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ALLOCATING RESOURCES: A CASE STUDY OF EARLY EDUCATION IN ZHEJIANG

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Abstract

Educational resources are varied by regions in China and early education has no exception, whereas student-teacher ratios, school facilities, teaching quality, and school curricula differed. Researching how educational resources are allocated could potentially improve the efficiency and equity of student learning despite regional differences. Zhejiang Province ranged from metropolitan cities such as Hangzhou to small cities and towns in rural areas, which provides diverse educational contexts to study this issue. Historically, Zhejiang has been a model for providing equitable student access and decreasing the cost of early education in China. However, the province has not provided solutions in addressing the equitable resources among various early education institutes. This study examines the differences in allocating educational resources by comparing the selected counties in Zhejiang. We will first employ the rough set theory to filter out the factors that might result from regional differences. In doing so, we could eliminate the possibility of multicollinearity and how it might affect the causal relationship in our regression

model. Our initial findings reveal that the quality of teachers, the number of full-time teachers and staff, and the county's economic index had various effects on teaching and learning. The study may provide a solution in addressing similar issues in other early education settings. The results suggest strategic planning for allocating early educational resources equitably and efficiently.

Keywords

Educational Resources, Learning Outcomes, Early Education, Regional Differences

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1. Introduction

More and more reforms are being proposed to enhance the effectiveness of teaching and learning in China (Cheng, 2003). Lu et al. (2013) suggested that the differences in teaching and learning effectiveness result from different resources. Given the differences in resources, the Ministry of Education in China implemented "Activate the Implementation of Early Childhood Education Plan" in 2017 to allocate resources equitably and efficiently (Wu, 2017). The plan intends to address the differences in educational resources based on different regions. Educational resources refer to the educational budget, number of full-time teachers, the number of enrolled students, student-teacher ratios, and number of schools. Examining educational resources by regions could be a starting point to reveal the differences.

Researching how educational resources vary in Zhejiang may provide some insights into how resources vary differently in China. Zhejiang Province covers an area of a 101,800-kilometer square with a density of 540 people per kilometer square and includes eleven prefecture-level cities, 90 counties, and 1570 townships (People's Government of Zhejiang Province's, 2015). The Chinese city tier system has been using for commercial strategies, resource allocation, and other public infrastructure (Kaminishi et al., 2020). Zhejiang Province ranges from metropolitan cities such as Hangzhou to small cities and towns in rural areas, which provides a diverse context (Guan & Rowe, 2016). It also provides a diverse educational context based on the nature of metropolitan cities, cities, and townships, and to explores this issue. This study is a pilot study to examine the regional difference by using selected regions from the four tiers out of the 90 counties in Zhejiang. By exploring the resources in selected regions, we might be able to detect the regional difference.

Historically, Zhejiang has been a model for providing equitable student access and reducing the cost of early childhood education in China. However, the province has not provided solutions in addressing the equitable resources among various early education institutions.

Researching this topic could potentially show how educational resources vary among regions of each tier. Particularly, this study focuses on the historical data before 2017 to show the trends before "Activate the Implementation of Early Childhood Education Plan." Given the context, this study seeks to answer the following questions:

- In what way, do resources differ region by region?
- What are the overall trends of educational resources by regions from 2007 to 2016?
- What policy implications could be drawn from this study?

This paper begins with a contextual description of how educational resources affect teaching and learning. Then, the research design and definition of the terms are presented in the method section; the findings of the study are reported in the result section. Finally, the last section provides discussion and policy implications.

2. Literature

Educational resources impact educational quality as they affect teaching resources, including student-teacher ratio, number of full-time teachers, and school facility (Belfield & Fielding, 2001). The educational budget in higher education institutions was mainly based on ranking (Ding & Zeng, 2015). Universities with a higher ranking had more endowment from government, alumni, and industry. The ranking of universities has impacted human capital and physical capital. Although early education institutions do not have such ranking, it does not imply equality or equity in terms of educational resources.

The early education budget is mainly based on government funding, which is different across regions. Su et al. (2019) examined the multiple regions and provinces in China and found significant regional differences in China. Their study concluded that most provinces in the eastern region had more resources compared to provinces in the central and west regions. Ma (2017) found that educational resources were distributed equitably and utilized more efficiently from 2002 to 2008. From 2008 to 2013, the efficiency of resource allocation has been declining. During this time frame, the overall efficiency in allocating resources is not as efficient as compared to that before 2008. From 2008 to 2013, there is observed better learning outcomes which might attribute to the resource allocation. In other words, the learning outcomes reflect the previous input resources.

Fang and Huang (2019) examined the resource allocation of early childhood education and found that the efficiency of allocating resources has been increasing. However, it is crucial to identify regions that need more resources. In other words, it is time to focus on equity in addition to efficiency to ensure that the gap of regional differences does not widen because of resource allocation. These studies caution that neglecting equity may increase the regional differences, such as that between urban and rural areas. Other studies compared higher education and primary education and found that the efficiency in allocating resources has been increasing. Zhejiang is located in the East region and the east region usually had higher efficiency compared to the middle and west regions. Previous research identified that the east region had higher efficiency in allocating resources compared to other regions (Fang et al., 2018). This province also had metropolitan cities such as Hangzhou, as well as small cities and towns in rural areas, which provides diverse educational contexts to study this issue. Investigating the regional differences, including budget and educational resources, might suggest any equity gaps in these areas.

