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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. Adachi's average scores relative to the Tokyo average have improved, while the between-school differences in scores have not expanded.

Keywords: School choice, Student sorting

JEL classification: I20, I21, I28

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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 Municipal 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. It is expected that students whose parents cannot afford the tuition fee of private junior high schools will benefit from the improvement. Another reason is to deal with bullying or absenteeism in public schools. They have been one of serious problems in public schools.

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

[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 independently, so that the school choice programs in high schools are common in most prefectures.

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 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 total 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. 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 13%. The rates vary among the attendance areas, and in some school attendance areas, they reach above 20%.

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

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 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

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[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.

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 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 2A). 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

[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.

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 schools shown in figure 2B (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

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[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.

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 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. Models, Data and Estimation Results

3.1. Models

School choice has two forms: one is whether to select private schools, and the other 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 public schools other than their assigned schools, and which attributes of public schools attract which types of students. As we have discussed in section 2, Adachi city has permitted students to change the assigned school easily even before the introduction of school choice program. So we have conducted two types of estimations: one is how the cross-border public-school enrollment has been changing since 1994, and the other being what makes students opt out to the other schools after the introduction of school choice program.

First we will explain the data structure and the estimation methods. The data structure is formalized in Table 1. There are N school attendance areas and corresponding junior high schools. Let y_{il} be the number of students selecting a public school l who live in the ith attendance area. The numbers of enrollee of public and of private junior high schools are $y_{i\bullet} = \sum_l y_{il}$ and w_i, respectively. Thus the total number of the enrollee either in public or private schools is $n_i = y_{i\bullet} + w_i$.

We employ the logistic regression model both for the private-school choice and for the cross-border public-school enrollment. The logistic regression models are used for the aggregated data of binary responses by subgroup. In our cases, the number of enrollee in private schools and the number of cross-border public-school enrollee, namely w_i and $y_{i\bullet} - y_{ii}$, are such subgroup-aggregated data and they follows the binomial distribution (see chapter 8 of Dobson (1990)). Then the probability function of w is

$$f(w) \propto \pi^w (1-\pi)^{n-w}. \qquad (1)$$

The selection probability to be enrolled in private schools, namely π, is formulated with logistic function as:

$$\pi_i = \frac{\exp(\alpha_1 + \beta_1 '\mathbf{x}_{1i})}{1 + \exp(\alpha_1 + \beta_1 '\mathbf{x}_{1i})}, \quad i = 1,..., N, \qquad (2)$$

where $\mathbf{x}_{1i}$ is the covariates for the *i*th school-attendance area.[6] The details of the covariates are explained in the next subsection. We also apply the same formulae for the cross-border public-school enrollee except that some of explanatory variables relevant to attributes of own school or to the geographic factors are different.[7]

When we estimate the selection probability within public schools after the introduction of school choice, we introduce the idea of choice set. We think a two-stage decision process for school choice where parents first decide a choice set among schools and second select one of schools from the choice set. Then the joint density function of $y_{i1},..., y_{iN}$ and the choice set C_i are as follows:

$$f(y_{i1},..., y_{iN}, C_i \mid y_{i\cdot}) = f(y_{i1},..., y_{iN} \mid y_{i\cdot}, C_i)\Pr(C_i \mid y_{i\cdot}). \qquad (3)$$

One of econometric reasons of introducing the choice set is that many cells of Table 1 are zeros so that the estimates are likely to have large standard errors or, at worst, the numerical process of maximizing the likelihood does not converge.

Let d_{ij} be a dummy variable that takes a value of one if the *j*th school belongs to the choice set of the *i*th attendance area, C_i, and zero otherwise; that is, $d_{ij} = I(j \in C_i)$. We think parents have reservation utilities that are those attained when their children attend the assigned schools and they decide if a school should be included in the choice set

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[6] Since we do not have individual-based data, we are forced to use the attendance-area-based aggregated data. This may cause biases of the estimates because of neglecting the individuals' heterogeneity. In order to mitigate the possible biases caused by the aggregation, we include the covariates representing the degrees of heterogeneity of the residents, namely proportion of high-status occupations. If parents of higher–status occupations are more likely to prefer to private-school education and the occupation is one of main factors of selecting private schools, the proportion of high–status occupations will capture the heterogeneity of parents within an attendance area.

[7] In our models, we assume a two-step decision process where parents first choose either private or public schools, and second those who select public schools choose either the assigned school or the other schools. We estimate the steps separately. However, parents may decide one of these three alternatives at one shot. If so, we had better employ the multinomial logit model for a grouped data or nested logit model when we are worried of the IIA (independence of irrelevant alternatives) assumption. We could not adopt such approaches because the data of cross-border enrollee is missing for 2002 and 2003.

independently without referring to the other schools. If the utility of attending the other school is larger than the reservation utility, then the school is included in the choice set. This implies the dummies of the second part of the right-hand side of the equation (3) are independently distributed as:

$$\begin{aligned}&\Pr(C_i \mid y_{i\cdot}) = f(d_{i1} \mid y_{i\cdot}) \cdots f(d_{iN} \mid y_{i\cdot}),\\&f(d_{il} \mid y_{i\cdot}) = P_{il}^{d_{il}} (1 - P_{il})^{1-d_{il}}, l = 1,\dots, N,\end{aligned} \tag{4}$$

where the selection probability is formulated with logistic probabilities as:

$$P_{il} = \frac{\exp(\alpha_2 y_{i\cdot} + \beta_2 '\mathbf{x}_{2i} + \gamma_2 '\mathbf{z}_{2l})}{1 + \exp(\alpha_2 y_{i\cdot} + \beta_2 '\mathbf{x}_{2i} + \gamma_2 '\mathbf{z}_{2l})}, i \neq l. \tag{5}$$

The vector of attributes of *l*th school, **z**, is included as well as the characteristics vector of an attendance area, **x**.

