School Choice and Student Sorting: Evidence from Adachi City in Japan

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Abstract

We examine whether the school choice program of public junior high schools in Adachi city has caused student sorting and has thus increased the differences in scores between the schools. We find that students are sorted in the sense that the students living in the school attendance areas where there is a higher proportion of high-status occupations are more likely to select private schools even after the introduction of the school choice program, or they select public schools with higher scores. However, the differences in scores between public schools have been decreasing, indicating that the sorting is not related to the scores.

Keywords: School choice, Student sorting

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1. Introduction

School choice is one of the most controversial issues in Japan, as in other countries. In 1997, the Ministry of Education allowed the Board of Education to introduce school choice programs in elementary and junior high schools.[1] Since then, the number of municipalities that have adopted these programs in junior high schools has increased by 11.1%, reaching 161 municipalities in 2005. In particular, 26 out of the 62 municipalities in Tokyo have adopted the programs, and 22 municipalities have selected the full-choice program that allows students to select a school from among all the schools within a municipality. We focus on Adachi city, which is adjacent to the center of Tokyo and has adopted the full-choice program, and we examine whether student sorting has occurred and, if so, whether the difference in scores between schools has been increasing.

One of the reasons for introducing the school choice program is to improve the quality of education, as evaluated by scores in the main subjects, by letting schools compete with each other. However, the program has been criticized from an equity viewpoint. First, it is argued that the program will induce student sorting so that differences in scores between schools will increase. Parents who are keenly interested in scores will have their children travel to the higher-score schools, and such parents are often wealthy and have higher-status occupations. Thus, eventually, schools are classified into two groups: one group is made up of the schools composed of students whose parents are strongly focused on education and who attain higher scores; the other group is composed of students whose parents are not focused on education and who attain lower scores. Second, the school-choice program is criticized in that it will not enhance competition between schools, but will only reduce the motivation of teachers. In fact, this program is not associated with budget transfers to schools or the allocation of good teachers. The budget of a school is mechanically determined by the size of its student body, teachers are moved from one school to another periodically, and their

[1] In principle, the Municipal Board of Education decides on local policies in education independently. However, in fact, most of the expenses for public education are financially supported by the central government, which makes the Board hesitate to adopt policies that differ from the central government’s guideline. Thus, important educational policies are decided by the central government. The municipal boards will be notified of the policy changes. On the other hand, governments of prefectures can determine policies in high school education, so that the school choice programs are common in most prefectures.

salaries are raised every year with little reference to their performance. Hence, more popular schools do not necessarily have higher budgets or more skillful teachers than less popular schools.

The program is limited to choice among public schools, but there is also competition between public schools and private schools. It is alleged that private schools provide a higher quality of education than do public schools, but the tuition fees are more than 500,000 yen (about 4,500 dollars) per year. There are many private schools within one hour's travel from Adachi city that are accessible using the well-developed public transportation systems in the Tokyo metropolitan area. Thus, parents who can afford the tuition fees of private schools will have their children attend them. Thus, there are two levels of student sorting: first, the selection of private schools rather than public schools, and second, the selection of public schools other than the assigned school under the school choice program. If the school choice program has succeeded in improving the scores of public schools, the proportion of enrollees selecting private schools will be declining.

Figure 1 shows the proportion of enrollees in private schools and the proportion of enrollees who opted out of their assigned schools from 1994 to 2005. Note that the school choice program was introduced in 2002, but in fact it had been possible for students to attend schools other than their assigned school even before the introduction of the program. The cross-border enrollment rate has steadily increased since 1994, a trend that was accelerated by the introduction of the school choice program. In 2001, the cross-border enrollment rate rose above 20%, and in 2005 it reached 31%.[2] On the other hand, the enrollment rate in private schools has remained constant at just above 10%, regardless of the introduction of the school choice program, until 2005, when it increased to 15%. The rates vary among the attendance areas, and in some school attendance areas, they reach above 20%.

The purpose of this paper is to examine whether the school choice program in Adachi city has caused student sorting and has increased the differences in scores between the public junior high schools. The first question is whether the proportion of students selecting private schools changed after the introduction of the school choice

[2] The data in 2002 and 2003 of the cross-border enrollment rate are not provided by the authority of Adachi city.

program. As the program was introduced to improve the quality of education provided in public schools, the proportion of students selecting private schools would be expected to decrease if the program was successful. Second, we will examine which characteristics of residents in a school attendance area affect the school choice. There are differences in the characteristics of the attendance areas, in particular in the types of occupations of the residents. Parents in high-status occupations, who are classified as professional and technical workers or managers and officials[3] in census data, tend to have a keen interest in education, and they are often concentrated in particular attendance areas. We wondered whether students of such attendance areas are more likely to select private schools or to select public schools attaining high scores, whereas students of other attendance areas will be reluctant to travel to schools with high scores located outside their areas. The third question is whether the difference in scores between schools has been increasing or decreasing and whether the average score of the public schools in Adachi city is improving compared with the average of all schools in the Tokyo metropolis. Adachi city is well known as a member of the worst-performing group in terms of school scores in the Tokyo metropolis. As Adachi city introduced the school choice program earlier than some other areas, an improvement in its performance should have been apparent if the program was working effectively.

Unfortunately, we cannot use individual data on school choice, but there are aggregated data that show how many students in a school attendance area choose particular public or private schools. Therefore, we conducted our studies based on this attendance area-based data.

Our empirical studies employ a conditional logit model (abbreviated as CLM hereafter) with the attendance area-based data. We cannot apply the CLM developed for the individual-based data directly to the small-area data as there are many schools that are rarely selected by the other school attendance areas. In this case, econometric problems arise when applying the CLM, such as the estimates having large standard errors or, at worst, the numerical process of maximizing the likelihood function failing

[3] In the census, households are asked the occupation of household members or the kind of company for which they work, and the occupations are classified into 10 major categories, namely: (I) professional and technical workers, (II) managers and officials, (III) clerical and related workers, (IV) sales workers, (V) service workers, (VI) protective service workers, (VII) agricultural, forestry and fisheries workers, (VIII) workers in transport and communications occupations, (IX) production process workers and laborers, (X) workers not classifiable by occupation.

to converge because the logit function is not adequate to represent a zero or near zero probability. In the process of the likelihood maximization, the numerical procedure makes the parameters too large in an absolute sense to represent a zero probability. This may happen even when using individual data where the selection probability of an alternative is very small, but it often happens with the area data. Therefore, we suggest a two-stage estimation model that determines a choice set for each school attendance area, excluding the unselected schools in the first stage, and applies the CLM for the choice set, taking the 'own school' attendance area as the base case in the second stage.

This paper is organized as follows. Section 2 explains the background of the school choice program of Adachi city and provides a brief literature survey. Section 3 presents the empirical results of student sorting and of the difference in the scores between schools. Section 4 concludes the paper.

2. Background and Literature Survey

Adachi city is one of Tokyo's special 23 wards,[4] and it is located in the northern part of the wards (see figure 2). It is one of the earliest cities to have introduced the school choice program both in elementary and junior high schools. Since the Ministry of Education in Japan allowed municipalities to relax the rigidity of school attendance areas, one of the main policy issues in local governments has been whether to make school attendance areas flexible. Of Tokyo's special 23 wards, Shinagawa was the first to introduce school choice in 2000, followed by Toshima in 2001, Adachi, Koto, Suginami, Sumida and Arakawa in 2002, and afterwards most of the remaining wards introduced the program in the following years up until 2005. The purpose of the relaxation is to improve the quality of education by making schools compete against each other. In the school choice program of Adachi city, pupils who will enter an elementary school or a junior high school can select any school among all of the schools within Adachi city. In 2005, this involved 73 elementary schools and 37 junior high

[4] Because the main functions of central governments or headquarters of firms are located in, and huge numbers of people live in, the central area of Tokyo, composed of the 23 special wards, the central area is administered with the close cooperation of the Tokyo metropolitan government and the wards to maintain the unity and cohesion of a single 'city'. Therefore, the wards have nearly the same jurisdictional power as the other cities but levying and collecting taxes, waterworks, sewerage and firefighting.

schools (in 2004 there were 38 of the latter, but two of the schools consolidated in 2005).[5]

One of the reasons for introducing the school choice program early in Adachi city was that there were many students who changed from their assigned school even before the introduction of the school choice program. Then, the municipality's Board of Education decided whether students were allowed to change school based on submitted documents describing the reasons for the change, and sometimes on the basis of talking to the parents of the student. Although the change of school must be allowed legitimately in some exceptional cases, about 15% of all students changed their junior high school every year from 1994 to 2001. Moreover, about 10% of students selected private junior high schools. Thus, in 1995, even before the 1997 notice from the Ministry of Education, the Board of Education had already decided to relax the regulation of the school attendance area. The reason for the relaxation was to deal with bullying or absenteeism in a school, which was socially acknowledged as one of the main reasons for changing schools. The Board considered that a student who did not fit in at one school might adapt better at another school, and thus bullying or absenteeism would be solved. In fact, therefore, since 1995, students have been able to select any school that they want to attend.