Educational resources such as the student-teacher ratio are commonly used as an important indicator. The fitted student-teacher ratio, the number of teachers per class, indicated the required teachers in the country (Chang & Chang, 2020). The 2017 OECD report shows that the ratio of students to teaching staff in primary education institutions is on average 1:15 in OECD countries (Organisation for Economic Co-operation and Development [OECD], 2017). The current student-teacher ratio in early childhood institutions in China is 1:16, which is higher than that of OECD standards for primary schools. OECD reports have also revealed that Chile, China, Israel, and Japan, on average, had more than 27 students in primary schools. In 2018, the average student-teacher ratio across OECD countries was 1:14. The student-teacher ratio also varied in OECD Countries (OECD, 2017). For example, more than 20 students in Chile, Colombia, Israel, France, and Mexico while fewer than 10 in Denmark, Finland, Germany, Iceland, Latvia, New Zealand, and Slovenia. In China, the average is 1: 17 in 2018 (OECD, 2020). More research could be conducted in determining the class size and how it affects the educational resources in regions.

3. Method

This study was designed to explore how regional differences might affect how resources are allocated equitably and efficiently. The data of this study was collected via approval in each region. Due to the regulation of data, each region had different data. Some regions documented

enrolled students as well as school-aged students while some regions did not. This study chose the same data to be reported in the result section.

3.1 Definition

The regions in this study refer to how China defines the scales of the cities from metropolitan cities, small cities, and townships. The tiers are based on indicators such as population size, infrastructure, administrative hierarchy, and income levels (Lerman et al. 2012). Collecting data, data access required administrative approvals from local governing agencies. Different regions have different levels of approval and access to data. Due to such regulation, some tiers do not have all the collected data. In this case, this study only reported tiers that have documented data. Chinese government defined which city is categorized into which tier.

- First-tier region: metropolitan cities include Hangzhou and Ning-bo.
- Second-tier region: cities include Wenzhou, Jia-xing, Shao-xing.
- Third-tier region: small cities include Jinhua, Xuzhou.
- Fourth-tier region: townships include Huzhou.

3.2 Data Analysis

Descriptive statistics and regression were applied to data analysis. This study applied descriptive statistics to explore the regional differences by examining the average of each tier. Predictors such as educational budget, number of schools, number of teachers, and number of students were examined by region and by year. The descriptive statistics of the four regions compared to any regional differences. The descriptive statistics of each region from 2007 to 2016 compared any differences in this timeframe.

Regression was used to determine the effect of each predictor on the overall educational resources. The outcome variable is the overall educational resources in a rounded-up numeric format. The outcome variable, educational resources, is the composite index of overall resources of educational budget, number of full-time teachers, the number of enrolled students, student-teacher ratio, and number of schools. The predictors include the number of full-time teachers, the number of enrolled students, the number of schools, and the educational budget. The regression equation is below:

$$y = \beta_0 + \beta_1 X + e_i \qquad (1)$$

If the educational budget is the predictor, then the equation is written as:

$$Educational\ Resources = \beta_0 + \beta_1 Educational\ Budget + e_i \quad (2)$$

The overall model fit will be reported as part of the regression result. The regression results will also reveal which predictor is related to educational resources and those that are not.

4. Results

This section will first show the overall educational resources, then 2016 educational budget data. Overall results of the number of schools, number of students, number of teachers, and student-teacher ratio will then be reported. After that, we will reveal the number of schools, number of students, number of teachers, and student-teacher ratio from 2007 to 2016. The section will be concluded with the regression results.

4.1 Overall Educational Resources by Regions

Educational resources include educational budget, number of teachers, number of schools, number of students, and student-teacher ratio from 2007 to 2016.