Since the reservation utility is the utility of attending the ‘own school’ of an attendance area, positive signs of the estimated parameters of the explanatory variables imply that they will increase the utility of attending the school rather than the ‘own school’. We predict $\alpha_2 > 0$, as many more schools are likely to be selected as the number of students in the ith attendance area, $y_{i\cdot}$, becomes large.

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

$$f(y_{i1},\dots, y_{iN} \mid y_{i\cdot}, C_i) \propto \pi_{i1}^{d_{i1}y_{i1}} \cdots \pi_{iN}^{d_{iN}y_{iN}}. \tag{6}$$

It is well known that the joint distribution of $y_{i1},\dots, y_{iN}$ conditional on $y_{i\cdot} = \sum_l y_{il}$ follows the multinomial distribution with the selection probability of the *l*th school being $\lambda_{il} / \sum \lambda_{ik}$ when each of $y_{i1},\dots, y_{iN}$ follows Poisson distribution with location parameters $\lambda_{i1},\dots,\lambda_{iN}$, respectively. Assuming $\lambda_{il} = \exp(\beta '\mathbf{x}_i + \gamma '\mathbf{z}_l)$, then the joint distribution follows the conditional logit (chapter 9 of Dobson (1990)). Then the probability of students in the *i*th attendance area selecting a school of the *l*th attendance area is given as:

$$\pi_{ii} = \frac{1}{1+\sum_{l=1}^{N-1} d_{il} \exp(\beta_3 '\mathbf{x}_{3i} + \gamma_3 '\mathbf{z}_{3l})}, i = l;$$
$$\pi_{il} = \frac{d_{il} \exp(\beta_3 '\mathbf{x}_{3i} + \gamma_3 '\mathbf{z}_{3j})}{1+\sum_{l=1}^{N-1} d_{il} \exp(\beta_3 '\mathbf{x}_{3i} + \gamma_3 '\mathbf{z}_{3l})}, i \neq l. \quad (7)$$

When no student in the *i*th attendance area selects a school of the *l*th 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 other school.

3.2. 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. The population data based on the resident registration is available by the attendance area. On the other hand occupation data based on the small area is available only in National Census conducted in 1995 and 2000, although the small areas of the census generally do not correspond to the attendance area. Thus, we have to construct the data by aggregating the census data for small areas.[8] 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 over 65 years old and the number of household members—and second, socioeconomic data—namely, the number of commercial stores

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[8] The census data are available at 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. We use the occupation data of 1995 census for 1994 to 1999 and the data of 2000 census for 2000 to 2005.

per 1000 persons[9], the yearly number of crimes per 100 persons[10] 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,[11] 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 building is, the more attractive the school becomes, 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.

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[12], 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

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[9] The data of number of commercial stores are available only for 1994, 1997, 1999 and 2002. We interpolate the data of the nearest year for the missing years. The variable is assumed to be a proxy of the proportion of the self-employed. We think the self-employed parents tend to select private schools or to opt out of the 'own' school.

[10] The data of yearly number of crimes are available for 2001 to 2005. We substitute the average of the data from 2001 to 2003 for the data from 1994 to 2000.

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

[12] The areal center of an attendance area is the center of gravity of the area that can be calculated with ArcGIS.

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 traveling 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. 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.[13]

Table 2 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. 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 has been decreasing. Third, the test scores for Math and English declined in 2005 compared with 2004, but that for R&W was unchanged.

3.3. Estimation results for school choice

Table 3 shows the estimation results for the private-school choice using a logistic regression model with year dummies for two cases, whether or not including the cross-products between the postreform dummy and the characteristics of school attendance areas 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. The marginal effects of the proportion of high status occupations calculated with the estimates of table 3 are 0.982 and 0.875 for case (1) and case (2), respectively. This implies that 10 percent point increase of the proportion results in increase of the probability of attending to private schools at ranging from 9 percent to 10 percent point.

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[13] 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.

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). Its marginal effect is 0.303 so that the total marginal effect of the proportion of high status occupations after 2002 is 1.178. 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 not put a brake on the selection of private schools in the attendance areas with high proportions of high-status occupations, while it has generally discouraged the choice of private schools in other areas. It is called 'white flight' or 'bright flight' that white or high-ability parents or students move to the districts of better school performance or select private schools. Downes and Schoeman (1997) show increasing share of enrollee in private schools in California associated with the school finance reform that places the upper limit on the amount school districts could spend on each student. Lankford and Wyckoff (2001) indicate that 'white flight' occurs as a result of enhanced school choice, although 'bright flight' appears to be overstated. Betts and Fairlie (2003) find 'native flight' in response to the increase of immigrant school children. In our results, a sort of 'white flight' has occurred and continued even after the introduction of school choice program.

Some supply-side shocks such as increase of the number of private schools, decline of the tuition fee or decrease of per-capita public expenditure to junior-high school education may be able to explain these estimation results since wealthy parents may respond to these factors. But we cannot find such shocks. [14] On the other hand, the

[14] There is only one private junior high school that has been newly founded in Tokyo from 2000 to 2005. The average tuition fee per year has been gradually increasing from 400 thousand yen in 2000 to 420 thousand yen in 2005. Per-capita public expenditure to junior-high school education in Adachi city is almost unchanged around 600 thousand yen in these years.

nationwide ‘education with latitude’ policy[15] fully implemented in 2002, namely five-day school week system accompanied with decreasing school hours, may induce the demand for private school education particularly in wealthy parents and that leads to ‘white flight’. It is almost difficult with the data of only Adachi city to identify the effects of the school choice program on private school enrollment rate from the effects of the ‘education with latitude’ policy since both of them have started at the same year. Whether the former effects may overwhelm the latter are to be examined with the data of private enrollment rates in the cities where the school choice programs has not been adopted, which will be discussed in future studies.

Table 4 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.[16] 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 marginal effects of the proportion of high-status occupations are 0.271 for case (1) and 0.274 for case (2), which are around one third or one fourth of those on the probability of attending private schools in table 3. 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

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[15] The school hours were firstly reduced in 1977 and successively reduced in 1989 and 1992. Then the nationwide ‘education with latitude’ policy has been decided by the Central Education Council of Ministry of Education and the new guideline for teaching was announced to the public in 1999 that is fully implemented from 2002. It is alleged that most parents have great concerns of the ‘education with latitude’ policy so that they have children fly to private schools for better education.