Hisatomi (2000) followed the historical changes of education policy relevant to the school choice program of Adachi city and indicated that the relaxation of attendance areas increased cross-border enrollments. As a result, schools diversified into two groups, one gathering large numbers of cross-border students, the other losing students from within their attendance areas. The former group is composed of large-scale schools having new buildings and a good reputation among parents, whereas the other is composed of small-scale schools adjacent to large-scale schools and having bad

[5] We explain how the school choice program proceeds for the case of students who will enroll or are enrolled in public junior high schools in April 2007. Students must submit an application form to the school that they would like to enter, between 15 and 21 November 2006. Applicants are notified whether they have been accepted. As long as the number of applicants is below the upper limit for new enrollees of the school, the school must accept all of the applicants. If the number of applicants is over the limit, then the new enrollees are decided by random assignment. The random assignment procedure is conducted openly from 14 to 16 December 2006. The applicants dropped from the assignment will apply to other schools where the number of applicants is below the limit. The procedure will proceed until mid-January 2007.

reputations. Hisatomi criticized the relaxation, arguing that it would result in student sorting.

School choice programs with or without school vouchers have been introduced in many countries, and there are many research papers concerning them. In theory, Nechyba (1999, 2003a, 2003b) discussed income and ability sorting by selecting the residence or by selecting private schools with school vouchers, taking the spillover effects of the choice into consideration under the different school systems. Epple and Romano (2003) focused on the differences in the ability of students, the income of their parents, and peer groups that impact on school qualities and the distribution of educational benefits after the student sorting. However, there is no general consensus as to whether the school choice program will encourage student sorting, whether differences in performance will increase between public schools or which social group will benefit from the program. Empirical studies by Bradley and Taylor (2002), Ladd and Fiske (2001), and Söderström and Uusitalo (2005) analyzed the program in England, New Zealand, and Sweden, respectively. There is no concrete result in the empirical studies, as was the case with the theoretical ones. Using rich microdata on Chicago Public Schools, Cullen, Jacob and Levitt (2005) found that systemic choice within a public school district does not seem to benefit those who participate.

On the other hand, regarding productivity improvements due to competition, Hoxby (2000) found that schools located in metropolitan areas where many competing private schools exist perform better than schools in less-competitive areas. In contrast, although Sandström and Bergström (2002) found a relationship between the severity of competition and the performance of public schools, the effect of the competition was not strong.

Although the school choice program was first introduced in 2000 in Shinagawa, there is no work that tackles the effects of the school choice program on student sorting, on differences of scores between schools, or on the productivity of public schools. In regard to school choice, only Akabayashi (2006) discussed the relation between the severity of competition and the performance of public high schools by exploiting the changes of high school attendance areas. This paper is the first one in Japan that examines the effects of the school choice program.

3. Data and Estimation Results

3.1. Data

The data in this study are composed of three parts: first, the socioeconomic characteristics of the school attendance areas; second, the attributes of the junior high schools; and third, the geographical factors that measure how easy it is for students to select schools other than their assigned school. We are concerned with the relation between the characteristics of the school attendance area or the attributes of schools and school choice.

First, attendance area-based data are needed, although the areas generally do not correspond to the statistical area units of the census or other public statistics. Thus, we have to construct the data by aggregating the census data for small areas.[6] As for the data representing the characteristics of a school attendance area, we adopt, first, demographic data—namely, the density of the population under 15 years old, the density of the population under 65 years old and the number of family members—and second, socioeconomic data—namely, the number of commercial stores per 1000 persons, the yearly number of crimes per 100 persons and the proportion of workers whose occupations are classified as professional and technical workers or managers and officials.

Second, we use the data representing the attributes of a school, including the total number of students of a school, the number of students accepted from other cities,[7] a renewal dummy for school buildings, and the scores of the main three subjects: Reading and Writing (R&W), Mathematics (Math) and English. We expect that the larger the total number of students or the newer the school buildings, the more attractive the school, as it can provide a large variety of cultural and athletic club activities—for example, science and computer studies, as well as baseball and football—which is undoubtedly one of the important factors in a comfortable school life. Schools with higher scores will also attract students whose parents are concerned with scores.

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[6] The census data are available at the small-area level where the census tract-based data are aggregated. The small areas often correspond to a block or some blocks for which a part of an address or a postal code is given. In general, the address is composed of the name of the city, the name of the block and the number indicating the exact location of the residence in the block.

[7] Adachi city accepts students from the adjacent cities of Arakawa, Kita and Soka.

Third, geographic factors are important for school choice. We first make boundary data for school attendance areas with GIS software, namely ArcGIS, and then we calculate the longest commuting distances within an attendance area (km), the number of schools within a one-kilometer circle from the areal center of the attendance area, the distances to the schools from the areal center of an attendance area, the average distance from an attendance area to the schools, and the dummy of commuting measures. The first three variables are used in the analysis of the cross-border enrollment, while the last two are used in the analysis of school choice. The longest commuting distance within an attendance area is defined as the longest distance from the areal center of the attendance area to the areal centers of the small areas that compose the attendance area. The number of schools within a one-kilometer circle from the areal center of the attendance area, which we refer to as the number of neighboring schools, includes the school of the attendance area itself. Hence, it never takes a value of zero. These two variables are used for factors possibly influencing cross-border enrollment. If traveling to the assigned school takes a lot of time and students can find many schools close to their attendance area, they are likely to select cross-border commuting to the nearby schools. Note that the distance from an attendance area to schools is calculated by averaging the distances from the areal centers of the small areas in the attendance area to the other schools. Thus, it is not measured as the distance from the center of an attendance area to the other schools. The dummy of public transportation takes a value of one if bus or railway lines can connect an attendance area to a school, otherwise it takes a value of zero.[8]

Table 1 shows the descriptive statistics of the data before and after the introduction of the school choice program, as well as the data for 2004 and 2005. First, we find that the proportion of students who selected private schools slightly increased even after the introduction of the school choice program, and it surged in 2005. At the same time, the number of cross-border enrollees drastically increased to nearly twice as many as before the policy change. Second, the characteristics of the school attendance areas are almost unchanged except that aging is progressing and the total number of students per school

[8] We assume that students of an attendance area can travel by bus or train if the bus or railway stations are located within 0.5 km of the center.

has been decreasing. Third, the test scores for Math and English declined in 2005 compared with 2004, but that for R&W was unchanged.

3.2. Estimation results for school choice

School choice has two forms: one choice is whether to select private schools, and the other choice is whether to select a public school other than the assigned school. First, we examine whether the ratio of students selecting private schools has changed following the introduction of the school choice program. Second, we examine in which attendance areas students are likely to select private schools or public schools other than their assigned schools, and which attributes of public schools attract which types of students.

Table 2 shows the estimation results for the private-school choice using a logistic regression model with year dummies for two cases, including the cross-products between the postreform dummy and the characteristics of school districts or the size of the school. Note that the positive sign of the estimates implies that students are more likely to select private schools than public schools. We will compare the results of two estimations. Both estimation results show that students living in areas with higher proportions of high-status occupations are more likely to select private schools. By examining the values of the year dummies, we can determine whether the program affects private school choice. In the case without cross-products, case (1), the estimates of the dummies from 2002 to 2004 are not significant, and so the program seems not to affect the private school choice. On the other hand, the cross-product of the proportion of high-status occupations and the postreform dummy, which takes a value of one after the introduction of the program, i.e., in the years from 2002 to 2004, is significantly positive in the case (2). At the same time, the year dummies from 2002 to 2004 are significantly negative, showing a nearly 1.9 point decline in the postreform period compared with the prereform period. Thus, we can conclude that the introduction of the school choice program has accelerated the selection of private schools in the attendance areas with high proportions of high-status occupations, whereas it has generally discouraged the choice of private schools in other areas.

Table 3 shows whether the cross-border enrollment has changed since the introduction of the school choice program, using the logistic regression model for two cases, the cases with and without cross-products, cases (2) and (1), respectively.[9] The positive sign of the estimates implies that students of a school attendance area are more likely to select a school other than their assigned school.

In general, the higher the proportion of high-status occupations in an attendance area, the more likely students of that attendance area are to select a school other than their assigned school. The attributes of the 'own school' are important as well as the characteristics of the school attendance areas. The larger the school or the more the school accepts students from the neighboring cities, the more the students hesitate to move to other schools. Geographical factors also matter. The greater the longest commuting distance, or the more schools nearby, the more likely students are to select other schools. Moreover, if there is a station near the attendance area center, then students readily select schools other than their assigned school.

The most impressive results are that the estimates of year dummies for case (1) increase significantly for descending years, with the value jumping in 2004, which implies that the cross-border enrollment was increasing even before the school choice program was introduced and that it has been accelerated by the program. By examining the cross-products of case (2), we can determine what factors contribute to the surge of the cross-border enrollment in 2004. The results show that the greater the density of people under 15 years and the higher the number of commercial stores, the more likely students of the area are to attend schools other than their assigned school. On the other hand, the larger the 'own school', the less the students opt out. We do not find that the students in areas with a higher proportion of high-status occupations do not change their behavior after the introduction of the program.

