality is, however, not solely determined by the qualifications and experience of the teaching personnel. It is also strongly affected by the teaching resources that are available to support the teaching and learning processes in universities. Thus, in this section we move forward by investigating the development of the regional distribution (inequality) of the following four types of teaching resources: books, computers, educational expenditures, and fixed assets of universities. All calculation in this section are based on the unweighted relative Theil index. Results are presented in Fig. 3.[18] Three major observations are particularly worth mentioning. First, the level of regional inequality of

[17] All teaching personnel who fulfill the qualification and experience requirements can apply for promotion. The evaluation and selection processes have been carried out either at the provincial level or at the university level subject to the number of limited free positions determined by the central government and responsible ministries see Ministry of Education of the People's Republic of China (MOE). (1986). 关于"高等学校教师职务试行条例"的实施意见 [Implementation suggestions for "PRC test rules for teaching posts for faculty of higher education"]. Retrieved February 5, 2018, from http://www.moe.gov.cn/s78/A04/s7051/201001/t20100129_180697.html; Ministry of Education of the People's Republic of China (MOE). (2016). 关于深化人才发展体制机制改革的意见 [Suggestions on deepening reform for talent development system]. Retrieved February 5, 2018, from http://www.xinhuanet.com/politics/2016-03/21/c_1118398308.htm.). Due to the more severe competition in the provinces where the top universities are more densely located, the requirements for obtaining senior positions in these universities and provinces are particularly high.

[18] We also calculated the weighted version of the inequality index. The development is comparable to that shown in Fig. 3. The only difference is that the weighted inequality indices had lower values than the unweighted ones, similar to the findings presented in Fig. 1 and Fig. 2. A comparable interpretation can be thus applied here as well. Results of the weighted inequality can be obtained upon request.

available books in universities was (much) lower than that for the other three teaching resources. Second, educational expenditures and fixed assets that are assumed to be spent or to be potentially disposable for education purposes in universities have been generally less equally distributed across provinces than books and computers. Third, while the regional inequality of available books only slightly increased over the years 2004–2013, the other three teaching resources considered have become much less equally distributed over time.

The relatively equal distribution of books across provinces in China in relation to the size of the university student population gives a positive first impression. It seems that at least students may, to some extent, compensate for their different access to senior teachers through accessing available (related) books.[19] Some doubt in such positive compensating effects can, however, be evoked if considering the finding that students' access to IT facilities like computers seems to be more unequal than their access to books. In the current digital age, computers rather than books are the dominant knowledge source and most important analytical instruments to support students' learning processes.

One may argue that nowadays students may have their own computers, thus reducing the need for public computers in universities. Even so, the provision of (well-functioning) computers in the universities is necessary for at least two reasons: First, students from more disadvantaged family backgrounds may be the ones who are not able to afford buying their own computers. In order for them not to be left behind, which would increase the digital divide among students, it is crucial to provide them at least access to the digital world via the public computers provided by the universities. Second, computers alone provide only the necessary but not the sufficient condition for accessing digital information. For research and advanced learning, adequate software and access codes need to be installed in computers to ensure access to data sets or journals that are only available for legal subscribers. Such software and access codes can, normally, be installed in only a limited number of computers owned by universities against payment to data providers. Providing public computers with adequate software and access codes at the universities ensure a better access of students to digital materials they need for advanced learning and research.

Against this background the finding that students' access to IT facilities like

[19] Books may, of course, differ from each other in quality. This issue can not be analysed in more detail here due to the lack of related statistics.

computers became more and more unequally distributed across provinces—particularly at the cost of students from economically less advanced provinces[20]—implies that the access to high quality education that enables students to improve their digital skills and advance their knowledge turns out to be more and more unequally provided in favour of the rich. This enhances the risk of widening the digital divide and leaving students with worse access to such devices ill prepared for the future challenges of the digital age.