[16] 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 the consolidated districts are enrolled.

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 change their behavior after the introduction of the program.

Table 5 shows the estimation results of the first and the second parts of the selection model explained in section 3.1 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 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 3 and 4, 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.[17]

[17] 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. We try the case where 2004 test scores are used for the estimation of 2005 school choice and find that the estimation results are almost the same as the current results.

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.

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 somewhat 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 not likely to travel to other schools, and the scores of the schools are irrelevant to this choice. [18]

This is likely to be related to 'white flight' tendency of enrollments in private schools shown in figure 1. Most students who lived in the areas with higher proportions of high-status occupations were more likely to select private schools in 2005 so that scores in public schools did not matter so much to them.

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

[18] The marginal effects of scores on choice probabilities are as follows: They are 0.0098, 0.0053 and 0.0038 for R&W, Math and English in the first part estimation of year 2004, and 0.0152, 0.0060 and 0.0048 in the second part estimation, respectively. On the other hand, they are 0.0047, 0.0013 and 0.0014 in the first part estimation of year 2005, and -0.0001, -0.0000 and -0.0000 in the second part estimation, respectively. This implies, for example, ten points increase in R&W score in 2004 leads to 9.8 percent point increase in the choice probability. But scores in 2005 have little marginal effects on the choice probabilities.

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.

3.4. Correlation between the scores and school choice measures

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. When the school choice program causes student sorting by scores, then we expect that the differences in scores between schools will be increasing. 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 or if the scores of schools of attendance areas where students tend to opt out for the other schools are lower. 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.[19] 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 beginning of the three grades. We focus on the scores of the three main subjects, R&W, Math and English.

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[19] 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.

Table 6 shows the correlation coefficient of the average scores of schools and four school choice measures: first, the cross-border enrollment ratio, which is the proportion of enrollees coming from the assigned local schools to total enrollees; second, the cross-border opting out ratio, which is the proportion of students opting out to the other schools; third, the share index adopted by Hoxby (2000), which is close to one when students come from many attendance areas and is otherwise close to zero; and forth, the choice index also adopted by Hoxby (2000), which is close to one when students opt out for many other schools and is otherwise close to zero. The third measure focuses on the degree how many students a school attracts from how many attendance areas, while the fourth measure focuses on the degree how many students opt out of their own school for how many other schools. Both measures are defined as (1 − Herfindahl index). [20]

We examine whether the scores are correlated with the measures 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 6 that the scores in the 7th grade are significantly correlated to the choice index both for the R&W and the Math scores but the correlation of the other measures are weak and insignificant. This implies that less selected schools are those with lower scores but more selected schools are not necessarily those with higher scores for 2005 enrollees. This is consistent to the results of table 5 where scores do not matter much to school choice for 2005 enrollee. The correlation becomes a little bit smaller in the next grade, as shown in the sixth column although they are insignificant except for the choice index. We test whether or not the pairs of coefficients are significantly different and we find they are not. Thus we are not sure that the initial advantage or disadvantage of the school may or may not continue to the next grade but we are sure that the advantage or disadvantage does not expand as grade advances.

Second, focusing on the new enrollees in 2004, where there is no data of the 7th grade, the correlation between scores and the measures in the 8th grade are significant

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[20] Let $x_1,\ldots,x_k$ and $z_1,\ldots,z_k$ be the proportion of the enrollees of a school from k different school attendance areas and the proportion of students of an attendance area opting to k different schools including their own school, respectively . Then, the share index of the school and the choice index of an attendance area are defined as $1-\sum_{l=1}^{k} x_l^2$ and $1-\sum_{l=1}^{k} z_l^2$, respectively.

in Math and English but weak or insignificant in R&W, as shown in the second column, but it does continue into the 9th grade. Among the subjects, the correlation of the Math and English scores with the measures are still relatively higher in the 9th grade. Differently from the 2005 enrollee, the 2004 enrollee are sorted in scores as is shown in table 5 so that the advantage or disadvantage continues to the 9th grade.

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 and significant correlation with the cross-border enrollment ratio and share index, whereas the R&W and English results have no correlation except for the choice index in English.

Summarizing these facts, we can state that schools that attract new enrollees from many attendance areas or schools that are avoided from the attendance-area students have higher or lower scores initially, and even as the grade advances, the correlation between scores and the measures are likely to continue but does not become larger.

3.5. Variations in scores between schools

In the previous subsection, we found, by focusing on new enrollees, that the initial correlation of scores with the school choice measures is likely to 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). We adopt an F statistic as a measure of difference in scores among schools and examine whether the F statistic is becoming bigger or smaller in response to the differences in scores between schools increasing or decreasing. We employ the idea of ANOVA (Analysis of Variance) that are often used to test if the group-means are the same or not with the F statistic. 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 7 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, score of the 95th percentile minus score of the 5th percentile and the interquartile range of the school-average scores, for the achievement tests conducted by TMG in 2004 and 2006 and by Adachi city in 2005 and 2006. 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 nearly the same tendency.

Second, we will examine the changes of F values for the 8th grade, for which data of TMG are available from 2004 to 2006 and data of Adachi city from 2005 to 2006. The F values have been decreasing in Math, but they have increased in R&W and slightly in English for the tests by TMG, while they have slightly decreased in R&W but increased in English and Math for Adachi city. Let us see what causes the changes of F values. We focus on the difference between 95%tile and 5%tile of the 8th-grade school-average scores of TMG proficiency tests. Then we find that the difference has decreased from 2004 to 2006 in Math accompanied by the decrease of F values, which implies that schools of worse schools have been getting better. The difference in English has also decreased while the F value increased slightly because the within-variations decreased more than between-variations. So this change of F values implies that the scores come to be equalized both between schools and within schools. On the other hand, it has increased in R&W accompanied by the decrease of F values. It implies that the difference between better schools and worse schools expands but the difference among middle-score-class schools may reduce. In total, the improvement of worse schools in scores contributes decrease of F values in Math and English but it does not in R&W. Note that both between-variations and within-variations in R&W are much smaller than those in Math or English. So the change in R&W is not serious compared with Math and English.

