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Inefficiency in School Consolidation Decisions*

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Abstract

We study school consolidation decisions and examine how the decisions are inefficient. First, we estimate willingness to accept (WTA) a school consolidation of the current school and an adjacent school and the determinants of WTA using an original survey. Then we examine the impact of actual school consolidations on the expenditure of municipalities to estimate the amount that the prefecture and municipality can save from such school consolidations. We find that much of the savings are due to class reductions, and about half the savings are at the prefectural level rather than the municipal level. The estimated WTA of and saving from school consolidations suggest a particular mechanism where the closure of schools could be delayed by inefficient decision-making due to the presence of fiscal externalities.

Keywords: school consolidation; local public goods; willingness to accept; economy of scale; fiscal externality
JEL classification: D61; H52; I21.

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1 Introduction

In most advanced countries, public elementary and middle schools are provided to all families in their school districts. These schoolings are a typical form of local public goods as they are financed by taxes and often provided almost free of charge. In the provision of schooling as local public goods, the size of schools matters not only for families' welfare but also for the costs of running them. School size matters for students' educational outcomes (Berry and West, 2010) and the degree of heterogeneity of schools and school districts (Alesina, Baqir, and Hoxby, 2004). Also, it is one of the most important determinants of the economic efficiencies of schooling in the presence of a scale economy (Duncombe and Yinger, 2007). Hence, the optimal size of schools should balance the costs and benefits of large schools and school districts.

In the phase of population decline, the size of schools tends to be small. In such a case, school closures and consolidations are potential policy measures to maintain an appropriate size of schools. However, public school closures face difficulty because school closures usually have a negative effect on the families in the closing school districts. The political opposition by the families in the closing districts hinders the implementation of school closures and consolidations even in the cases that the total benefits to society outweigh the costs and welfare loss due to closure. Although decisions to close schools are made at the municipal level or equivalent jurisdiction with control over schools, implementation of efficient school closures is difficult. Since a municipality has many school zone decisions, the cost of closure is localized but the benefits diffuse across municipalities. Also, families without children attending school influence local policy including decisions on school closures. As a consequence, the actual level of school closures and consolidation can be highly inefficient level.

This paper studies how these problems of inefficiency are serious in the context of school closure decisions. Firstly, we build a simple model of school zones and decisions for school closures. We consider the economy where individuals with one school-age child are distributed on a plane and assigned to one local school based on the current residential location. Then we analyze the acceptance of school consolidation. In the model, the increase in commuting time due to school consolidation plays a crucial role to determine the willingness to accept. We analyze how much subsidies are needed to make individuals accept school consolidation to the next close school by compensating for the disutility due to the increase in traveling time. This amount of subsidy is a measure of the willingness to accept s school consolidation.

With the theoretical model, we estimate the parameters of the model by estimating the determinants of the willingness to accept (WTA) school consolidation to a school next to the current one. For the measurement of the WTA, we conducted our original survey for about 10,000 parents with children in elementary or middle schools randomly sampled from all over Japan. In the survey, we asked how much increases in the amount of child allowances makes them accept school consolidation. In addition, we ask for the respondent's postal code which enables us to identify the school where the respondent's child is attending to a large extent. Then we estimate the model parameters regressing the WTA on the additional distance to school by consolidation and other child/household characteristics. We see that the willingness to accept is increasing in distance to the next closest school. The estimated coefficient implies that a 1km increase in distance would be associated with a 2,290 JPY increase in monthly willingness to accept, equivalent to an annual increase of 27,480 JPY.