Table 4 shows the estimation results of the first and the second parts of the selection model explained in Appendix A for two years, 2004 and 2005. Note that the first part of the model examines what factors affect the selection of schools other than the assigned school—that is, it examines whether a school other than the assigned school belongs to the choice set—whereas the second part of the model clarifies why so many students in

[9] Senju-aoba Junior High School is omitted from the dataset used for the estimation. Senju-aoba was established in 2003 by the consolidation of two schools, the third and the fifteenth schools. Hence, the data for these schools before the consolidation are also omitted. The rationale for this is that these two schools are located close to each other and so the cross-border enrollment between these two schools is large. However, when we take them as one school, we do not know in which school the students of this consolidated districts are enrolled.

an attendance area tend to select a certain school and why this school attracts so many students. We are concerned with the time-series changes of the cross-border enrollments and whether the introduction of the school choice program encourages the tendency in Tables 2 and 3, but instead we are concerned with whether students are sorted after the introduction of the program. We have conducted four cases, a without-score case and three with-score cases, involving scores for R&W, Math and English. The negative signs of the estimates imply that students are likely to select the school in their own attendance area. Note that the scores are taken from the achievement tests conducted by the Tokyo metropolitan government in 2004 and 2005.[10]

We first discuss the estimation results of 2004. The most important estimates are those of the proportion of high-status occupations, the score and the cross-product of the score and the proportion of high-status occupations, as they indicate whether students are sorted. In the estimation results of the first part, we find that the higher the proportion of high-status occupations, the less likely it is that students will select schools other than the assigned school in the with-score cases from (2) to (4). The estimates of the parameter of the proportion of high-status occupations are significantly negative for these cases. This implies that students who live in attendance areas with high-status occupations are likely to select the 'own school', which means that the school tends not to accept students from other attendance areas. At the same time, the estimated parameters of the cross-products are significantly positive for all cases, whereas the estimated parameters of scores are insignificant. This implies that scores do not attract students in general, but they do attract students who live in the attendance areas with higher proportions of high-status occupations.

Estimated parameters of school attributes other than the score, namely the size of school and the renewal dummies, are significantly positive, which implies that the larger the school or the newer the school building, the more likely the school is to be selected. As for the geographical factors, the distance from an attendance area to a school is significantly negative, although the public transportation dummy is not significant.

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[10] When the school choice procedure was in process in 2004, the test scores for 2004 were not available to the public. However, as parents have information on the educational achievement of schools to some extent, it is reasonable to use the scores of the same periods as a proxy of the educational quality of the school.

The estimates from the second part of the estimation correspond to a school's probability of being selected by students over the 'own school', assuming that schools can be selected. The positive sign of the parameters indicates that students prefer to select other schools over the 'own school'. The results relevant to the proportion of high-status occupations and the school score are the same as the results from the first part of the estimation. Students from the attendance areas with a large proportion of high-status occupations will select other schools only when the scores of these schools are high; otherwise, they will select the 'own school'. Scores by themselves are negatively and significantly related to the school choice, which implies that schools with high scores are not necessarily selected by students. As well as the results from the first part of the estimation, the size of school and renewal dummies are significantly positive, and the distance from the attendance area to a school is significantly negative. In contrast with the first part of the estimation, the public transportation dummy is significantly positive, which means students are more likely to select schools if there are public transport connections between the attendance area and the school.

The 'without score' columns of the table show the estimation results without the scores incorporated. The main difference between the cases with and without the scores is the sign of the estimated parameters of the proportion of high-status occupations. In the case of the second part of the estimation without the scores, the sign of this parameter is significantly positive, which implies that students living in the areas with higher proportions of high-status occupations are likely to move to other schools. Taking the results of the with-score cases into consideration, this result reflects the fact that the students will move only when the score of the other schools is high.

The estimation results using the 2005 data are totally different from those using the 2004 data. The proportion of high-status occupations or the cross-product of the score and the proportion of high-status occupations is not significant in the first part of the estimation. The scores are insignificant, as was the case for 2004. This implies that the difference between the areas with higher proportions of high-status occupations and the other areas disappears in 2005. In the second part of the estimation, the proportion is negatively significant for Math and English, but the cross-product is insignificant. Therefore, the students living in the attendance areas with higher proportions of high-status occupations are likely to travel to other schools, but the scores of the schools are irrelevant to this choice.

This may be related to the surge in enrollments in private schools shown in Figure 1. Most students of parents who lived in the areas with higher proportions of high-status occupations and who were keenly concerned with scores were more likely to select private schools in 2005. In fact, we can see in Figure 3 that, in the top five areas with higher proportions of high-status occupations, the private school enrollment rates surged more than the average in 2005.

Thus, we conclude that students were sorted among public schools in 2004 in the sense that the students of the areas with higher proportions of high-status occupations selected the schools with higher scores. However, the students were sorted in 2005 in a different sense, in that these students from the higher-status areas were more likely to select private schools. Thus, the student sorting in the first sense was decreasing in 2005.

3.3. Correlation between the scores and the cross-border enrollment ratio

When the school choice program causes student sorting by scores, then we expect that the differences in scores between schools will be increasing. In the previous subsection, we found that students residing in school attendance areas with higher proportions of high-status occupations were likely to choose the schools with high scores in 2004, but that this was not the case in 2005. We have not yet confirmed whether those students traveling to other schools are in fact students of high ability. In other words, we are wondering if the average scores of schools attracting students are higher than the other schools. Therefore, we will first examine whether in fact students of high ability are sorted to some schools, thus making the scores of those schools higher than the other schools. Second, we will examine if the initial difference in scores continues to the upper grades. In this subsection, schools are the units of analysis rather than the attendance areas that were the focus in the previous subsection.

We use the scores of the achievement tests conducted by Adachi city and the Tokyo metropolitan government (TMG). Both governments have conducted tests independently for all 8th grade students, while Adachi city has also conducted tests for 7th and 9th grade students. The tests conducted by TMG are held in January or February for three major subjects, namely R&W, Math and English, whereas the tests conducted by Adachi city are held in April for five subjects, including social studies and science as well as the former three subjects.[11] The scores of the tests by TMG represent achievement at the end of the 8th grade, whereas those in the tests by Adachi city represent achievement at the end of the 7th grade. We focus on the scores of the three main subjects, R&W, Math and English.

Table 5 shows the correlation coefficient of the average scores of schools and measures how many students select a school from their assigned local schools. We adopt two measures: first, the cross-border enrollment ratio, which is the proportion of enrollees coming from the assigned local schools to total enrollees; and second, the share index adopted by Hoxby (2000), which is defined as (1 − Herfindahl index),[12] which is close to one when students come from many attendance areas and is otherwise close to zero.

We examine whether the scores are correlated with the measures of cross-border enrollment in the 7th grade and whether they remain correlated in the 8th or 9th grade using the tests scores from the Adachi city data. First, focusing on new enrollees in 2005, we can see from the fifth column of Table 5 that there is a relatively high correlation between the scores in the 7th grade and the cross-border enrollment measures both for the R&W and the Math scores. This implies that more-frequently selected schools are those with higher scores. However, the correlation almost disappears in the next grade, as shown in the sixth column, which means that the initial advantage of the school does not continue to the next grade. Second, focusing on the new enrollees in 2004, where there is no data of the 7th grade, the correlation between scores and the cross-border enrollment measure is not very strong in the 8th grade, as shown in the second column, but it does continue into the 9th grade. Among the subjects, the correlation of the mathematics scores with the cross-border enrollment measure is still relatively higher in the 9th grade.

[11] To be precise, the tests by TMG were conducted on 20 February 2004, 18 January 2005 and 17 January 2006, while the tests by Adachi city were held on 11 April 2005 and 18 April 2006. As English is first taught in junior high schools, there is no score for English for the 7th grade students.

[12] Let $x_1,\ldots,x_k$ be the proportion of the enrollees of a school from k different school attendance areas. Then, the share index of the school is defined as $1-\sum_{l=1}^{k} x_l^2$.

From the TMG data, we obtain only the scores of the 2004 new enrollees in the 8th grade. These data show that the Math test result has a positive but low correlation with the cross-border enrollment measures, whereas the R&W and English results have no correlation.

Summarizing these facts, we can state that schools that attract new enrollees from many attendance areas have high scores initially, but as the grade advances, the correlation between scores and cross-border enrollment falls. This result suggests that the education provided by the schools is more important to the scores than is the ability of the new enrollee.

3.4. Variations in scores between schools

In the previous subsection, we found, by focusing on new enrollees, that the initial correlation of scores with the cross-border enrollment measures did not continue into the higher grades. Now, we examine whether the differences in scores between schools have increased following the introduction of the school choice program. The school-based average scores are available from 2004 in tests by TMG and from 2005 in tests by Adachi city. Furthermore, as the average scores for schools and the distribution of scores of all students within Adachi city are publicly available, we are able to calculate F statistics using these data (for details, see Appendix B). We adopt an F statistic and examine whether the F statistic is becoming bigger or smaller in response to the differences in scores between schools increasing or decreasing. The F statistic is defined as the proportion of between-school variation to within-school variation adjusted by degrees of freedom. Thus, we can determine which factor, between-school variation or within-school variation, most influences the changes of the F statistic. Note that the score distribution for all students for 2006 for the test conducted by TMG is not available, so we are unable to calculate the F statistic for that year.

Table 5 shows the between-school variation and the within-school variation, both of which are adjusted by the degrees of freedom, and the F values, as well as the other measures of variation, the 95th percentile, the 5th percentile and the interquartile range, for the achievement tests conducted by TMG in 2004 and 2006 and by Adachi city in

2005 and 2006.[13] First, we will examine the changes of the F values of the Adachi city 7th-grade test scores, which express how large the difference is between the schools in the abilities of the new enrollees. Comparing the F values in 2005 and 2006, those for R&W virtually remain the same and those in Math decrease slightly in 2005, with the between-school variation decreasing. Thus, there is no substantial difference between 2005 and 2006 in the average scores. The variation of scores by schools, measured by the difference in the scores between the 95th percentile and the 5th percentile or the interquartile differences of scores, shows the same tendency.