Third, the F values for the 9th grade slightly increased from 2005 to 2006 in Math and R&W, while those in English slightly decreased. In Math, the between-school variations increased in 2006 while the within-school variations decreased, which implies that the difference in scores between schools in the 9th grade is increasing although the difference within school is shrinking.

Table 7 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 not been expanding and the scores have been improving relative to the Tokyo average after the introduction of school choice program. 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 scores relative to the average of Tokyo have been improving. 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.[21]

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

[21] We think that the school choice program has changed the motivations of the headmaster and/or teachers. According to the five-day series of articles in Yomiuri Shinbun (Koto Local News) entitled Investigating Reform in Education from Sep. 25 to Sep. 29, Adachi city has already started the reform in education since 2000 before most of the other wards commence the reform. The board of education has encouraged teachers to attend the training seminars to improve their educational skills provided by lecturers of a preparatory school or has given incentives in form of budget transfer to enhance the scores. It is reported by newspapers in August 2007 that teachers of an elementary schools conducted manipulations in the proficiency test to enhance the scores and to prevent parents from selecting the other schools. This report implies that the school choice program has a large impact on teachers' incentives.

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. The scores of schools of the attendance areas where students are likely to opt out to the other schools were lower in the 7th grade, but the differences of scores between schools do not expand or slightly decrease in the next grade, which implies that the education provided by schools is as important as grade advancing. Furthermore, the relative scores of Adachi city to the Tokyo average have been improving 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 between-school difference in scores caused by sorting does not expand in the next grades associated that the Adachi's average scores relative to the Tokyo average have improved.

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 scores relative to the Tokyo average have been improving and the differences in scores among schools have not expanded. 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:

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[22] 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 *j*th individual of the *i*th school, $\bar{y}_{i\cdot}$ the mean within school score, $\bar{y}_{\cdot\cdot}$ the total mean and r_i the number of students of the *i*th 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:

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

[22] 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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Table 1 Data Structure

Attendance area	Characteristics Vector	Public School						Private School
		1	…	l	…	N		
		Attributes vector					No. of enrollee	No. of enrollee
		$\mathbf{z}_1$	…	$\mathbf{z}_l$	…	$\mathbf{z}_N$		
1	$\mathbf{x}_1$	y_{11}, d_{11}	$\cdots$	y_{1l}, d_{1l}	$\cdots$	y_{1K}, d_{1N}	$y_{1\bullet}$	w_1
$\vdots$	$\vdots$	$\vdots$		$\vdots$		$\vdots$	$\vdots$	$\vdots$
i	$\mathbf{x}_i$	y_{i1}, d_{i1}	$\cdots$	y_{il}, d_{il}	$\cdots$	y_{iK}, d_{iN}	$y_{i\bullet}$	w_i
$\vdots$	$\vdots$	$\vdots$		$\vdots$		$\vdots$	$\vdots$	$\vdots$
N	$\mathbf{x}_N$	y_{N1}, d_{N1}	$\cdots$	y_{Nl}, d_{Nl}	$\cdots$	y_{NN}, d_{NN}	$y_{N\bullet}$	w_N

Note: $y_{i\bullet} = \sum_{l=1}^{N} y_{il}$

Table 2: 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 thousand)	(4.92)	(4.54)	(4.58)	(4.08)
No. of crimes	2.521	2.521	2.521	2.226
(per handred)	(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 rebuilding dummy			0.237	0.243
			(0.431)	(0.435)
Geographical 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 conducted by Tokyo Metro. Gov.				
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 (1): The values in the parentheses are standard deviations.

Note (2): Some of the cells are blank since the data of the cells are unavailable or not used in our estimations in the specific periods.

Table 3: Estimation results of private vs. public schools selection

	(selection of private school = 1)	
	(1)	**(2)**
constant	-0.940 *	-0.274
	(0.535)	(0.606)
<u>Charactersitics of school atendance area</u>		
Pop. density under 15years	-0.087 **	-0.155 ***
(thousand / km2)	(0.040)	(0.047)
Pop. density over 65 years	-0.039	-0.022
(thousand / km2)	(0.024)	(0.029)
No. of household member	-0.829 ***	-0.991 ***
	(0.177)	(0.197)
No. of commercial stores	0.035 ***	0.035 ***
(per thousand)	(0.004)	(0.004)
No. of crimes	-0.224 ***	-0.241 ***
(per handred)	(0.023)	(0.028)
Prop. of socially high occupations	10.456 ***	9.324 ***
	(0.844)	(1.027)
<u>Attributes of own school</u>		
Total number of students (hundred)	-0.027 ***	-0.018
	(0.009)	(0.011)
<u>Geographical factors</u>		
Railway dummy	0.047	0.046
	(0.044)	(0.044)
<u>Year dummy</u>		
1995	-0.093	-0.099 *
	(0.059)	(0.059)
1996	-0.087	-0.100 *
	(0.061)	(0.061)
1997	-0.007	-0.027
	(0.061)	(0.061)
1998	-0.076	-0.104 *
	(0.063) ***	(0.063)
1999	-0.182	-0.216 ***
	(0.065)	(0.067)
2000	-0.098	-0.137 **
	(0.066)	(0.067)
2001	-0.247 ***	-0.293 ***
	(0.070)	(0.072)
2002	-0.076	-1.962 *
	(0.070)	(1.186)
2003	-0.060	-1.931 *
	(0.071)	(1.178)
2004	-0.077	-1.939 *
	(0.072)	(1.173)
<u>Cross products (×2002-2004 dummy)</u>		
Pop. density under 15years		0.250 **
		(0.092)
Pop. density over 65 years		-0.054
		(0.053)
No. of household member		0.467
		(0.403)
No. of commercial stores		0.004
		(0.008)
No. of crimes		0.040
		(0.050)
Prop. of high-status occupations		3.229 *
		(1.840)
Total number of students (hundred)		-0.033
		(0.020)
Log Likelihood	-20692.1	-20683.5
Sample Size	418	418