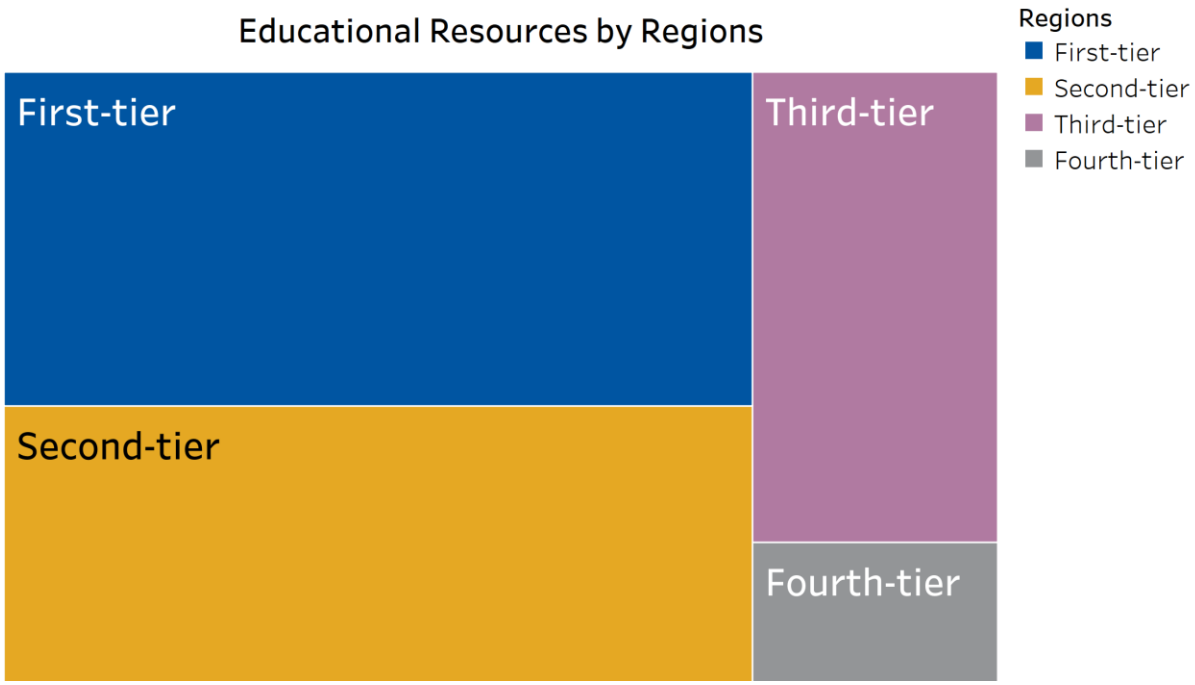

Figure 1: *Educational Resources by Regions*

Figure 1 shows how regional resources varied, particularly the resources in the fourth-tier compared to another region. The first-tier region had relatively higher resources compared to others. When further examining the regional differences, the first-tier and second-tier regions did

not vary much about 1.2 times difference. However, the resources in the first-tier region are 7 times more compared to the fourth-tier region. It is worthwhile to investigate what factors might result in such different regional differences. Factors such as educational budget, number of schools, number of teachers, and number of students, the student-teacher ratio will be examined in the following sections.

4.2 Educational Budget by Regions

Educational budgets are only available for 2016, and no available data before or after. The educational budget is the average of each tier rather than each city or township. The CNY on the graph refers to the Chinese Yuan, the official currency in Mainland China.

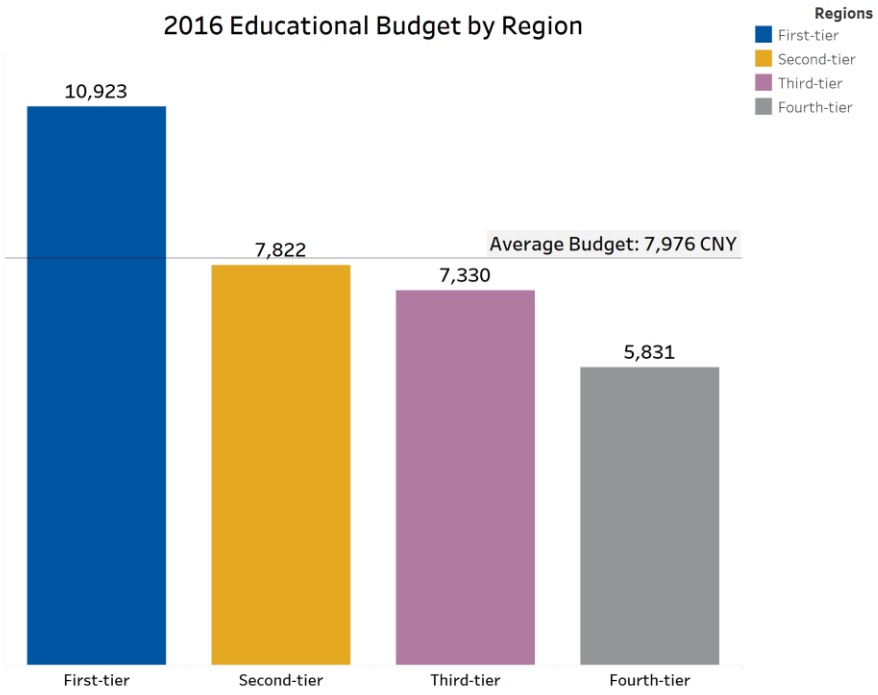

Figure 2: *2016 Educational Budget by Region*

The result showed that the first-tier region had above-average resources compared to other regions. Specifically, the first-tier region had twice more resources compared to the fourth-tier region.

4.2 Educational Resources by Regions

The number of schools provided the average number of schools that each region had. The number of schools does not suggest the capacity of each school. Thus, it is also important to consider the number of teachers, number of students, and student-teacher ratio to estimate the

overall educational resources by region. The official recommended student-teacher ratio for early education institutions is one teacher to 16 students.