Second, we will examine the changes of F values from 2004 to 2006 for the 8th grade, for which data from both TMG and Adachi city are available. The F values have been decreasing in R&W and Math, but they have remained nearly unchanged in English for the tests by both TMG and Adachi city. These facts are interesting because they imply that the differences in the scores between schools have been decreasing in these years. Looking into the detail of the F values, the between-school variation has decreased drastically, but the within-school variation has increased a little in R&W and Math for the tests by both TMG and Adachi city. In English, however, both the between-school variation and the within-school variation have been decreasing for the tests by TMG, with the former increasing a little and the latter remaining almost unchanged for the tests by Adachi city.

Third, the F values for the 9th grade increased from 2005 to 2006 in Math and English, while those in R&W remained virtually the same. In Math and English, the between-school variations increase in 2006, which implies that the difference in performance between schools in the 9th grade is increasing. This can be explained by the differences in the ability of the cohorts of enrollees in particular years. Focusing on the cohort of the enrollees that is in the 9th grade in 2006, and in the 8th grade in 2005, this group's F values in English in 2005 are larger than those for the 8th grade cohort in 2006, and their F values in the 9th grade in 2006 are still high. Thus, the changes of F

[13] As Adachi city conducted tests for students of all grades, we can also see the changes of the same two cohorts, one in the 7th grade in 2005 and the other in the 8th grade in 2005. However, we cannot derive concrete results by examining whether the difference in scores between students in the same cohort increases as they advance to upper grades by using only two consecutive years. The scores of the same cohort will increase as they advance to the 8th grade but will decrease in the 9th grade because most students start studying for the high school entrance examination.

values in English from 2005 to 2006 in the 9th grade must depend on the characteristics of the cohort.

Table 6 also lists the relative values that are means of the scores of all students in Adachi city, divided by the means of all students in all of the cities in Tokyo. The values are improving for all subjects, which implies that the scores of Adachi city relative to the Tokyo average are improving, although they remain lower than the average for Tokyo.

In summary, we find that the differences in scores between schools have been decreasing and the scores have been improving relative to the Tokyo average. Then, the question arises: why have the scores behaved in this way? There is one possible explanation that supports the school choice program: the program, together with the other educational policies of Adachi city, makes teachers more productive, and thus the differences in between-school scores have been decreasing and the scores relative to the average of Tokyo have been improving. Even though the budget transfer to well-performing schools is not built into the system, the managers or teachers have incentives to improve their performance because, in the long run, the staff of the schools performing less well or selected less often will lose the chance of promotion.

4. Conclusion

In this paper, we examined whether the school choice program of junior high schools in Adachi city has caused student sorting, thus increasing the differences in scores between public schools. We found that students are sorted in the sense that the students living in the school attendance areas with higher proportions of high-status occupations were more likely to select private schools even after the introduction of the school choice program, or they selected public schools with higher scores. On the other hand, students of the other areas were more likely, in general, to select public schools following the introduction of the school choice program, and the scores were irrelevant to their selection choices. Surprisingly, however, the scores of the schools that attracted students from many other attendance areas were higher in the 7th grade, but decreased in the next grade, which implies that the education provided by schools is as important as grade advancing. Furthermore, the differences in scores between schools decreased from 2004 to 2006. Thus, we can conclude that students must be sorted even within public schools when they are enrolled in the 7th grade, but the sorting has nothing to do with the scores of the next grades.

As we have examined, the school choice program has not resulted in an increase in the differences in scores between public schools, but the program, together with the other educational programs of Adachi city, may affect the motivations of teachers to improve the quality of education in all schools. Thus, the differences in scores have been decreasing and the scores relative to the Tokyo average have been improving. However, student sorting between private and public schools has increased. An issue that should be examined in the future is whether the differences in scores between private and public schools have increased.

Appendix A:

We will briefly explain the data structure and the estimation methods.

The data structure is formalized in Table A1. There are N school attendance areas and junior high schools. Let $y_{i1},...,y_{iN}$ and $d_{i1},...,d_{iN}$ be the number of students selecting a school who live in the *i*th attendance area, where d_{ij} is a dummy variable that takes a value of one if y_{ij} is positive and zero otherwise; that is, $d_{ij} = I\left(y_{ij} \neq 0\right)$, respectively. It is well known that the joint distribution of $y_{i1},...,y_{iN}$ conditional on $y_{i\bullet} = \sum_l y_{il}$ follows the conditional logit with the selection probability of the *l*th school being $\lambda_{il} \big/ \sum \lambda_{ik}$, where the expectation of y_{ij} is $\lambda_{il} = \exp(\beta' \mathbf{x}_i + \gamma' \mathbf{z}_l)$. When estimating the parameters in the case where many cells of Table A1 are zeros, the estimates are likely to have large standard errors or, at worst, the numerical process of maximizing the likelihood does not converge.

We formulate the joint density function of $y_{i1},...,y_{iN}$ and $d_{i1},...,d_{iN}$ as follows:

$$f(y_{i1},...,y_{iN}, d_{i1},...,d_{iN} \mid y_{i\bullet}) = f(y_{i1},...,y_{iN} \mid y_{i\bullet}, d_{i1},...,d_{iN})\, f(d_{i1},...,d_{iN} \mid y_{i\bullet}).$$

We assume that the dummies of the second part of the right-hand side of the equation are independently distributed as:

$$f(d_{i1},...,d_{ik} \mid y_{i\bullet}) = f(d_{i1} \mid y_{i\bullet}) \cdots f(d_{ik} \mid y_{i\bullet}),$$
$$f(d_{il} \mid y_{i\bullet}) = P_{il}^{d_{il}} P_{il}^{1-d_{il}}, l = 1,...,N,$$

where the selection probability is formulated with logistic probabilities as:

$$P_{il} = \frac{\exp(\alpha_1 y_{i\bullet} + \beta_1 ' x_{1i} + \gamma ' z_{1l})}{1 + \exp(\alpha_1 y_{i\bullet} + \beta_1 ' x_{1i} + \gamma ' z_{1l})}.$$

Note that the 'own school' of an attendance area is always selected, so it gives us no information on the selection. Thus, we omitted the data on the 'own school' in estimating the first step. We assume that $\alpha_1 > 0$, as many more schools are likely to be selected as the number of students in the i th attendance area, $y_{i\bullet}$, becomes large.

In the second stage, we formulate the conditional density function of the number of school choices as:

$$f(y_1,...,y_k \mid y_\bullet, d_1,...,d_K) \propto \pi_1^{y_1} \cdots \pi_k^{y_K} .$$

The probability of students in the ith attendance area selecting a school of the lth attendance area is given as:

$$\pi_{ii} = \frac{1}{1+\sum_{j=1}^{N-1} d_{ij} \exp(\beta_2 ' x_{2i} + \gamma_2 ' z_{2j})}, \quad \pi_{il} = \frac{d_{il} \exp(\beta_2 ' x_{2i} + \gamma_2 ' z_{2j})}{1+\sum_{l=1}^{N} d_{il} \exp(\beta_2 ' x_{2i} + \gamma_2 ' z_{2j})}, i \neq l .$$

When no student in the ith attendance area selects a school of the lth attendance area, that is $d_{il} = 0$, then the selection probability becomes zero. Furthermore, differently from CLM with an individual-based data, we set base cases for own schools so that the positive sign of the estimated parameters implies that the explanatory variable contributes to the selection of the school.

Table A1 Data Structure

		School				
Attendance area	Characteristics Vector	1 Attributes vector $\mathbf{z}_1$	$\cdots$ $\cdots$	l $\mathbf{z}_l$	$\cdots$ $\cdots$	N $\mathbf{z}_N$
1	$\mathbf{x}_1$	y_{11}, d_{11}	$\cdots$	y_{1l}, d_{1l}	$\cdots$	y_{1K}, d_{1N}
.	.	.		.		.
.	.	.		.		.
.	.	.		.		.
i	$\mathbf{x}_i$	y_{i1}, d_{i1}	$\cdots$	y_{il}, d_{il}	$\cdots$	y_{iK}, d_{iN}
.	.	.		.		.
.	.	.		.		.
.	.	.		.		.
N	$\mathbf{x}_N$	y_{N1}, d_{N1}	$\cdots$	y_{Nl}, d_{Nl}	$\cdots$	y_{NN}, d_{NN}

Appendix B:

There are four available sets of scores for investigating the performance of students: two sets from tests conducted by the Tokyo metropolitan government in 2004 and 2006[14] and two sets from tests conducted by Adachi city in 2005 and 2006. The reports on these investigations have only the average scores by subject and by school and the distribution of scores of all students who participated in the examination. In the case of mathematics, for example, 3 or 4 points are allocated to one question so that the score ranges from 0 to 100, with individual scores differing by at least 3 or 4 points. We have the data on how many students obtain a specific score, but we do not know to which school the students belong. The individual scores of students are not available. However, with the available information, we can derive the F statistic to test whether the means of scores within schools are significantly different between schools.