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

Table 4: Estimation results of cross-border enrollment

(Opting out of the assigned school = 1)	(1)		(2)	
constant	-2.459	***	-2.578	***
	(0.518)		(0.559)	
Charactersitics of school attendance areas				
Pop. density under 15years	0.018		-0.082	
(thousand / km2)	(0.052)		(0.055)	
Pop. density over 65 years	0.027		0.120	***
(thousand / km2)	(0.028)		(0.031)	
No. of household member	0.059		0.081	
	(0.171)		(0.182)	
No. of commercial stores	-0.041	***	-0.047	***
(per thousand)	(0.004)		(0.004)	
No. of crimes	0.344	***	0.395	***
(per handred)	(0.024)		(0.025)	
Prop. of high-status occupations	1.890	**	1.921	*
	(0.934)		(1.022)	
Attributes of own school				
Total number of students (hundred)	-0.283	***	-0.264	***
	(0.012)		(0.013)	
No. of enrollments outside Adachi	-0.079	***	-0.070	***
	(0.012)		(0.012)	
Gepgraphical factor				
Commuting distance within the district	0.573	***	0.508	***
	(0.159)		(0.161)	
No. of neighboring schools	0.199	***	0.203	***
	(0.016)		(0.016)	
Railway dummy	0.468	***	0.460	***
	(0.046)		(0.046)	
Year dummy				
1995	0.094		0.091	
	(0.060)		(0.060)	
1996	0.095		0.077	
	(0.061)		(0.061)	
1997	0.228	***	0.204	***
	(0.060)		(0.061)	
1998	0.254	***	0.218	***
	(0.062)		(0.062)	
1999	0.294	***	0.255	***
	(0.063)		(0.064)	
2000	0.284	***	0.235	***
	(0.065)		(0.066)	
2001	0.423	***	0.360	***
	(0.065)		(0.066)	
2004	1.007	***	1.200	
	(0.069)		(1.404)	
Cross products (×2004 dummy)				
Pop. density under 15years			0.474	***
			(0.128)	
Pop. density over 65 years			-0.452	***
			(0.073)	
No. of household member			0.184	
			(0.484)	
No. of commercial stores			0.034	***
			(0.011)	
No. of crimes			-0.340	***
			(0.072)	
Prop. of high-status occupations			3.317	
			(2.514)	
Total number of students (hundred)			-0.099	***
			(0.029)	
No. of enrollments outside Adachi			-0.061	
			(0.038)	
Log Likelihood	-19155.5		-19107.6	
Sample Size	333		333	

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

Table 5: Estiamtion results of the selection model

YEAR 2004

	First-part estimation				Second-part estimation			
	(1) Without Score	**(2) R&W**	**(3) Mathematics**	**(4) English**	**(1) Without Score**	**(2) R&W**	**(3) Mathematics**	**(4) English**
constant	-2.201	20.204	6.203	6.708	-0.395 *	5.945 ***	2.750 ***	3.471 ***
	(3.479)	(14.007)	(6.577)	(5.813)	(0.204)	(0.779)	(0.359)	(0.313)
Charactersitics of school attendance areas								
Pop. density under 15years	-0.617	-0.589	-0.617	-0.605	-0.826 ***	-0.787 ***	-0.785 ***	-0.751 ***
(thousand / km2)	(0.379)	(0.383)	(0.385)	(0.385)	(0.017)	(0.018)	(0.018)	(0.018)
Pop. density over 65 years	0.077	0.086	0.089	0.093	-0.005	-0.028 ***	-0.023 **	-0.024 **
(thousand / km2)	(0.181)	(0.185)	(0.185)	(0.185)	(0.010)	(0.011)	(0.011)	(0.011)
No. of household member	0.073	-0.093	0.076	-0.026	0.031	0.042	-0.011	0.084
	(1.271)	(1.287)	(1.286)	(1.287)	(0.071)	(0.071)	(0.071)	(0.071)
No. of enrollments in public school	0.006 *	0.007 **	0.006 **	0.007 **				
	(0.003)	(0.003)	(0.003)	(0.003)				
No. of commercial stores (per thousand)	0.103 ***	0.070 ***	0.065 **	0.068 **	0.012 ***	0.003	0.004 *	0.004 *
	(0.025)	(0.027)	(0.027)	(0.027)	(0.002)	(0.002)	(0.002)	(0.002)
No. of crimes (per hundred)	0.359 **	0.456 ***	0.420 ***	0.455 ***	-0.194 ***	-0.163 ***	-0.154 ***	-0.163 ***
	(0.149)	(0.156)	(0.154)	(0.155)	(0.009)	(0.009)	(0.010)	(0.009)
Prop. of high-status occupations	7.175	-251.625 **	-95.014 **	-88.704 **	1.340 ***	-87.217 ***	-36.515 ***	-42.890 ***
	(5.546)	(109.457)	(44.465)	(37.052)	(0.322)	(6.486)	(2.462)	(2.011)
Attributes of School								
Score		-0.278	-0.114	-0.119		-0.078 ***	-0.041 ***	-0.054 ***
		(0.173)	(0.080)	(0.065)		(0.010)	(0.004)	(0.003)
Total number of students (hundred)	0.410 ***	0.338 ***	0.333 ***	0.337 ***	0.169 ***	0.142 ***	0.145 ***	0.145 ***
	(0.054)	(0.058)	(0.058)	(0.057)	(0.002)	(0.002)	(0.002)	(0.002)
New or rebuilding dummy	0.675 ***	0.741 ***	0.790 ***	0.819 ***	0.119 ***	0.123 ***	0.204 ***	0.179 ***
	(0.241)	(0.246)	(0.246)	(0.248)	(0.011)	(0.011)	(0.011)	(0.011)
Gepgraphical factor								
distance to the school	-1.560 ***	-1.592 ***	-1.605 ***	-1.603 ***	-0.980 ***	-0.981 ***	-0.975 ***	-0.967 ***
	(0.117)	(0.120)	(0.121)	(0.121)	(0.008)	(0.008)	(0.008)	(0.008)
Public transportation dummy	0.307	0.296	0.313	0.309	0.136 ***	0.184 ***	0.152 ***	0.178 ***
	(0.279)	(0.281)	(0.281)	(0.282)	(0.028)	(0.029)	(0.029)	(0.029)
Score × Prop. of high-status occupations								
Prop. of high-status occupations		3.329 **	1.496 **	1.384 **		1.120 ***	0.524 ***	0.606 ***
		(1.407)	(0.643)	(0.529)		(0.083)	(0.035)	(0.028)
Log Likelihood	-362.014	-354.748	-353.223	-353.677	-203510	-203114	-203117	-202969
Sample Size	1406	1406	1406	1406	1444	1444	1444	1444