Next, we estimate the savings from school consolidations using our municipal panel data on school expenditures and teacher staffing numbers. We examine the impact of actual school mergers on the expenditure of municipalities using school enrollment and expenditure panel data. We try to answer two questions: how much money is saved when a school is closed; and which level of government benefits from these savings? Through the panel-data regression as well as event studies, we find that much of the savings is due to class reductions, and about half the savings here is at the prefectural level rather than the municipal level. These findings suggest a particular mechanism where the closure of schools could be delayed by inefficient decision-making. When a school is closed, prefectures enjoy an immediate budgetary benefit corresponding to the two administrators that were previously running the now-closed school, plus a number of classroom teachers corresponding to the number of classes under the 40-student cap that can be combined after the consolidation. The municipality, however, which is actually responsible for closing schools, bears a substantial adjustment cost as the post-consolidation school building must be renovated. These adjustment costs may result in the municipality avoiding mergers that might have been beneficial if the prefectural budget savings were internalized.

The remainder of the paper is as follows. Section 2 reviews related literature. Section 3 presents a theoretical model. Section 4 explains our data, beginning with a brief summary of the institutional background related to school closure decisions in Japan. Section 5 discusses the estimation results of the determinants of willingness to accept a school merger, the results of the expenditure analysis, and how these estimated coefficients compare with the actual closure decisions that have been made by municipalities. Section 6 concludes.

2 Literature Review

With multiple layers of decision-makers in school closure decisions, our theoretical framework is related to a strand of literature on fiscal externalities with multiple-layer governments. Dahlby (1996) builds a model with the vertical tax and expenditure externalities that arise when state governments' tax and expenditure decisions affect the federal government's budget constraint and vice versa. He finds that, with vertical expenditure externalities, the federal government should provide a matching expenditure grant equal to the additional federal revenue generated from a state's additional dollar on productivity-enhancing activities such as education. Dahlby and Wilson (2003) examine vertical fiscal externalities in a model where a state government provides productivity-enhancing public input and both the state and the central government tax wages and profits. They show that an increase in the provision of public input can either increase or reduce federal tax revenues, leading to either under or over-provision of the public input by the state government. These studies indicate that decisions of local public good provisions can be inefficient when multiple-layer governments are involved in this decision process and these fiscal externalities are not considered explicitly. Empirically, Andersson, Aronsson, and Wikström (2004) find the presence of vertical external effects associated with tax base sharing among local and regional governments in Sweden. Our empirical findings provide another example of inefficiency due to fiscal externalities.

Taking school districts as political jurisdictions, our paper is related to the literature on the formation of political jurisdiction. Alesina and Spolaore (1997) and Bolton and Roland (1997) study the trade-off between size and income heterogeneity as determinants of the number and size of nations. Weese (2015) and Weese, Hayashi, and Nishikawa (2020) study the municipal merger decisions in the Heisei era and Meiji era of Japan respectively, and find that the realized number of municipalities was far more than the optimal level suggesting enormous inefficiencies. With school district consolidation as a specific application, Alesina, Baqir, and Hoxby (2004) build a model of political jurisdictions such as school districts and find evidence of a trade-off between economies of scale and racial and income heterogeneity. Brasington (1999) studies the determinants of school district mergers in Ohio, the U.S. and finds that population and property value factors matter more than sociodemographic factors in determining whether two neighboring entities will form a consolidated school district. Brasington (2003) focuses on the difference in sizes of cities and finds that bigger differences in size make large cities more likely to prefer consolidation of school districts and small cities more likely to prefer separation, hindering consolidation. Gordon and Knight (2009) study the determinants of school district mergers using the wave of mergers in Iowa, the U.S. during the 1990s and find the importance of state financial incentives for consolidation, (dis)economies of scale, and heterogeneity in the decisions of school district consolidations. Duncombe and Yinger (2007) estimate consolidation's cost impacts and find economies of size in operating spending. In addition, they find that consolidation also involves large adjustment costs, which are particularly large for capital spending, lowering net cost savings substantially. Similarly, Zimmer, DeBoer, and Hirth (2009) find economies of scale using Indiana school district data primarily from 2004 through 2006, Dodson III and Garrett (2004) find scale economies for Arkansas school districts, and Gronberg, Jansen, Karakaplan, and Taylor (2015) find scale economy for Texas. Overall, these studies imply the importance of trade-off between scale economy and heterogeneity as one of the determinants of school consolidations.