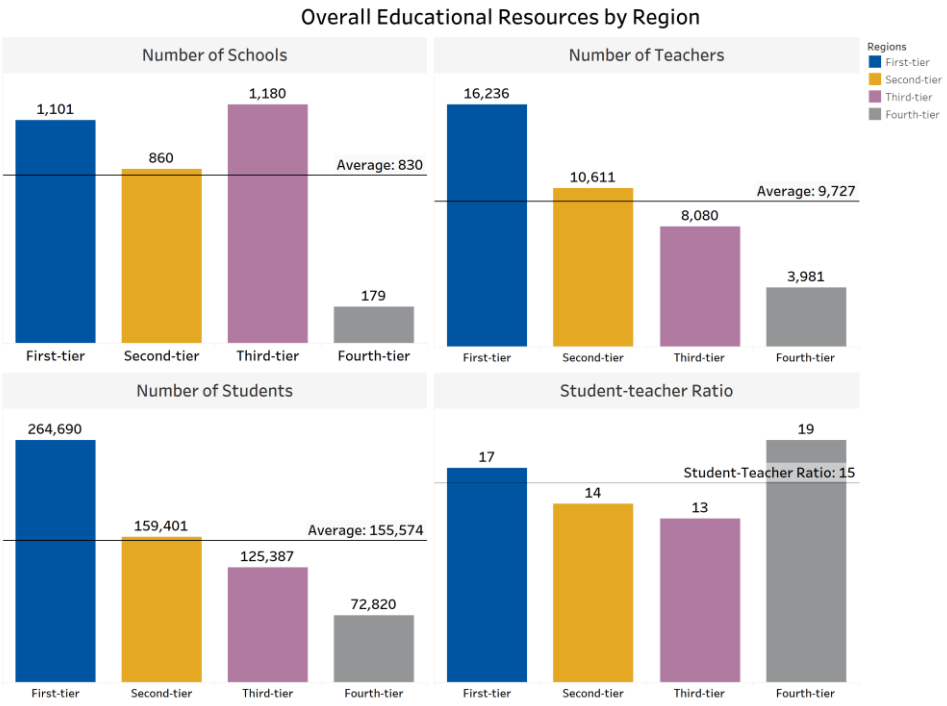

Figure 3: *Educational Resources by Region*

Overview of educational resources showed that the fourth-tier region is below average in terms of schools, students, and teachers. As a result, the student-teacher ratio is far above the average compared to other regions. This index implies that every teacher in the fourth-tier region needs to teach at least three more students than the nation-wide recommended average and four more than the provincial average.

Students in the third-tier region have more resources in terms of school choices and more individual attention from teachers. The First-tier region had the highest number of teachers and students, as well as above the national recommended student-teacher ratio. The second-tier region had the above number of schools, teachers, and students. The student-teacher ratio is also below the average. The regions' overall educational resources suggested that the Second-tier region seems to allocate its resources effectively and efficiently compared to the other regions. The next section examined the resource allocation from 2007 to 2016 to explore any trends over the years.

4.3 Annual Trends by Region

This section reports the overall educational resources trends by region from 2007 to 2016 by annual trends. The year 2007 representing 2007 to 2008, thus ten years with nine data points. It starts with the first-tier region, then the second-tier region, the third-tier region, and finally the fourth-tier region.