Note: We have the data of 38 schools in 2004 so that the sample size of the second-part estimation is 38x38=1444. On the other hand, the sample size of the first estiamtion is 1406=1444-38 since we drop the cases of the assigned schools.

Table 5: Estiamtion results of the selection model (cont.)

	YEAR 2005							
	First-part estimation				Second-part estimation			
	(1) Without Score	(2) R&W	(3) Mathematics	(4) English	(1) Without Score	(2) R&W	(3) Mathematics	(4) English
constant	-0.833	-1.315	0.208	-1.619	-0.955 ***	-0.694	-0.838 ***	-0.902 ***
	(3.085)	(11.341)	(5.805)	(5.172)	(0.214)	(0.541)	(0.306)	(0.289)
Charactersitics of school attendance areas								
Pop. density under 15years	-0.120	-0.140	-0.122	-0.125	-0.769 ***	-0.769 ***	-0.769 ***	-0.769 ***
(thousand / km2)	(0.314)	(0.315)	(0.315)	(0.315)	(0.017)	(0.017)	(0.017)	(0.017)
Pop. density over 65 years	-0.039	-0.045	-0.048	-0.050	0.139 ***	0.139 ***	0.139 ***	0.140 ***
(thousand / km2)	(0.176)	(0.177)	(0.177)	(0.177)	(0.010)	(0.010)	(0.010)	(0.010)
No. of household member	0.149	0.196	0.113	0.139	-0.774 ***	-0.773 ***	-0.773 ***	-0.773 ***
	(1.125)	(1.127)	(1.126)	(1.127)	(0.076)	(0.076)	(0.076)	(0.076)
No. of enrollments in public school	0.007 **	0.007 **	0.007 **	0.007 **				
	(0.003)	(0.003)	(0.003)	(0.003)				
No. of commercial stores (per thousand)	0.140 ***	0.123 ***	0.125 ***	0.130 ***	0.001	0.001	0.001	0.001
	(0.024)	(0.025)	(0.025)	(0.025)	(0.002)	(0.002)	(0.002)	(0.002)
No. of crimes (per hundred)	0.130	0.135	0.142	0.138	-0.168 ***	-0.168 ***	-0.168 ***	-0.168 ***
	(0.125)	(0.126)	(0.125)	(0.125)	(0.008)	(0.008)	(0.008)	(0.008)
Prop. of high-status occupations	-17.846 ***	-56.102	-44.475	-21.737	-3.881 ***	-5.328	-4.496 **	-4.006 **
	(5.278)	(93.961)	(42.545)	(34.906)	(0.312)	(4.080)	(1.832)	(1.643)
Attributes of School								
Score		0.010	-0.009	0.017		-0.003	-0.002	-0.001
		(0.141)	(0.082)	(0.062)		(0.007)	(0.004)	(0.003)
Total number of students (hundred)	0.389 ***	0.375 ***	0.367 ***	0.363 ***	0.002	0.002	0.002	0.003
	(0.045)	(0.045)	(0.046)	(0.047)	(0.002)	(0.002)	(0.002)	(0.002)
New or rebuilding dummy	0.954 ***	0.975 ***	0.953 ***	0.953 ***	0.002	0.004	0.005	0.005
	(0.214)	(0.213)	(0.213)	(0.213)	(0.011)	(0.011)	(0.011)	(0.011)
Gepgraphical factor								
distance to the school	-1.118 ***	-1.135 ***	-1.128 ***	-1.134 ***	0.004	0.004	0.004	0.004
	(0.088)	(0.089)	(0.089)	(0.089)	(0.003)	(0.003)	(0.003)	(0.003)
Public transportation dummy	0.708 ***	0.690 ***	0.685 ***	0.697 ***	0.009	0.009	0.009	0.009
	(0.230)	(0.232)	(0.232)	(0.231)	(0.011)	(0.011)	(0.011)	(0.011)
Score × Prop. of high-status occupations								
Prop. of high-status occupations		0.486	0.427	0.055		0.019	0.010	0.002
		(1.198)	(0.686)	(0.516)		(0.053)	(0.030)	(0.025)
Log Likelihood	-432.923	-430.507	-430.106	-431.496	-277988	-277988	-277988	-277988
Sample Size	1332	1332	1332	1332	1369	1369	1369	1369

Note: We have the data of 38 schools in 2004 so that the sample size of the second-part estimation is 38x38=1444. On the other hand, the sample size of the first estiamtion is 1406=1444-38 since we drop the cases of the assigned schools.