In our model, we focus on the distance to school as the most important source of heterogeneity in school. With a different approach, Ma (2016) examines the trade-offs faced by central decision-makers responsible for delivering local public goods with a special focus on home-to-school commuting costs using data from China. He builds and estimates a structural model of local governments' decision-making to recover the preferences of local authorities with a special focus on heterogeneous productivity across schools, increasing returns in schooling production, and home-to-school commuting costs and finds that distance cost was under-evaluated by the central government in local governments' decisions. In contrast, we estimate the preferences of the local community for home-to-school commuting costs directly from stated preferences rather than the revealed-preference approach by estimating preference parameters for distance to school structurally.

There are several studies examining the effects of school consolidation on students' academic achievements. Using the variation of timing of school consolidation from 1930 to 1970 in the U.S., Berry, and West (2010) find that students educated in states with smaller schools obtained higher returns to education and completed more years of schooling compared to those in large schools due to school consolidation. Contrary, Haan, Leuven, and Oosterbeek (2016) find that an increase in the minimum required school size of 10% has a small positive effect on student achievement of 0.72% of a standard deviation, using a reform leading to an increase in actual school size and a reduction in the number of schools in Dutch primary education in the mid-1990s. Beuchert, Humlum, Nielsen, and Smith (2018) find that the achievement of students in closing schools is adversely affected in the short run and that students initially enrolled in small schools experienced the most detrimental effects in Denmark from 2010 to 2011. Although we do not explicitly examine the impact of school consolidation on students' academic outcomes, they are captured implicitly by the utility of households and thus matter for school closure decisions.

Our paper is related to the studies applying the contingent valuation method to non-market goods/services. These methods are used often in the measurement of the value of the natural environment. For example, Bishop and Heberlein (1999) and Venkatachalam (2004) review methods on measures to address the validity and reliability issues from different kinds of biases/errors and other related empirical and methodological issues concerning the contingent valuation method. CVM is used in other literature too. Klose (1999) reviews the use of CVM in healthcare literature. In the context of education, Süssmuth and Mande (2016) study the determinants of preferences for small classes of college students in Munich, Germany asking about willingness to pay to maintain small classes and willingness to accept to compensate for a larger class. They find male students to systematically show a higher preference for small class sizes. Our paper provides a unique application of the CVM to the school consolidation problem.

Finally, our paper is related to the literature on school mergers in Japan. Aoki et. al (2016) studies the determinants of school mergers using municipality-level panel data from 2004 to 2013 in Japan and find that population aging and fiscal expenditure are the main determinants. Sakurai (2012) examines a municipality's determinants of primary and middle schools. He argues that school mergers are seen as a scheme to cut the educational budget, but it incurs a surge of adjustment costs such as expenditure on school buses and political adjustments at least in the short run. Using school-level data in Yokohama city, Hirotani (2018) studies the impact of school mergers on the school budget focusing on two cases. He finds that school mergers can reduce not only educational expenditures but also educational revenues. Our paper is the first paper to evaluate the efficiency of school consolidation decisions in Japan considering both data on spending data willingness to accept school consolidation.

3 Theory

Suppose that individuals (=family with exactly one child) are distributed on a plane. There are two schools located on this plane, j_1 and j_2. Each individual must attend exactly one school. If individual i attends school j, then the payoff to individual i will be

$$u_i(T_i, j, x_j) = T_i + v_i(j, x_j) \tag{1}$$

$$v_i(j, x_j) = \gamma d(i, j) + x_j \beta$$

where T_i is a cash transfer received by i, $d(i, j)$ is the distance (travel time) between i and j, x_j are some characteristics of school j (size, average family income, etc.), and β is a parameter vector describing the importance of these characteristics, and we expect scalar γ to be negative because travelling longer distances to go to school is undesirable.

Suppose that there is an existing assignment of individuals to schools. Let $\mathcal{I}(j_1)$ be the set individuals assigned to school j_1, and $\mathcal{I}(j_2)$ the set of individuals assigned to school j_2.