4.3.1 Annual Trends of First-tier Region

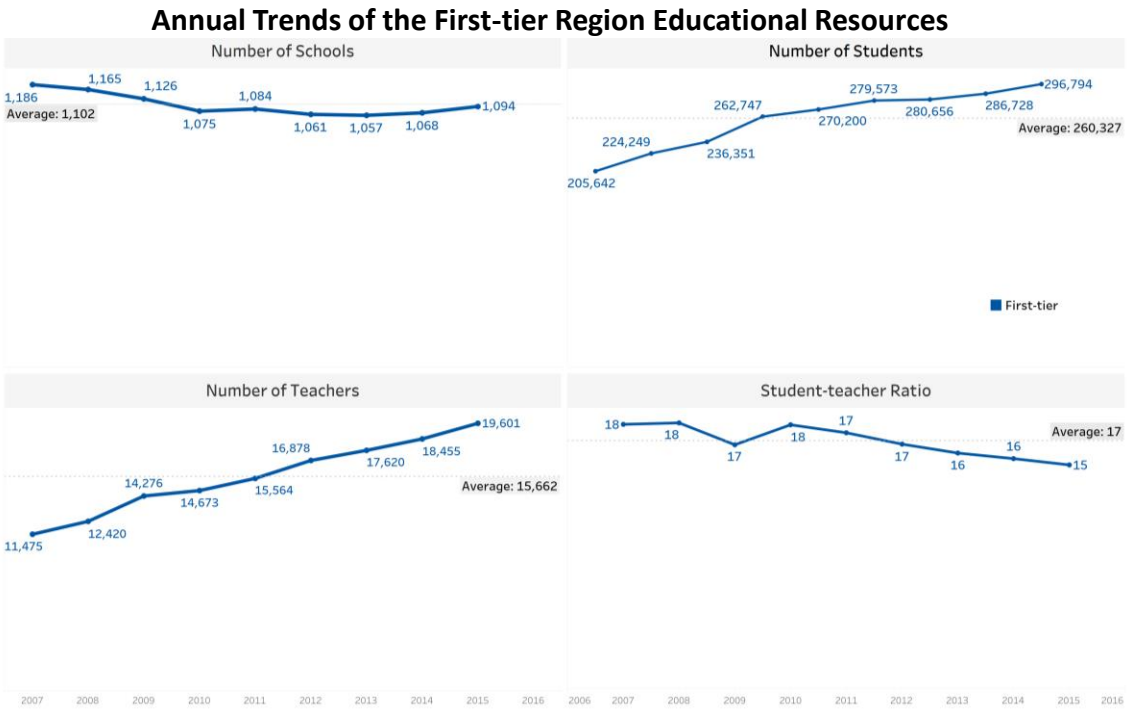

Figure 4: *2007-2017 Educational Resources of the First-tier Region*

The result shows that the number of students and teachers has been increasing since 2007. The number of schools has also been declining since 2007, except during the years 2011 and 2015. These indicators showed that students have fewer choices in terms of school choices. As the schools still could enroll students under their capacity, the first-tier region has more classes in one school, according to the provided data. One of the first-tier cities, Hangzhou increased the number of classes from 7,455 to 11,116 within these ten years. The result suggests that mid-size and above schools might have more resources and can increase their student enrollment, hire more full-time teachers, and secure educational resources.

4.3.2 Annual Trends of the Second-tier Region

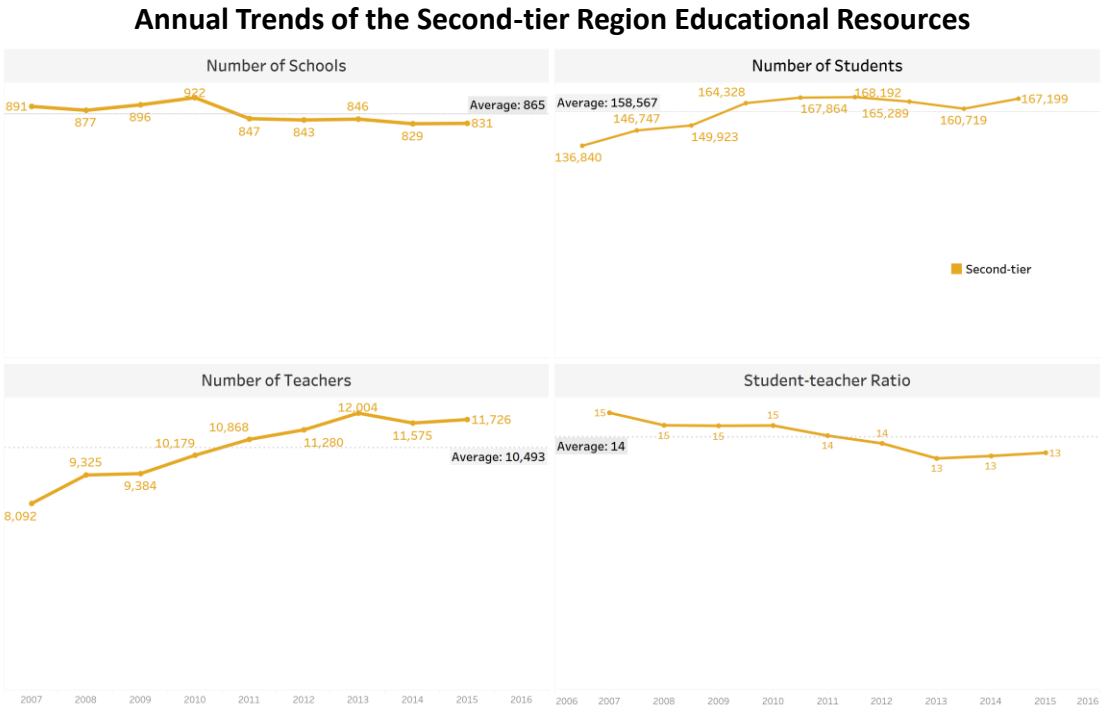

Figure 5: *2006-2017 Educational Resources of the Second-tier Region*

The result shows that the number of schools has been decreasing gradually, except during 2009 and 2010. This trend might suggest that most schools in the second-tier region have similar resources and equal quality. Low-quality schools are being examined via market mechanisms and shut down. The demand and supply mechanism between teachers and students is quite balanced, where schools hire more full-time teachers as enrollment increases. From 2007 to 2016, the student-teacher ratio has always been under the recommended ratio of 1:16. The ratio of 1:13 after 2013 is very close to the 1:12 ratio in early childhood institutions in the United States.