Both books and computers only represent a small part of education resources that students would gain access to in the universities to support their learning processes. Generally the quality and the extent of education resources provided to the students are expected to be strongly determined by the financial resources available to or potentially disposable by universities for education purposes. From Fig. 3 we observe that both educational expenditures per student and fixed assets per student have become more and more unequally distributed across provinces over time. Among the two types of financial resources, the distribution

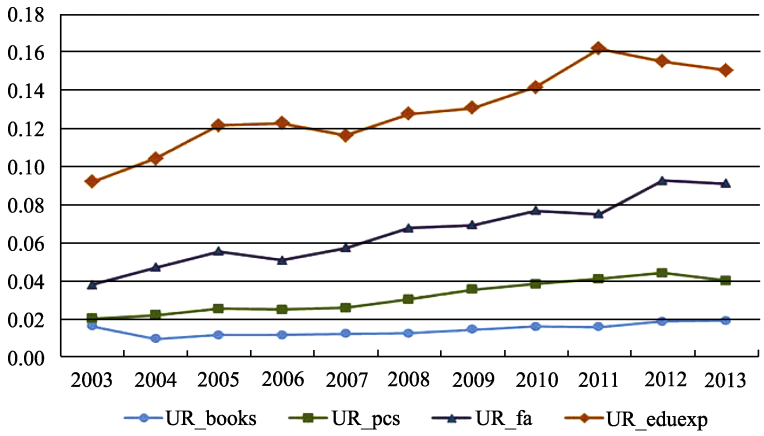


**Fig. 3** Regional Inequality of Teaching Resources

*Note*. "UR_books," "UR_pcs," "UR_fa," and "UR_eduexp" refer to the unweighted relative Theil indices of books, computers, fixed assets, and educational expenditures of universities, respectively.

Sources: MOE (2003–2013); MOE & NBSC (2004–2014); NBSC (2004–2014).

[20] Taking statistics for 2013 as an example, the top three provinces with the highest computer to student ratio were Beijing, Shanghai, and Jiangsu; all are among the economically more advanced provinces in China. They were also among the provinces with top growth rates in the computer to student ratio over the research period.

of educational expenditures of universities across provinces was particularly unequal.

Comparing Fig. 2 and Fig. 3, one can observe additionally that the regional inequality of financial resources for universities was (much) worse than the inequality of access to (senior) teaching staff. This finding is not surprising, considering the fact that universities in China have been endowed with strongly different levels of financial resources (from governments and companies, and through donations or tuition fees) in favour of the top universities.[21] In contrast to the allocation of teaching staff there is no limiting force such as a reference teacher-student ratio working here.

All these observations further strengthen the concerns that students in China have by no means equal access to high quality higher education. The increasingly unequal distribution of financial resources for universities that determine universities' investment in education in the long term further induces one to expect that such unequal access to higher education in China is likely to become even more pronounced in the future.

## Development of within- and between-Group Inequality of Teaching Resources

The findings above suggest that students' access to higher education of high quality in China have become more and more unequal over time. They also suggest that the economically more advanced provinces were more likely the ones where students tended to have better access to a larger number of senior teaching personnel and to different kinds of teaching resources. Against this background one might be inclined to conclude that the increasing overall inequality has been mainly attributable to substantially deteriorating differences between students from the poor and rich regions. This conclusion would be consistent with the general public's concerns in China but it may not be the whole story. In this section we carry out decomposition analyses to learn more about the development of within- and between-group inequalities and thus gain more insights into sources of the increasing overall inequality. The analyses are

[21] Beijing and Shanghai were, for example, found to have the highest educational expenditures to student ratio in 2013. They also belonged to the group with top growth rates in this regard over the research period.

again based on the unweighted relative inequality index and focus on the teaching resources except for books.

For the following decomposition analyses we consider two types of group classifications. First, we classify the 31 provinces in China into four regional groups (East, Central, West, and Northeast) following the definition of China's regional policy. In the early 21st century, China started to deal more intensively with the issue of unequal regional development by implementing several regional policies to support the development of the economically backward regions. Providing a more equal access to higher education has been one of the main topics considered.[22] Bickenbach and Liu (2013b) indeed find that the distribution of higher education opportunities (number of universities and university places) has become more equal. Their finding is consistent with the regional policies implemented. Our findings in the previous section, however, suggest that the situation may be different, when the quality issue reflected in higher education resources is considered for the inequality analysis. A decomposition analysis using the four-region geographic classification is thus expected to provide more information about the sources of inequality from a regional perspective.