We would like to consider a potential closure of school j_1, sending all students that were previously attending school j_1 to school j_2 instead. After this closure the characteristics of school j_2 will be $\tilde{x}_{j_2}$, because the school will include the students that were originally attending school j_1.

Suppose that individual i who is currently attending school j_1 is offered a choice between two options: close school j_1 and receive a cash transfer of T, or keep school j_1 open and receive a cash transfer of 0 (status quo). Individual i will prefer to close school j_1 when

$$u_i(T_i, j_2, \tilde{x}_{j_2},) > u_i(0, j_1, x_{j_1},)$$

Suppose now that we have a Benthamite social planner deciding whether to close school j_1. Suppose that there is a fixed cost F of keeping a school open (i.e. the savings from closing j is F). The disutility this closure would generate would be

$$\Delta U = \sum_{i \in \mathcal{I}(j_1)} v_i(j_2, \tilde{x}_{j_2}) - v_i(j_1, x_{j_1}) + \sum_{i \in \mathcal{I}(j_2)} v_i(j_2, \tilde{x}_{j_2}) - v_i(j_2, x_{j_2}).$$

The general expression given for ΔU above is quite complicated; however, if β turns out to be close to zero, and the characteristics of schools (other than their location) are relatively unimportant compared to cash transfers and travel distance, then the above expression simplifies to

$$\Delta U = \sum_{i \in \mathcal{I}(j_1)} (u_i(j_2) - u_i(j_1))$$

where $u_i(j_2) - u_i(j_1) = \gamma d(i, j_2) - \gamma d(i, j_1)$, because quasilinear utility means that transfers can be decided later, and thus only the increase in distance is relevant for the social planner's decision to close the school or not. The school should be closed when

$$F + \Delta U > 0$$

that is, when the distance cost that is imposed by a merger is less than the fixed cost of keeping school j open.

Now, suppose instead that there is a local government in charge of making the decision whether to close school j or not. This government, however, does not receive the full cost savings F from closing the school: instead, it receives only fraction λ of these savings. If this local government is the decision-maker, then it will decide the school should be closed when

$$\lambda F + \Delta U > 0$$

Here, the portion of the cost savings that the local government does not receive is a "fiscal externality". If λ is low, then many schools may remain open due to lack of internalization of cost savings from closing them. We are interested in whether this problem is empirically important, and whether there is any other evidence of related problems in closing schools.

4 Data

We use three main types of data to conduct our analysis of school consolidations. First, we collect survey responses regarding willingness-to-accept for school consolidations. These surveys are based on a random sample of parents of children enrolled in Japanese elementary and junior high schools, and provide us with an estimate of the costs imposed on families from a school closure. To estimate the savings from a school closure, we use municipal expenditure data and information about the number of teachers deployed in each municipality. Finally, to examine actual municipal revealed preferences, we produce at dataset of actual school consolidations.

Below, in subsection 4.1 we describe the public compulsory education system in Japan. In subsection 4.2 we describe our survey data, in 4.3 our municipal expenditure and staffing data, and in 4.4 our school closure data.

4.1 Compulsory Education in Japan

Education is mandatory for Japanese children through to the end of junior high school. Students attend six years of elementary school followed by three years of junior high school. 99% of children in Japan attend public elementary schools, and 99% of these attend non-selective local schools. At the junior high school level, however, 7.5% of children attend private schools and 1.5% of children attend selective prefectural or national public schools. We do not consider these children in our analysis below, because they have already chosen to leave the local public system. The policy being considered in this paper is a potential school merger that makes attendance at local public schools *less* attractive, and thus families that had already decided to opt out of the local public system (who we do not include in our survey or subsequent analysis) would not re-enter if the policy were implemented, and thus we are not missing an important extensive margin here.