4.3.3 Annual Trends of the Third-tier Region

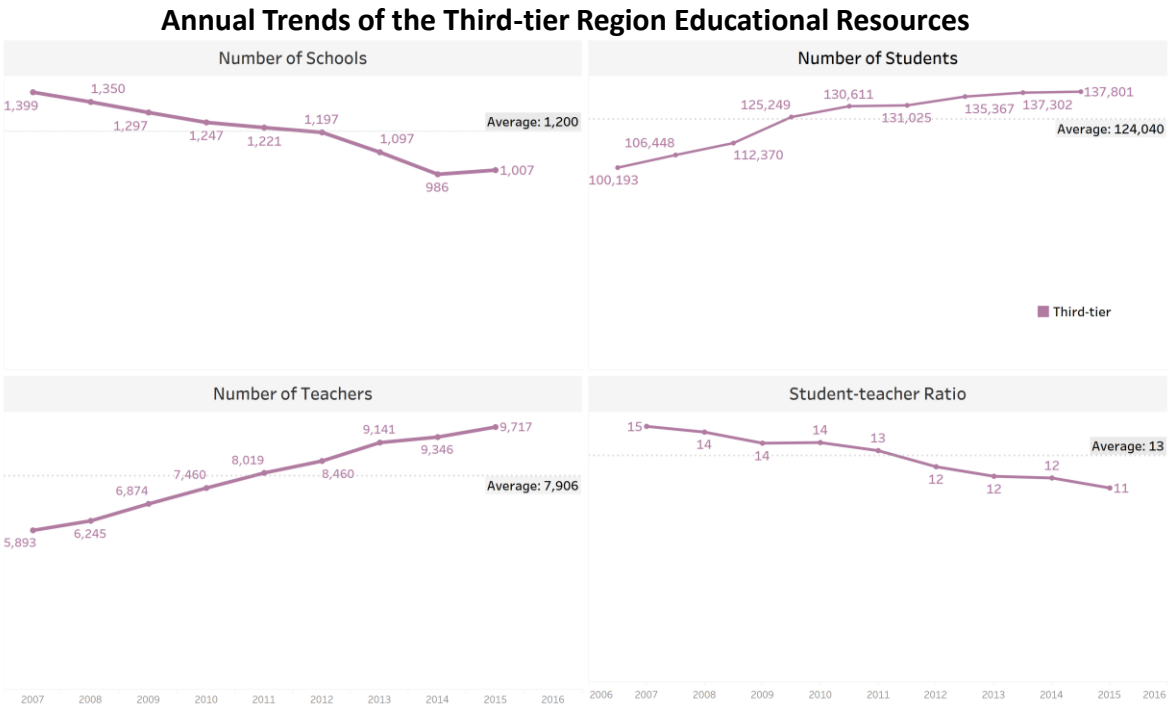

Figure 6: *2006-2017 Educational Resources of the Third-Tier Region*

As for the third-tier region, the number of schools has been declining since 2007. The result showed that the number of students increased slightly from 2007 to 2010, then decreased slightly from 2011 to 2013. In the third-tier region, the number of schools was initially at 1,399, then decreased to 1,006. In contrast, the number of students was initially at 100,193 in 2007, then increased to 137,505 in 2016. The third-tier region has more schools than school-aged students in 2007. One thing to note is the number of schools did not increase or decrease with the number of students. The results showed that the third-tier region did not establish schools according to the market mechanism. After 2014, the result showed that the number of schools related to the increase or decrease in the number of students. The number of teachers is aligned with the number of students. When the number of students increases, the number of teachers increases as well. In other words, the number of teachers and the number of students is aligned with the supply-demand model. The student-teacher ratio in the third-tier region has always been under the recommended ratio — 1:16. The ratio is similar to or lower than the U.S. standard of 1:12 after 2012. Such a student-teacher ratio suggests that students in the third-tier region have more individual attention from teachers.