The results are presented in Fig. 4(a). It shows, firstly, that the levels of between-group inequality have been generally lower than within-group inequality over time for all three teaching resources considered. This suggests that between-group inequality is not the main component responsible for the (rising) overall inequality. The within-component of the overall inequality plays a rather dominant role in determining the development of overall inequality. Secondly, although both within- and between-group inequalities have increased over the research period, the increase in within-group inequality, particularly for educational expenditures, was substantially stronger. As a result, the dominant role of within-group inequality in determining the development of the overall inequality seems to be further strengthened over time. Since within-group inequality is a weighted sum of within-region inequality for the four regions considered (see Equation *2*), we are able to further break down the corresponding value to investigate which regions have been more responsible for the strongly increasing within-group inequality. In so doing we are able to trace the inequality increase back to changes in the heterogeneity between provinces within each of the four regions considered. Using educational expenditures as an example,

[22] A summary of related regional policies can be found in Bickenbach and Liu (2013b).

results of the regional decomposition of the corresponding within-group inequality are presented in Fig. 4(b). It shows that the within-region inequality has been much lower for the Central, Western, and Northeastern regions than for the Eastern region. Moreover, while within-region inequality for the former three regions either decreased or fluctuated at relatively low levels over time, the corresponding inequality for the Eastern region rose substantially to a much higher level in 2013 as compared to 2003. The strong increase in the provincial heterogeneity within the Eastern region can be identified as the main driver of the substantial rise of within-group inequality of educational expenditures shown in Fig. 4(a) and thus also the main source of the increase in the corresponding overall inequality (Fig. 3).[23] These observations imply that it would not be

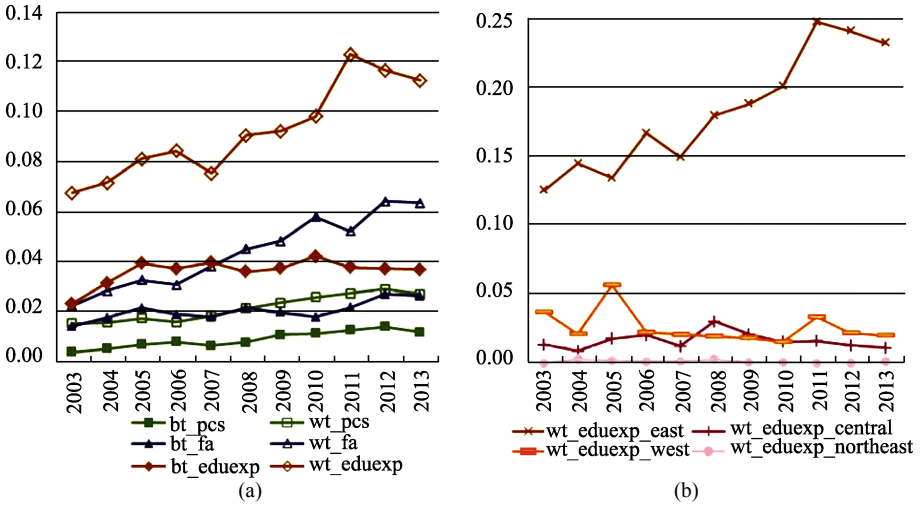


**Fig. 4** Regional Inequality of Selected Teaching Resources: Decomposed by Four Regions

*Note.* (1) "bt_pcs," "bt_fa," and "bt_eduexp" refer to the between-group inequality of computers, fixed assets, and educational expenditures of universities, respectively, while "wt_pcs," "wt_fa," and "wt_eduexp" refer to the corresponding within-group inequality; (2) The within-group inequality for the educational expenditures is further decomposed into four within inequalities by region: "wt_eduexp_east," "wt_eduexp_central," "wt_eduexp_west," and "wt_eduexp_northeast."

Sources: MOE (2003–2013); MOE & NBSC (2004–2014); NBSC (2004–2014).

[23] The within-region inequality in the Eastern region as a main driver for the increasing within-group inequality can also be identified for the other two teaching resources considered in Fig. 4(a). For the sake of brevity, the corresponding results are not presented here. They can be obtained from authors upon request.

sufficient for policies to only look at the development differences between the four regions and implement policies that particularly support the provision of teaching resources and a much faster development in the economically backward regions. The increasing provincial difference within particularly the Eastern region needs to be dealt with appropriately as well.

The decomposition analysis using the geographic four-region classification suggests that the increasing inequality with respect to the distribution of teaching resources in relation to the size of the university student population has been attributable not only to the increasing between-group inequality but actually even more strongly to the strong deterioration in equality within regions, in particular within the Eastern region. In other words, the issue of increasing inequality in accessing high quality higher education seems not only to be an issue between regions with different development status and economic advancements. Does it mean that the increasing inequality is not an issue of differing treatment between poor and rich regions? In order to gain more insights in this regard, we adopt a second group classification based on GDP per capita for another decomposition analysis.[24] Provinces with GDP per capita lower than the median value in 2002 are grouped as low-income provinces, while the others are considered as high-income provinces. The same decomposition techniques are applied and results are presented in Fig. 5(a). At first sight it can be observed that the between-group and within-group inequality indices for the three teaching resources have similar developing trends as the results shown in Fig. 4(a), where the geographic four-region classification is applied. The main difference between the two figures is that the levels of the between-group inequality in the case of two-group classification seem to be generally lower than the corresponding inequality results in the case of geographic four-region classification. The results for the within-group inequality were the other way around. This observation is, however, not surprising, taking into account the large overlap of the two group definitions. While the whole Eastern and Northeastern region and three more economically advanced provinces in the Western region belong to the high-income group, the low-income group consists of the whole Central region and most of the provinces in the Western region. In other words, parts of the