We will explain briefly how we construct the F statistics. Let y_{ij} be the score of the jth individual of the ith school, $\bar{y}_{i\bullet}$ the mean within school score, $\bar{y}_{\bullet\bullet}$ the total mean and r_i the number of students of the ith school. Then, the total variation can be decomposed into the between-group variation and the within-group variation as follows:

$$\sum_i \sum_j \left(y_{ij} - \bar{y}_{\cdot\cdot} \right)^2 = \sum_i r_i \left(\bar{y}_{i\cdot} - \bar{y}_{\cdot\cdot} \right)^2 + \sum_i \sum_j \left(y_{ij} - \bar{y}_{i\cdot} \right)^2 ,$$

where the left-hand side represents the total variation, the first term on the right-hand side represents the between-group variation, and the second term represents the within-group variation. Let S_T, S_B and S_W be the total variation, the between-group variation and the within-group variation, respectively. Then, the F statistic is obtained as:

$$F = \frac{S_B / (k-1)}{S_W / (n-k)} ,$$

[14] The achievement tests by the Tokyo metropolitan government have been conducted every year, but the distribution of scores of all students in Adachi city is not reported for 2005.

where k is the number of schools and n is the total number of students. Even though we do not know y_{ij}, we can obtain S_T from the data on the distribution of scores of the total number of students.

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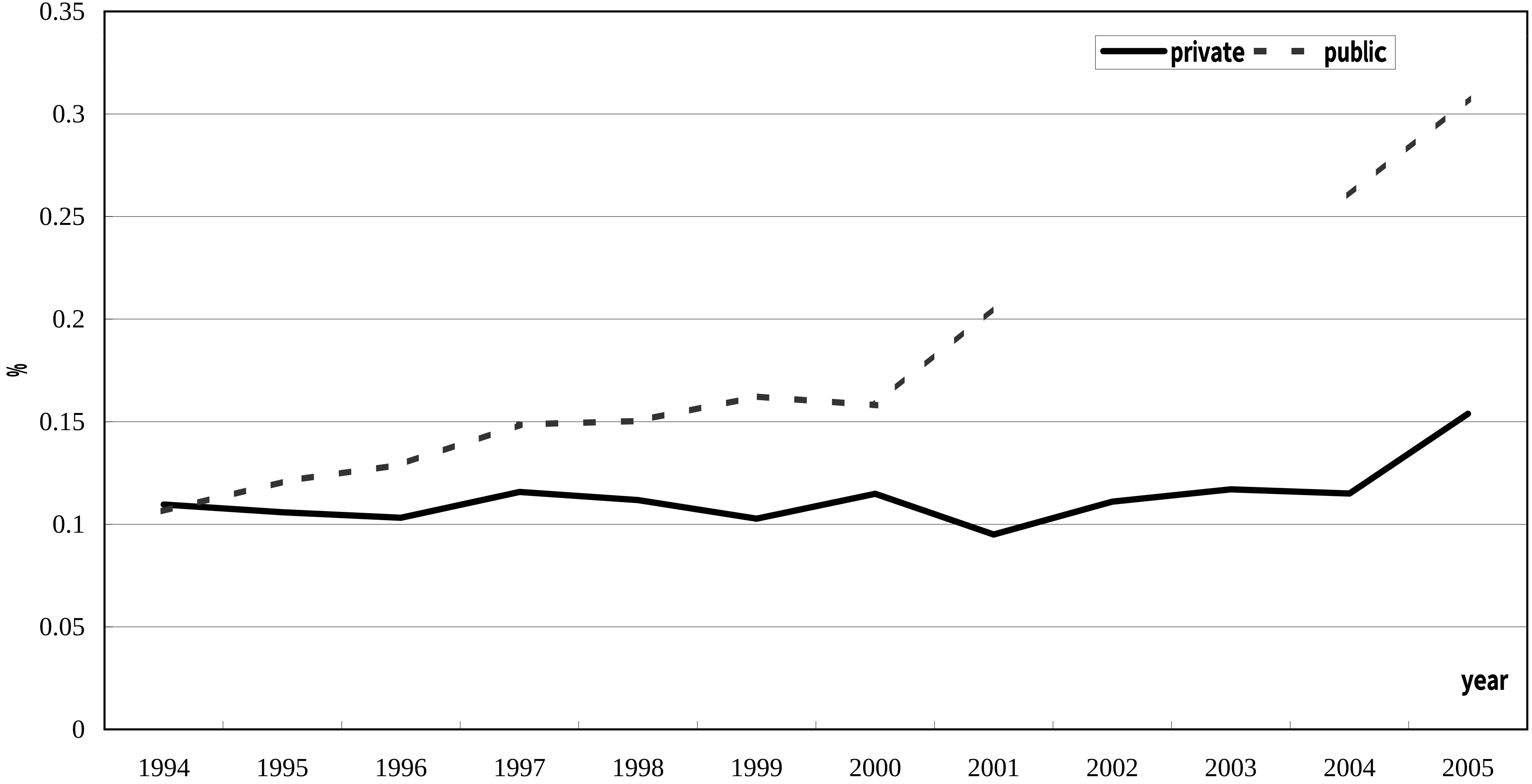
Figure 1: Percentages of enrollee out of their attendance areas



Note: The data of the proportions of students who attended public schools opting out of their assigned schools is not available for 2002 and 2003.