4.3.4 Annual Trends of the Fourth-Tier Region

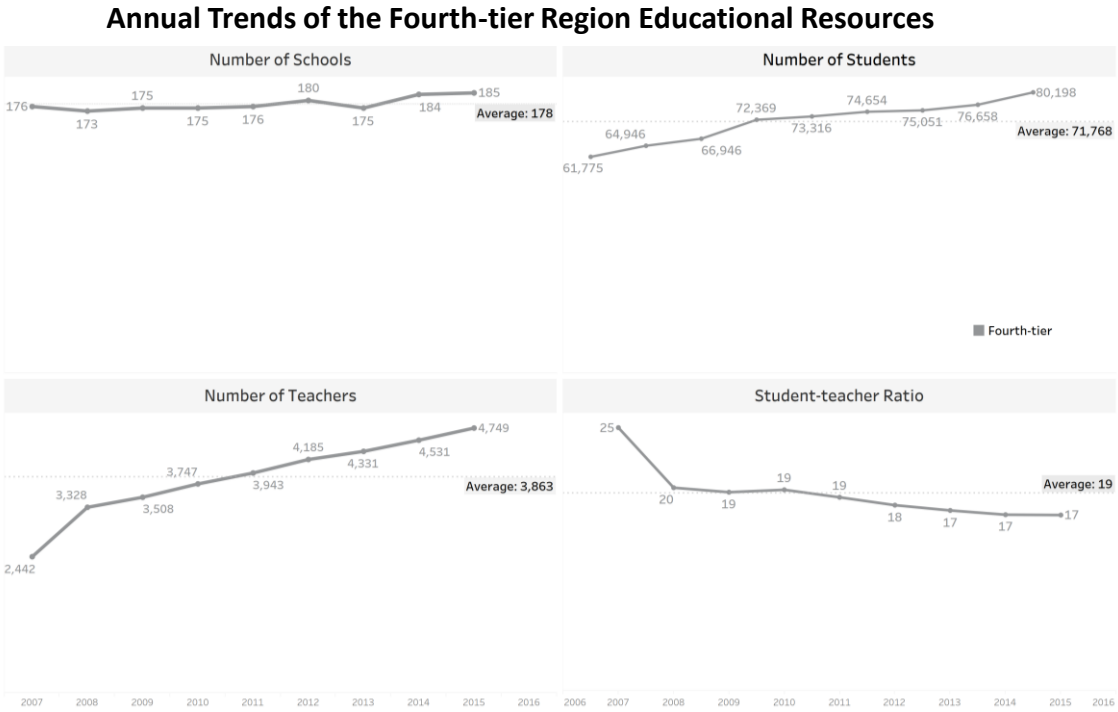

Figure 7: *Annual Trends of the Fourth-tier Region Educational Resources*

The fourth-tier region had the lowest educational budget among the four regions in this study. As this graph shows, the number of schools has been steady around the average from 2007 to 2016. The number of students has been aligned with the number of teachers in the fourth-tier region. As such, the student-teacher ratio finally reached 1:16 in 2016, a recommended national average in China. The student-teacher ratio started at 1:25 in 2007, which is much higher than the national recommended average. The result suggests that the fourth-tier region has allocated resources to hire more full-time teachers rather than establish new schools. This strategy has ensured that students in the fourth-tier region had more individual attention from teachers.

Overall, the number of schools decreased in the first-tier, second-tier, and third-tier regions. The only exception is the fourth-tier region; the number of schools increased from 176 in 2006 to 193 schools in 2016. The third-tier region had the highest number of schools, then the first-tier, second-tier, and the fourth-tier region in 2006. In 2017, the first-tier region had the highest number of schools, then the third-tier, second-tier, and fourth-tier regions. Such changes suggest the supply-demand model in each region. For example, the third-tier region might offer more schools than the actual demand. We could observe the rapid increase in the number of students in the first-

tier region, almost 1.5 times more students when compared to the number of students in 2017 to that of 2006. The other regions increased at a slower pace and no such pattern. For example, we observed 1.3 times more students in the third-tier region. In accordance with the increased number of students, the number of teachers also increased. For instance, the fourth-tier region doubled the number of teachers. With such effort in hiring more full-time teachers, the student-teacher ratio lowered down from 1:25 to 1:16. Continuing with educational resources differences, the next section introduces the overall differences by regions.

4.4 Regional Resources Changes by Years

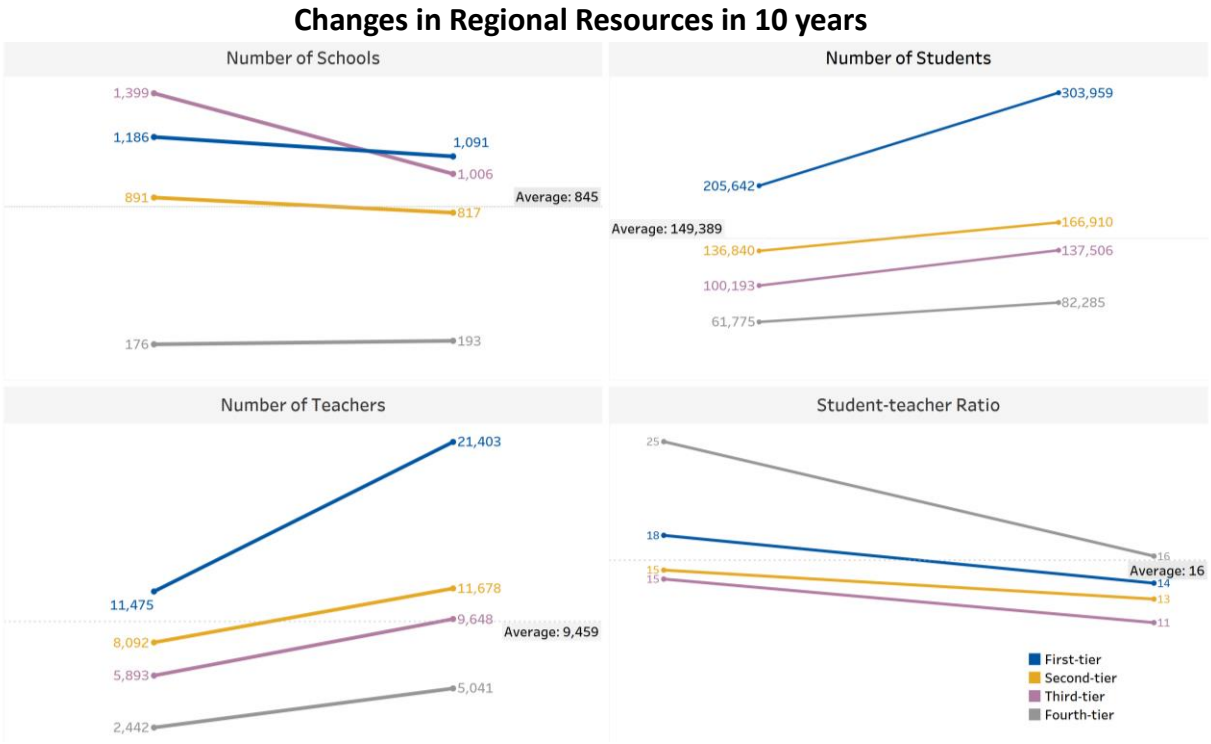

Figure 8: *2006-2017 Educational Resources by Region*

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4.5 Factors related to Educational Resources