[24] The only difference is the application of another group classification method. Thus, the sums of the between-group and within-group inequality shown in Fig. 4(a) and Fig. 5(a) are the same and are equal to the corresponding overall inequality shown in Fig. 3.

between-group inequality observed in the case of four-region classification are now parts of the within-group inequality using the rich-versus-poor classification. Due to the overlapping regional coverage in both group classifications and the dominant role of the Eastern region in the broadly defined high-income group, it is not surprising, either, that the within-region inequality of the rich region has been mainly responsible for the strong increase in the within-group inequality in this case (Fig. 5b).

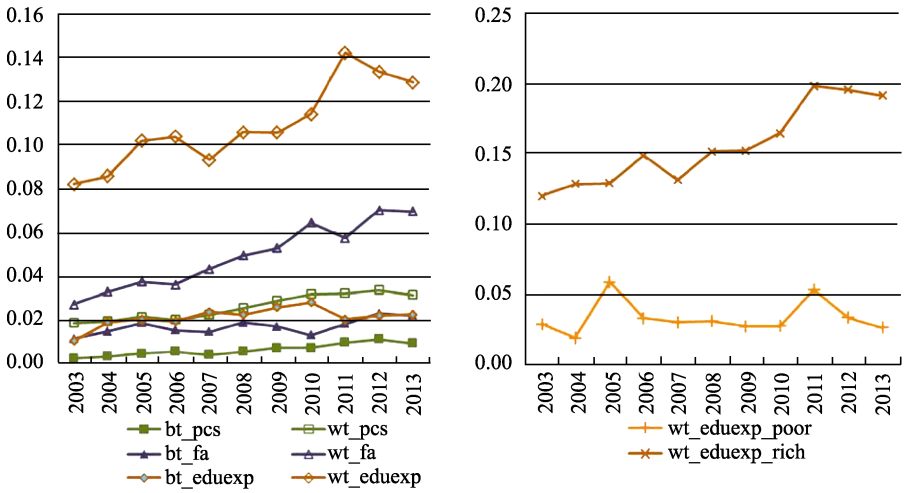


**Fig. 5** Regional Inequality of Selected Teaching Resources: Decomposed by Two Income Groups

*Note*. (1) "bt_pcs," "bt_fa," and "bt_eduexp" refer to the between-group inequality of computers, fixed assets, and educational expenditures of universities, respectively, while "wt_pcs," "wt_fa," and "wt_eduexp" refer to the corresponding within-group inequality; (2) The within-group inequality for the educational expenditures is further decomposed into two within inequalities by income classification: "wt_eduexp_poor" and "wt_eduexp_rich."

Sources: MOE (2003–2013); MOE & NBSC (2004–2014); NBSC (2004–2014).

To go one step further, we focus on the rich region only and reclassify the 16 provinces into two groups: the richest eight provinces based on the GDP per capita in 2002. The same analysis procedure is applied here again. Results suggest that the strong increase in the inequality within the rich region in Fig. 5(b) was mainly attributable to the increasing provincial difference among the richest

provinces but not among the second richest provinces.[25] Additionally, the access difference between the richest and the second richest played a non-trivial role in this regard, although its role was still less dominant than the cross-province difference among the richest provinces.[26]

All in all, results of the decomposition analysis using the economic two-group classification are consistent with the findings using the geographic four-region classification. They show that the increasing overall inequality has been mainly driven by the within-group inequality rather than the between-group inequality. This finding may indicate that regional policies for development should not be restricted to addressing the traditional consideration of different regional developments only. More attention needs to be paid to the provincial differences within regions as well. Such attention may be even more required for the well-developed provinces, where a strongly increasing heterogeneity with respect to the provision of teaching resources to students was found.