Figure 2A: Location of Adachi city

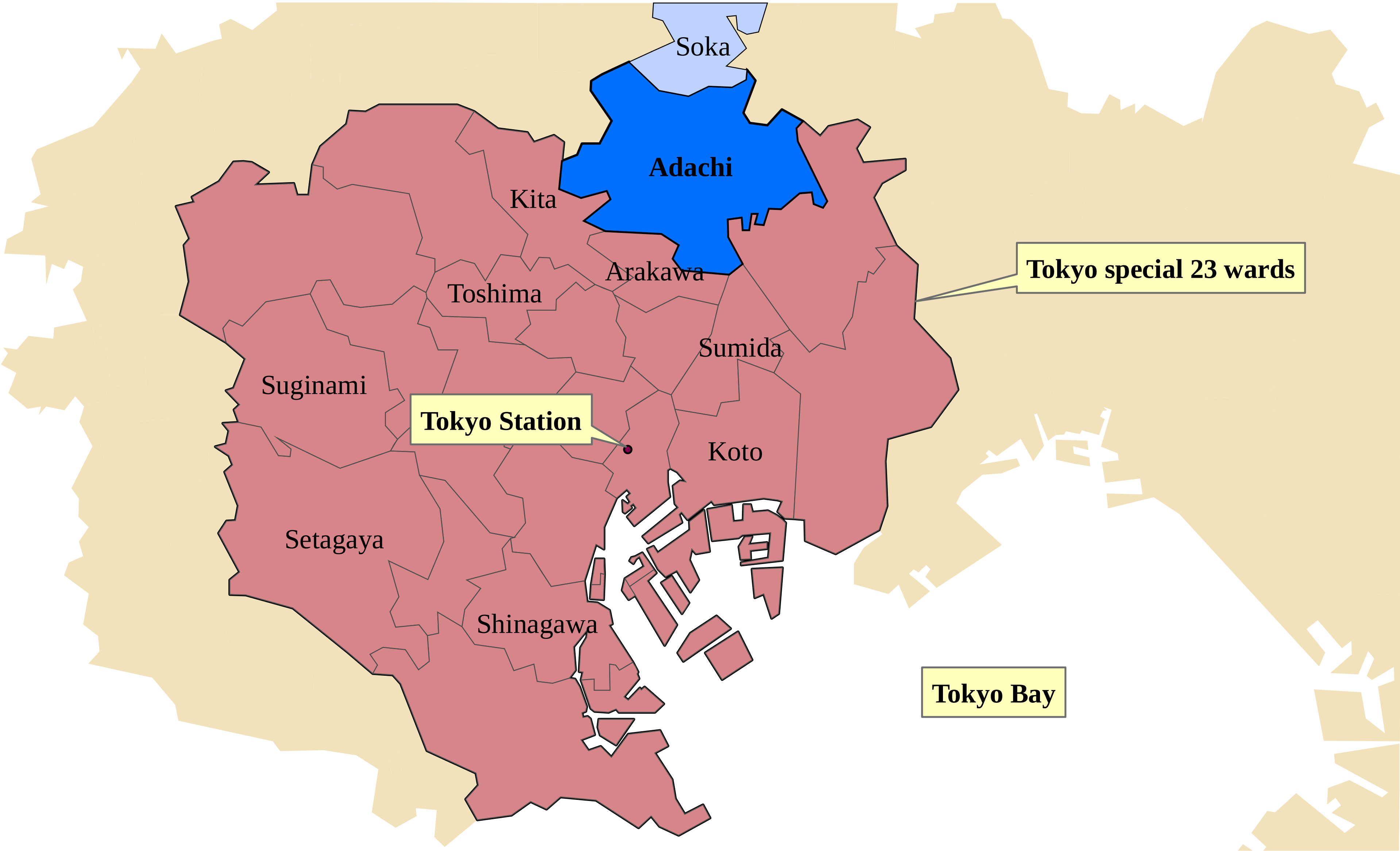


Figure 2B: Geographic distribution of proportions of high-status occupations

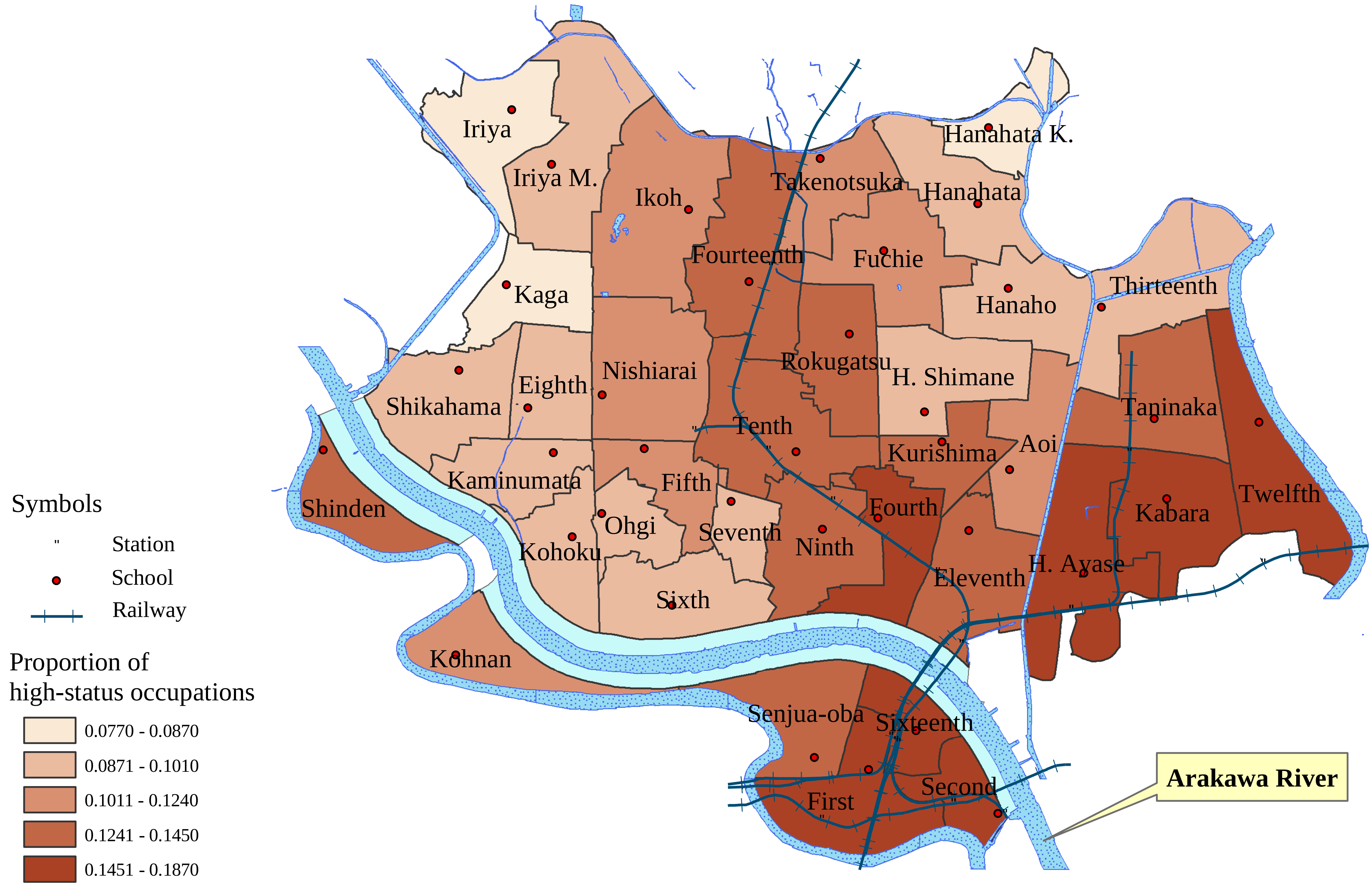


Figure 3: Private school enrollment rate in the top 5 areas of proportions of high-status occupations

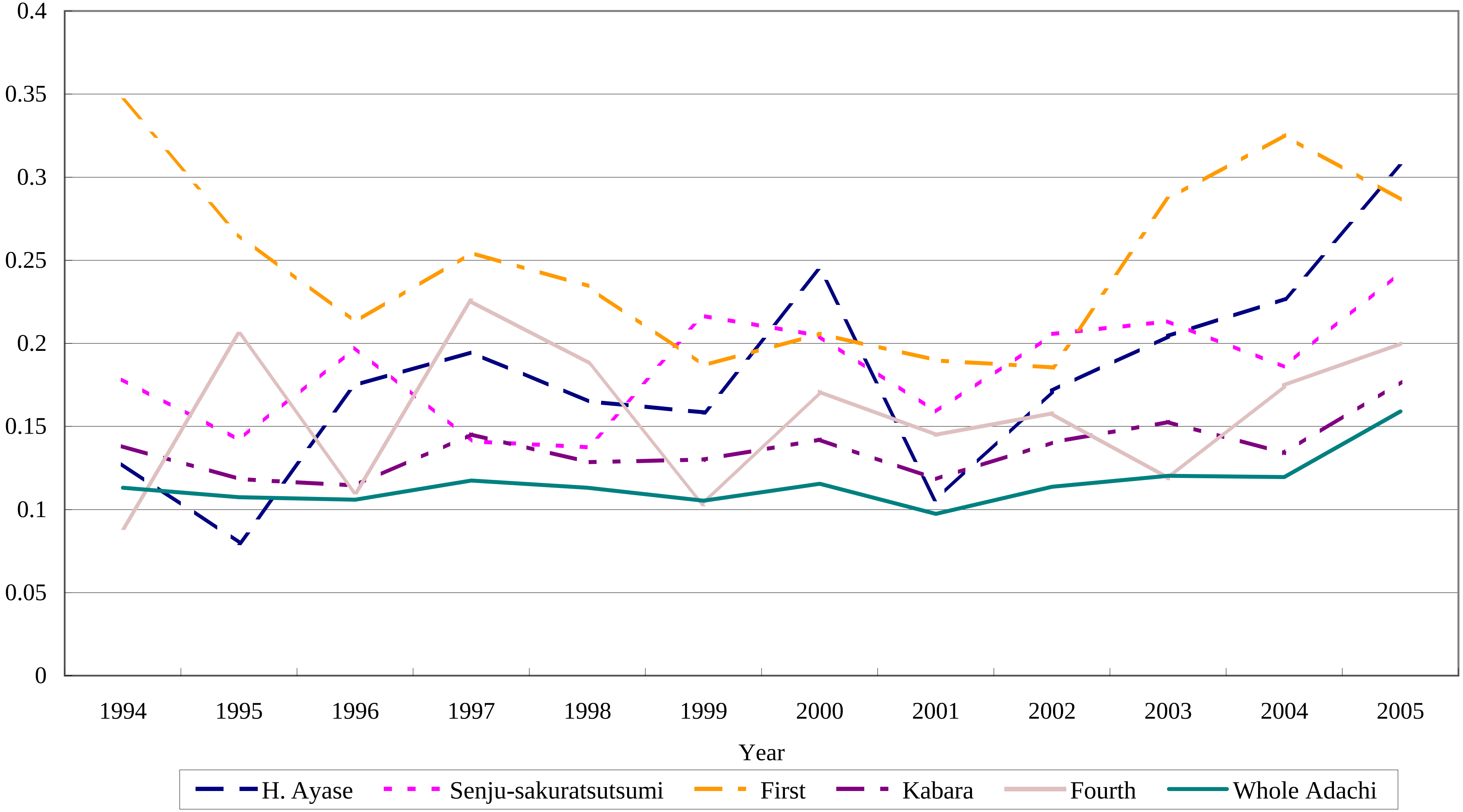


Table 1: Summary statistics

	Before the School Choice (1994-2001)	After the School Choice (2002-2004)	YEAR 2004	YEAR 2005
Enrollee per school attendance area	150.06	140.60	140.13	148.78
	(50.47)	(51.24)	(53.95)	(50.84)
public school enrollee	132.76		127.97	125.89
	(44.06)		(49.59)	(43.60)
cross-border enrollee	21.28		38.61	45.76
	(17.61)		(27.29)	(29.34)
private school enrollee	16.00	16.16	16.68	22.89
	(10.38)	(10.35)	(11.33)	(14.12)
Charactersitics of school districts				
Pop. density under 15years	1.779	1.707	1.699	1.695
(thousand / km2)	(0.479)	(0.448)	(0.443)	(0.445)
Pop. density over 65 years	1.852	2.413	2.503	2.550
(thousand / km2)	(0.936)	(0.944)	(0.932)	(0.891)
No. of household member	2.450	2.291	2.269	2.253
	(0.181)	(0.140)	(0.138)	(0.133)
No. of commercial stores	13.12	11.87	11.87	11.67
(per 1000 pop.)	(4.92)	(4.54)	(4.58)	(4.08)
No. of crimes	2.521	2.521	2.521	2.226
(per 100 pop.)	(0.779)	(0.810)	(0.788)	(0.812)
Prop. of high-status occupations	0.120	0.120	0.120	0.120
	(0.026)	(0.027)	(0.028)	(0.028)
Attributes of School				
Total number of students (hundred)	4.068	3.684	3.657	3.724
	(1.677)	(1.739)	(1.871)	(2.113)
No. of enrollments traveling from outer cities	0.645		0.622	
	(1.632)		(1.460)	
New or rebuild dummy			0.237	0.243
			(0.431)	(0.435)
Gepgraphical factor				
Average distance to the other schools			3.820	3.790
			(1.858)	(1.850)
Commuting distance within the district	0.543		0.543	
	(0.121)		(0.123)	
No. of neighboring schools	2.108		2.108	
	(0.982)		(0.994)	
Public transportation dummy			0.594	0.581
			(0.491)	(0.494)
Railway dummy	0.500	0.500	0.486	
	(0.501)	(0.502)	(0.507)	
Test scores				
Reading and writing			77.02	77.21
			(2.773)	(3.339)
Mathematics			67.30	59.50
			(5.924)	(5.754)
English			68.29	64.71
			(7.203)	(7.051)

Note: The values in the paretheses are standard deviations.