Four linear trend models are computed for educational resources with each factor: educational budget, number of schools, number of full-time teachers, number of enrolled students. The model has to be significant at p <= 0.05 to be considered a related factor. The results are shown in the following graph:

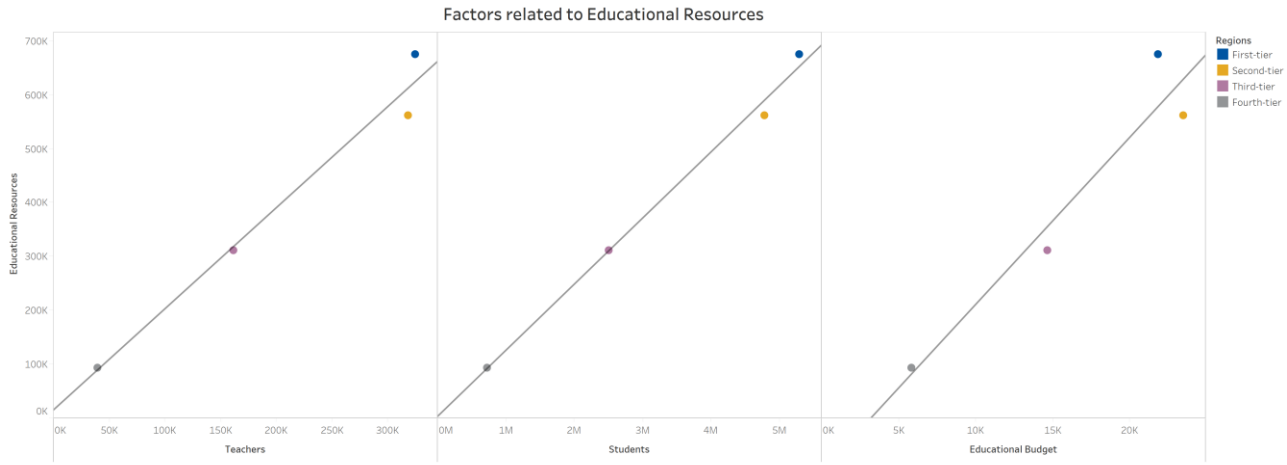

Figure 9: *Factors related to Educational Resources*

The regression model showed that the number of schools is not related to this region's overall educational resources. In other words, having more school is not related to more educational resources. The three factors that are related to educational resources are the number of full-time teachers, the number of enrolled students, and the educational budget. The detailed model fit information is shown in Table 1.

Table 1: *Factors Related to Educational resources*

Variables				Coefficients			
Outcome	**Predictors**	R^2	DF	β_1	StdErr	t-value	p-value
Educational Resources	**Teachers	0.99	2	9.64478	0.556923	17.318	0.0033177

	**Students	0.99	2	0.642111	0.0318007	20.1917	0.0024438
	*Educational Budget	0.92	2	31.0465	6.39371	4.85579	0.0398907

According to the intercorrelation among predictors, the number of schools is highly related to the educational budget. In other words, establishing more schools takes up a significant amount of the educational budget. However, the regression results suggested that the number of schools is not related to overall educational resources. Such results indicate that budget allocation in this region should be allocated to hire more full-time teachers, so enrolled students have more educational resources.

The results showed that the number of full-time teachers and the number of enrolled students is more related to educational resources. The high value of R^2 also suggested that a good model fit. Such results indicated that schools are not related to educational resources but took up a significant educational budget.

5. Conclusion and Policy Recommendation

The purpose of this study is to identify trends before the "Activate the Implementation of Early Childhood Education Plan." The result showed that the resources do differ by region. For example, the first-tier region had almost two times more of the educational budget compared to the fourth-tier region. It also showed that the resources are not balanced in each region. For example, the third-tier region had a higher number of schools but a lower number of students. The fourth-tier region and the first-tier region also need more teachers according to their student-teacher ratio. Overall, the second-tier region is most balanced in terms of number of schools, number of teachers, number of students, and student-teacher ratio.

The overall trends showed that all four regions had a decreased number of schools from 2006 to 2017 except for the fourth-tier region. It suggests that the number of schools might not be a demanded resource in this province. On the contrary, the number of students has increased in all of the regions, particularly the first-tier region. In accordance with the increased number of students, the number of teachers also increased. Such increase help ensure the quality of teaching and learning with a lower student-teacher ratio.

As the regression result showed, that number of schools is not related to educational resources; however, it is highly related to the educational budget. Based on the result, it implied

that establishing more schools in this province might not be a wise approach to allocate resources in this region. The regression showed that the number of teachers and the education budget are both highly related. The regression results suggested that investing educational budget in hiring more full-time teachers might contribute to teaching and learning in this region in Zhengjiang Province.

Since Zhengjiang Province is in the East region, the results of this study might not be able to generalize to other regions in China. The data of the study came from the initial data collection; thus, it contained 8 out of 90 counties in Zhengjiang Province. Although the data is limited, it still provides a reference point to explore the resources by regional differences. This study is a pilot study of a larger-scale study that will have more completed data for all 90 counties in four regions. The timeline of study set before 2017 of policy to allocate resources equitably and efficiently; thus, it might be worthwhile to reexamine the data after the policy implementation.

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