## Conclusions

Striving for a more quality-oriented growth model, China has strongly emphasised the crucial role of innovation. Innovation should help Chinese industries upgrade and climb up global value chains to foster economic growth. To innovate, China needs an adequately large reservoir of qualified workers and talents. Higher education plays a key role here. China underlines the substantial relevance of a more equal regional development for China's success under the "new normal" development mode as well. Against this background, China not only needs good higher education to help build an adequately large reservoir of qualified workforce. Access to higher education needs to be also more equally provided across different provinces in China.

Among others, Bickenbach and Liu (2013b) analysed the development of the regional distribution of higher education opportunities over past years in China. They found that the distribution of universities and university places became

[25] Results are not shown in figures here. They can be obtained from authors upon request.
[26] The increasing inequality between the richest and the second richest provinces was mainly driven by the strong increase in education expenditures per student in Beijing, Shanghai, and Guangdong, compared to the average development in the second richest provinces.

more and more equally distributed in relation to, for example, the size of the young population. What matters for a more equal higher education across provinces, however, is not only the availability of an adequate number of universities or university places in this regard. Even if the young are getting more equal opportunities to be accepted for universities, it does not mean that the quality of the higher education that they receive would be the same or at least become more comparable over time. Thus, the current paper aimed at investigating this quality issue in more detail by analysing the development of inequality in terms of students' access to higher education resources measured by teaching personnel as well as physical and financial teaching resources. While considering the distribution of teaching personnel, we additionally took into account teachers' heterogeneity in their qualifications and experiences. When carrying out the analysis for teaching resources, we based the analysis on four different types of teaching resources including different physical resources and universities' financial capacities for sustaining higher education quality. The empirical analysis was carried out by using the generalised Theil index to measure the inequality over the research period (2003–2013). This paper with its province-based analysis of education inequality supplements earlier (more qualitative) studies which were carried out at more disaggregated individual, household and/or county levels. The more aggregated analysis here served as base for helping determine the overall directions of related policies, while the more disaggregated studies may provide important insights for more specific policy measures.

Empirical results showed that regional inequality in the distribution of teaching personnel in general seemed not to be a problem for China. However, when focusing on the more experienced and more qualified teaching personnel, results showed an increasing inequality in the provision of such teachers in relation to the size of student populations across provinces in China—in favour of the economically more advanced areas. The increasingly unequal distribution of higher education resources among students was found to be even more severe, when considering teaching resources measured by the number of computers, by universities' educational expenditures or by the size of university fixed assets—again in favour of the economically more advanced regions. These results suggested that students from economically more advanced regions do not

only have a better access to a greater number of more experienced and more qualified teachers but also to more advanced teaching resources like computers to support their learning processes. Due to the strong increase in inequality with respect to the distribution of universities' financial resources for future education investment, one may expect that such regional differences regarding students' access to higher education resources of high quality will become even worse in the future.

In order to investigate whether the increasing inequality in accessing higher education resources has been indeed mainly driven by rising heterogeneity between regions with different development status, we carried out decomposition analyses. Results generally found that the between-group inequality with respect to the provision of teaching resources between regions with different development backgrounds has played a certain but not a dominant role in backing the increase in overall inequality. Instead, the main source of increasing overall inequality was a strong increase in the within-group inequality in general and in the inter-provincial inequality in the Eastern, the economically more advanced region, in particular. A final decomposition analysis focusing on the richest 16 provinces in China suggests, additionally, that the provincial heteorogeneity within these 16 provinces has not only been determined by the increasing difference between the eight richest provinces but even more by the strongly rising difference among the eight richest provinces.

The general inequality analysis and the decomposition analysis here showed that despite an increasingly equal distribution of higher education opportunities (university places) across provinces over time, students' access to higher education resources once entering the universities have been by no means equal. Higher education resources relative to the number of university students have actually become more and more unequally distributed over time. Adequate regional policies are needed here, if China aims at realising a more equal and more quality-oriented economic development across provinces in the long term. The findings that unequal development is not just an issue of differing treatments between regions with different development status but also within regions suggests that regional policies need to expand their targets going beyond traditional regional development considerations. More attention may need to be paid to the provincial differences within regions in general and within the richest region in particular.

Designing adequate regional policies to effectively deal with unequally distributed higher education resources, paying appropriate attention to all groups of provinces concerned is the key. This, however, should not be interpreted as implying that the sources of education inequality at a more disaggregated level stressed in the more traditional literature on educational inequality are less relevant. With the increasing higher education inequality found in this paper, individuals and families with different demographic, economic, locational, minority, migrant backgrounds may benefit or suffer from the developments identified here to different degrees. Future research may try to empirically investigate this issue in more detail if adequate datasets are made available for the analysis.

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