Table 2: Estimation results of private school vs. public school selection

	(1)	(2)
constant	-0.9398 *	-0.2737
	(0.5347)	(0.6058)
Charactersitics of school atendance area		
Pop. Density under 15years	-0.0870 **	-0.1551 ***
(thousand / km2)	(0.0400)	(0.0474)
Pop. Density over 65 years	-0.0386	-0.0221
(thousand / km2)	(0.0241)	(0.0294)
No. of household member	-0.8291 ***	-0.9905 ***
	(0.1771)	(0.1971)
No. commercial stores	0.0353 ***	0.0347 ***
	(0.0037)	(0.0043)
No. of crimes	-0.2240 ***	-0.2410 ***
	(0.0229)	(0.0276)
Prop. of socially high occupations	10.4560 ***	9.3242 ***
	(0.8436)	(1.0272)
Attributes of own school		
Total number of students (hundred)	-0.0268 ***	-0.0180
	(0.0093)	(0.0109)
Geographical factors		
Railway dummy	0.0469	0.0458
	(0.0437)	(0.0439)
Year dummy		
1995	-0.0926	-0.0987 *
	(0.0593)	(0.0594)
1996	-0.0866	-0.1001 *
	(0.0608)	(0.0611)
1997	-0.0070	-0.0271
	(0.0605)	(0.0611)
1998	-0.0763	-0.1035 *
	(0.0625) ***	(0.0633)
1999	-0.1825	-0.2158 ***
	(0.0654)	(0.0665)
2000	-0.0979	-0.1368 **
	(0.0657)	(0.0672)
2001	-0.2470 ***	-0.2927 ***
	(0.0699)	(0.0720)
2002	-0.0761	-1.9617 *
	(0.0704)	(1.1860)
2003	-0.0600	-1.9315 *
	(0.0713)	(1.1775)
2004	-0.0773	-1.9387 *
	(0.0723)	(1.1732)
2002-2004		
Cross products (×2002-2004 dummy)		
Pop. density under 15years		0.2504 **
		(0.0924)
Pop. density over 65 years		-0.0541
		(0.0532)
No. of household member		0.4671
		(0.4035)
No. of commercial stores		0.0043
		(0.0084)
No. of crimes		0.0404
		(0.0500)
Prop. of high-status occupations		3.2292 *
		(1.8397)
Total number of students (hundred)		-0.0331
		(0.0202)
Log Likelihood	-20692.1	-20683.5
Sample Size	418	418

Note: The symbols *, ** and *** means significant at 10%, 5% and 1% level, respectively.

Table 3: Estimation results of Cross-border enrollment

	(1)		(2)	
constant	-2.4594	***	-2.5776	***
	(0.5179)		(0.5590)	
<u>Charactersitics of school attendance areas</u>				
Pop. density under 15years	0.0178		-0.0816	
(thousand / km2)	(0.0521)		(0.0554)	
Pop. density over 65 years	0.0274		0.1202	***
(thousand / km2)	(0.0281)		(0.0313)	
No. of household member	0.0592		0.0809	
	(0.1706)		(0.1816)	
No. of commercial stores	-0.0408	***	-0.0471	***
	(0.0039)		(0.0041)	
No. of crimes	0.3441	***	0.3953	***
	(0.0235)		(0.0253)	
Prop. of high-status occupations	1.8897	**	1.9211	*
	(0.9339)		(1.0220)	
<u>Attributes of own school</u>				
Total number of students (hundred)	-0.2826	***	-0.2637	***
	(0.0120)		(0.0133)	
No. of enrollments outside Adachi	-0.0795	***	-0.0705	***
	(0.0117)		(0.0124)	
<u>Gepgraphical factor</u>				
commuting distance within the district	0.5734	***	0.5076	***
	(0.1587)		(0.1609)	
No. of neighboring schools	0.1991	***	0.2034	***
	(0.0159)		(0.0159)	
Railway dummy	0.4677	***	0.4602	***
	(0.0462)		(0.0465)	
<u>Year dummy</u>				
1995	0.0944		0.0905	
	(0.0604)		(0.0604)	
1996	0.0948		0.0766	
	(0.0607)		(0.0609)	
1997	0.2282	***	0.2043	***
	(0.0604)		(0.0607)	
1998	0.2535	***	0.2183	***
	(0.0618)		(0.0624)	
1999	0.2941	***	0.2553	***
	(0.0630)		(0.0637)	
2000	0.2843	***	0.2349	***
	(0.0648)		(0.0657)	
2001	0.4227	***	0.3595	***
	(0.0647)		(0.0660)	
2004	1.0073	***	1.2002	
	(0.0686)		(1.4039)	
<u>Cross products (×2004 dummy)</u>				
Pop. density under 15years			0.4737	***
			(0.1283)	
Pop. density over 65 years			-0.4522	***
			(0.0728)	
No. of household member			0.1841	
			(0.4838)	
No. of commercial stores			0.0344	***
			(0.0114)	
No. of crimes			-0.3403	***
			(0.0720)	
Prop. of high-status occupations			3.3169	
			(2.5142)	
Total number of students (hundred)			-0.0986	***
			(0.0292)	
No. of enrollments outside Adachi			-0.0607	
			(0.0376)	
Log Likelihood	-19155.5		-19107.6	
Sample Size	333		333	

Note: The symbols *, ** and *** means significant at 10%, 5% and 1% level, respectively.

Table 4: Estiamtion results of the selection model

YEAR 2004

	First-part estimation (1) Without Score	(2) R&W	(3) Mathematics	(4) English	Second-part estimation (1) Without Score	(2) R&W	(3) Mathematics	(4) English
constant	-2.2014	20.2044	6.2032	6.7081	-0.3947 *	5.9451 ***	2.7498 ***	3.4707 ***
	(3.4791)	(14.0067)	(6.5774)	(5.8129)	(0.2037)	(0.7795)	(0.3589)	(0.3132)
Charactersitics of school attendance areas								
Pop. density under 15years	-0.6174	-0.5892	-0.6172	-0.6051	-0.8265 ***	-0.7873 ***	-0.7850 ***	-0.7513 ***
(thousand / km2)	(0.3794)	(0.3835)	(0.3847)	(0.3848)	(0.0175)	(0.0176)	(0.0176)	(0.0177)
Pop. density over 65 years	0.0772	0.0861	0.0888	0.0927	-0.0050	-0.0279 ***	-0.0233 **	-0.0238 **
(thousand / km2)	(0.1812)	(0.1851)	(0.1847)	(0.1852)	(0.0105)	(0.0106)	(0.0106)	(0.0106)
No. of household member	0.0730	-0.0926	0.0760	-0.0259	0.0312	0.0420	-0.0110	0.0837
	(1.2713)	(1.2868)	(1.2856)	(1.2875)	(0.0706)	(0.0707)	(0.0708)	(0.0708)
No. of enrollments in public school	0.0058 *	0.0069 **	0.0064 **	0.0067 **				
	(0.0032)	(0.0032)	(0.0032)	(0.0032)				
No. of commercial stores	0.1028 ***	0.0699 ***	0.0645 **	0.0675 **	0.0118 ***	0.0029	0.0038 *	0.0037 *
	(0.0248)	(0.0270)	(0.0272)	(0.0268)	(0.0017)	(0.0017)	(0.0017)	(0.0017)
No. of crimes	0.3595 **	0.4562 ***	0.4201 ***	0.4546 ***	-0.1938 ***	-0.1626 ***	-0.1541 ***	-0.1626 ***
	(0.1490)	(0.1562)	(0.1535)	(0.1553)	(0.0094)	(0.0094)	(0.0095)	(0.0095)
Prop. of high-status occupations	7.1748	-251.625 **	-95.0135 **	-88.7042 **	1.3399 ***	-87.2169 ***	-36.515 ***	-42.8897 ***
	(5.5457)	(109.457)	(44.4649)	(37.0520)	(0.3224)	(6.4858)	(2.4620)	(2.0113)
Attributes of School								
Score		-0.2784	-0.1139	-0.1192		-0.0783 ***	-0.0408 ***	-0.0545 ***
		(0.1734)	(0.0798)	(0.0654)		(0.0098)	(0.0044)	(0.0035)
Total number of students (hundred)	0.4102 ***	0.3380 ***	0.3328 ***	0.3369 ***	0.1685 ***	0.1424 ***	0.1447 ***	0.1449 ***
	(0.0538)	(0.0585)	(0.0581)	(0.0574)	(0.0021)	(0.0024)	(0.0024)	(0.0024)
New or rebuild dummy	0.6749 ***	0.7411 ***	0.7898 ***	0.8187 ***	0.1186 ***	0.1229 ***	0.2038 ***	0.1794 ***
	(0.2406)	(0.2462)	(0.2463)	(0.2485)	(0.0110)	(0.0110)	(0.0114)	(0.0111)
Gepgraphical factor								
distance to the school	-1.5599 ***	-1.5918 ***	-1.6048 ***	-1.6030 ***	-0.9801 ***	-0.9805 ***	-0.9748 ***	-0.9666 ***
	(0.1174)	(0.1204)	(0.1206)	(0.1209)	(0.0081)	(0.0082)	(0.0083)	(0.0081)
Public transportation dummy	0.3070	0.2962	0.3129	0.3086	0.1362 ***	0.1838 ***	0.1519 ***	0.1776 ***
	(0.2790)	(0.2811)	(0.2806)	(0.2822)	(0.0284)	(0.0288)	(0.0288)	(0.0288)
Score × Prop. of high-status occupations								
Prop. of high-status occupations		3.3286 **	1.4961 **	1.3845 **		1.1196 ***	0.5237 ***	0.6061 ***
		(1.4074)	(0.6430)	(0.5286)		(0.0829)	(0.0348)	(0.0277)
Log Likelihood	-362.014	-354.748	-353.223	-353.677	-203510	-203114	-203117	-202969
Sample Size	1406	1406	1406	1406	1444	1444	1444	1444

Table 4: Estiamtion results of the selection model (cont.)