Table 6: Correlation coefficients 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	0.249	0.290 *	0.209	0.300 *	0.157
	(1.520)	(1.792)	(1.264)	(1.859)	(0.941)
1 – Herfindahl Index (Share Index)	0.235	0.246	0.170	0.256	0.140
	(1.431)	(1.498)	(1.018)	(1.569)	(0.835)
Cross-border opting out ratio	-0.159	-0.091	-0.050	-0.438 ***	-0.252
	(0.951)	(0.539)	(0.294)	(2.883)	(1.540)
1 – Herfindahl Index (Choice Index)	-0.280 *	-0.190	-0.189	-0.479 ***	-0.325 **
	(1.722)	(1.144)	(1.137)	(3.224)	(2.030)
Mathematics					
Cross-border enrollment ratio	0.431 ***	0.427 ***	0.379 **	0.234	0.197
	(2.823)	(2.793)	(2.421)	(1.422)	(1.186)
1 – Herfindahl Index (Share Index)	0.415 **	0.401 **	0.387 **	0.180	0.190
	(2.698)	(2.591)	(2.482)	(1.082)	(1.145)
Cross-border opting out ratio	-0.270	-0.140	-0.189	-0.496 ***	-0.367 **
	(1.662)	(0.836)	(1.137)	(3.379)	(2.333)
1 – Herfindahl Index (Choice Index)	-0.300 *	-0.212	-0.272	-0.546 ***	-0.419 ***
	(1.858)	(1.280)	(1.674)	(3.860)	(2.731)
English					
Cross-border enrollment ratio	0.406 **	0.336 **	0.211	-	0.124
	(2.625)	(2.110)	(1.279)		(0.737)
1 – Herfindahl Index (Share Index)	0.385 **	0.300 *	0.188	-	0.105
	(2.470)	(1.862)	(1.129)		(0.622)
Cross-border opting out ratio	-0.322 *	-0.235	-0.264		-0.506 ***
	(2.009)	(1.429)	(1.622)		(3.468)
1 – Herfindahl Index (Choice Index)	-0.417 **	-0.348 **	-0.380 **		-0.560 ***
	(2.718)	(2.198)	(2.432)		(4.000)

Note (1): 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.

Note (2): The values in the parentheses are z values to test if the correlation coefficient is zero. The symbols *, ** and *** means the estiamtes are significantly different from zero at 10%, 5% and 1% level, respectively.

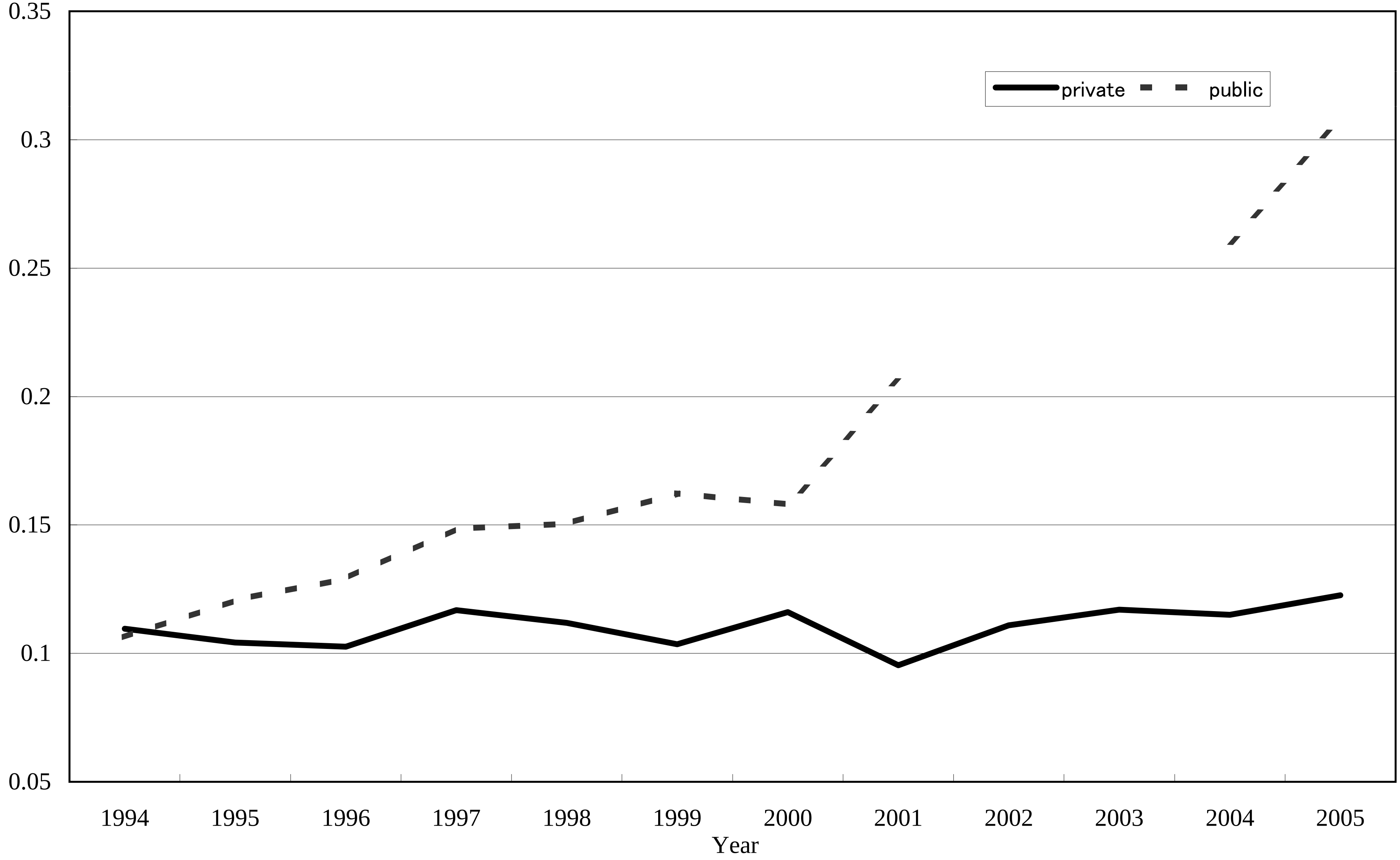
Table 7: Between-group Variation, Within-group Variation, F values and Relative Scores to Tokyo

	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	813	(37)	1102	(37)	1502	(36)	2407	(36)	2352	(36)	3240	(36)	2693	(36)	3280	(36)	3262	(36)
Within variation	203	(4552)	N.A.	(4531)	231	(4611)	334	(4606)	307	(4640)	390	(4611)	338	(4577)	361	(4591)	308	(4740)
F value	4.01	(0.00)	-	(-.--)	6.49	(0.00)	7.21	(0.00)	7.67	(0.00)	8.30	(0.00)	7.97	(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	3892	(37)	3545	(37)	3963	(36)	4685	(36)	3416	(36)	8001	(36)	10281	(36)	7551	(36)	8765	(36)
Within variation	484	(4552)	N.A.	(4531)	618	(4611)	451	(4606)	423	(4640)	619	(4611)	600	(4577)	680	(4591)	635	(4740)
F value	8.04	(0.00)	-	(-.--)	6.42	(0.00)	10.39	(0.00)	8.08	(0.00)	12.93	(0.00)	17.15	(0.00)	11.10	(0.00)	13.80	(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	5652	(37)	6148	(37)	4305	(36)	-		-		7615	(36)	7693	(36)	7489	(36)	7806	(36)
Within variation	410	(4552)	N.A.	(4531)	305	(4611)	-		-		471	(4611)	439	(4577)	421	(4591)	470	(4740)
F value	13.80	(0.00)	-	(-.--)	14.10	(0.00)	-		-		16.18	(0.00)	17.53	(0.00)	17.78	(0.00)	16.60	(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 (1): The values in parentheses are degrees of freedom for between-variation or within-variation and are p values for the F value.

Note (2): The degrees of freedom in "between variation" in the 5th and 9th columns are different, although the year is the same. The reason is that two schools have been consolidated from April 2005 and that the tests by TMG are conducted in January, while those by Adachi in April.

Figure 1: Percentages of enrollee opting out of their attendance areas



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

Figure 2A: Location of Adachi city

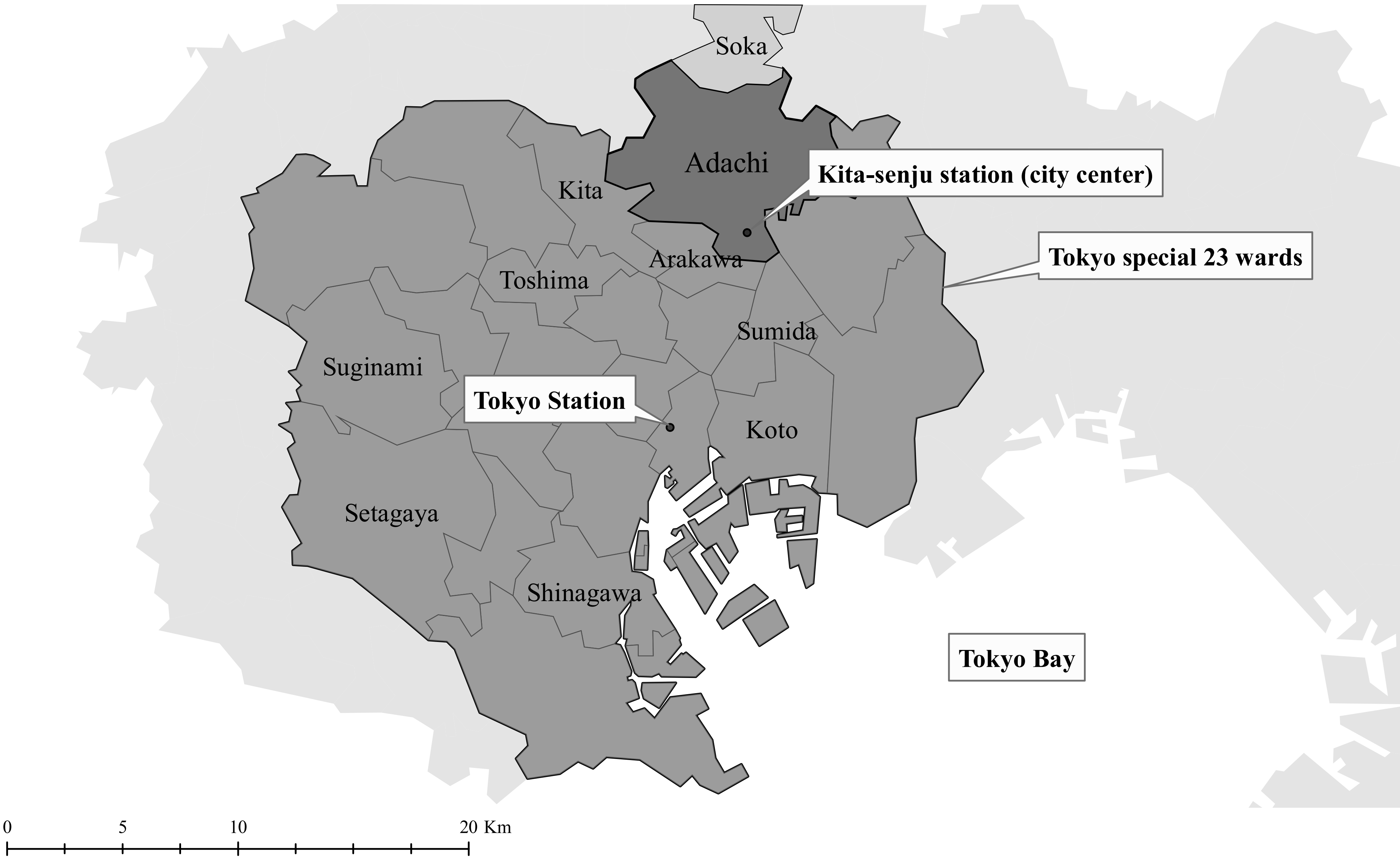


Figure 2B: Geographic distribution of proportions of high-status occupations in Adachi city