YEAR 2005

	First-part estimation				Second-part estimation			
	(1)	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
	Without Score	**R&W**	**Mathematics**	**English**	**Without Score**	**R&W**	**Mathematics**	**English**
constant	-0.7921	-2.3431	0.6693	-1.2880	-0.9533 ***	-0.6933	-0.8358 ***	-0.9012 ***
	(3.1139)	(11.7696)	(5.8734)	(5.2045)	(0.2139)	(0.5413)	(0.3057)	(0.2890)
Charactersitics of school attendance areas								
Pop. density under 15years	-0.1358	-0.1531	-0.1357	-0.1383	-0.7690 ***	-0.7690 ***	-0.7691 ***	-0.7688 ***
(thousand / km2)	(0.3171)	(0.3184)	(0.3179)	(0.3186)	(0.0173)	(0.0173)	(0.0173)	(0.0173)
Pop. density over 65 years	-0.0377	-0.0448	-0.0425	-0.0455	0.1395 ***	0.1395 ***	0.1395 ***	0.1395 ***
(thousand / km2)	(0.1779)	(0.1790)	(0.1787)	(0.1788)	(0.0105)	(0.0105)	(0.0105)	(0.0105)
No. of household member	0.2101	0.2580	0.1875	0.2082	-0.7735 ***	-0.7733 ***	-0.7733 ***	-0.7733 ***
	(1.1363)	(1.1383)	(1.1370)	(1.1379)	(0.0760)	(0.0760)	(0.0760)	(0.0760)
No. of enrollments in public school	0.0067 **	0.0067 **	0.0068 **	0.0067 **				
	(0.0027)	(0.0027)	(0.0027)	(0.0027)				
No. of commercial stores	0.1413 ***	0.1274 ***	0.1320 ***	0.1361 ***	0.0015	0.0015	0.0015	0.0015
	(0.0237)	(0.0245)	(0.0241)	(0.0241)	(0.0016)	(0.0016)	(0.0016)	(0.0016)
No. of crimes	0.0380	0.0256	0.0177	0.0271	-0.1681 ***	-0.1680 ***	-0.1681 ***	-0.1680 ***
	(0.1136)	(0.1134)	(0.1139)	(0.1137)	(0.0085)	(0.0085)	(0.0085)	(0.0085)
Prop. of high-status occupations	-17.9636 ***	-44.0589	-44.4511	-20.8977	-3.8802 ***	-5.31946	-4.49303 **	-4.00275 **
	(5.3239)	(97.636)	(43.1876)	(35.1664)	(0.3124)	(4.0803)	(1.8321)	(1.6431)
Attributes of School								
Score		0.0237	-0.0176	0.0112		-0.0034	-0.0020	-0.0009
		(0.1461)	(0.0826)	(0.0624)		(0.0065)	(0.0038)	(0.0031)
Total number of students (hundred)	0.4188 ***	0.4069 ***	0.4007 ***	0.4019 ***	0.0016	0.0020	0.0023	0.0025
	(0.0450)	(0.0453)	(0.0458)	(0.0472)	(0.0022)	(0.0023)	(0.0023)	(0.0024)
New or rebuild dummy	0.8954 ***	0.9057 ***	0.8864 ***	0.8905 ***	0.0022	0.0042	0.0048	0.0047
	(0.2103)	(0.2097)	(0.2096)	(0.2096)	(0.0107)	(0.0110)	(0.0111)	(0.0110)
Gepgraphical factor								
distance to the school	-1.1419 ***	-1.1585 ***	-1.1468 ***	-1.1508 ***	0.0040	0.0042	0.0040	0.0042
	(0.0894)	(0.0914)	(0.0904)	(0.0909)	(0.0031)	(0.0031)	(0.0031)	(0.0031)
Public transportation dummy	0.7041 ***	0.6866 ***	0.6888 ***	0.6994 ***	0.0085	0.0092	0.0089	0.0087
	(0.2333)	(0.2346)	(0.2344)	(0.2337)	(0.0107)	(0.0108)	(0.0107)	(0.0107)
Score × Prop. of high-status occupations								
Prop. of high-status occupations		0.3307	0.4256	0.0422		0.0186	0.0103	0.0018
		(1.2437)	(0.6955)	(0.5183)		(0.0526)	(0.0303)	(0.0249)
Log Likelihood	-424.552	-422.649	-422.817	-423.921	-277988	-277988	-277988	-277988
Sample Size	1332	1332	1332	1332	1369	1369	1369	1369

Table 5: Correlation coefficient of cross-border enrollment measures and scores

	2004 enrollee			2005 enrollee	
	Adachi		TMG	Adachi	
	2005 (8th grade)	2006 (9th grade)	2006 (8th grade)	2005 (7th grade)	2006 (8th grade)
Reading and writing					
Cross-border enrollment ratio	0.105	0.152	0.058	0.474	0.157
1 – Herfindahl Index	0.072	0.090	-0.010	0.389	0.140
Mathematics					
Cross-border enrollment ratio	0.286	0.244	0.212	0.388	0.197
1 – Herfindahl Index	0.281	0.238	0.207	0.336	0.190
English					
Cross-border enrollment ratio	0.190	0.180	0.035	-	0.124
1 – Herfindahl Index	0.182	0.131	-0.008	-	0.105

Note: The tests by Adachi city are conducted at the beginning of the grades, namely in April, while those by TMG at the end of the grades, namely in January.

Table 6: Between-group Variation, Within-group Variation, F values and Relative Scores to Tokyo

	Tokyo Metropolitan Government (8th grade)						Adachi City (7th grade)				Adachi City (8th grade)				Adachi City (9th grade)			
	2004		2005		2006		2005		2006		2005		2006		2005		2006	
Reading and writing																		
Between variation	7273	(37)	1102	(37)	1502	(36)	2407	(36)	2352	(36)	5285	(36)	4547	(36)	3280	(36)	3262	(36)
Within variation	158	(4324)	N.A.	(4531)	231	(4611)	334	(4640)	307	(4606)	202	(4611)	209	(4577)	361	(4740)	308	(4591)
F value	46.02	(0.00)	-	(-.--)	6.49	(0.00)	7.21	(0.00)	7.67	(0.00)	26.18	(0.00)	21.64	(0.00)	9.09	(0.00)	10.60	(0.00)
95 %tile - 5%tile	8.91		10.45		12.00		13.68		12.88		15.64		14.00		14.52		16.18	
Inter-qurtile	4.40		4.95		4.80		4.90		7.20		6.50		8.50		8.30		6.70	
Mathematics																		
Between variation	5633	(37)	3545	(37)	3963	(36)	8635	(36)	5646	(36)	43638	(36)	25561	(36)	32518	(36)	44695	(36)
Within variation	431	(4324)	N.A.	(4531)	618	(4611)	420	(4640)	405	(4606)	308	(4611)	452	(4577)	485	(4740)	362	(4591)
F value	13.06	(0.00)	-	(-.--)	6.42	(0.00)	20.56	(0.00)	13.93	(0.00)	141.76	(0.00)	56.27	(0.00)	67.11	(0.00)	123.62	(0.00)
95 %tile - 5%tile	19.79		19.01		16.18		16.30		15.52		24.60		25.48		22.86		21.50	
Inter-qurtile	7.40		8.20		10.20		10.40		6.70		14.40		13.00		13.90		10.40	
English																		
Between variation	5765	(37)	6148	(37)	4305	(36)	-		-		8881	(36)	9454	(36)	10762	(36)	19084	(36)
Within variation	494	(4324)	N.A.	(4531)	305	(4611)	-		-		270	(4611)	267	(4577)	396	(4740)	385	(4591)
F value	11.68	(0.00)	-	(-.--)	14.10	(0.00)	-		-		32.94	(0.00)	35.24	(0.00)	27.20	(0.00)	49.63	(0.00)
95 %tile - 5%tile	24.44		21.44		18.80		-		-		21.82		24.30		23.06		22.12	
Inter-qurtile	9.52		11.68		8.80		-		-		10.00		9.40		12.30		13.30	
Adachi / Tokyo																		
R&W	0.961		0.976		0.973													
Math	0.938		0.926		0.950													
English	0.905		0.917		0.943													

Note: The values in parentheses are degrees of freedom for between-variation or within-variation and are p values for the F value.