Responsibility for providing compulsory education is split among the three different levels of government in Japan. Curriculum is set by the Ministry of Education at the national level. Teachers are hired and paid for by prefectural governments. The elementary and junior high schools themselves, however, are managed by municipalities, the lowest level of government in Japan. Municipal responsibilities include building, maintaining, and renovating schools, as well as providing school lunches and other non-education-related services to students. Municipalities are also responsible for deciding when to open or close schools.

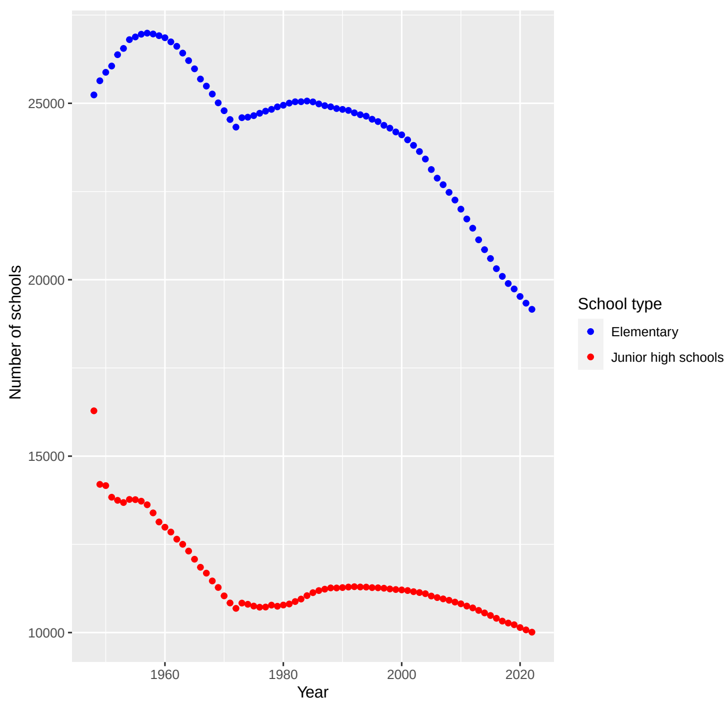


Figure 1: Number of schools (1948-2022)
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

Figure 2 shows that the total number of students in compulsory education in Japan has declined by about 50% since its peak around 1960. Schools were constructed to accommodate the large student numbers of this previous era, and the current decline in student numbers has resulted in many schools that are under-enrolled. Some schools have already been closed,

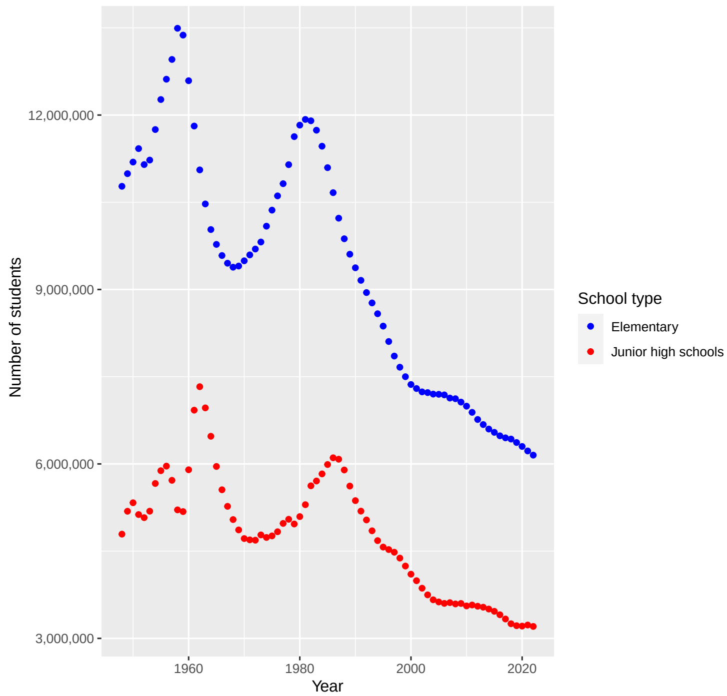


Figure 2: Number of students (1948-2022)

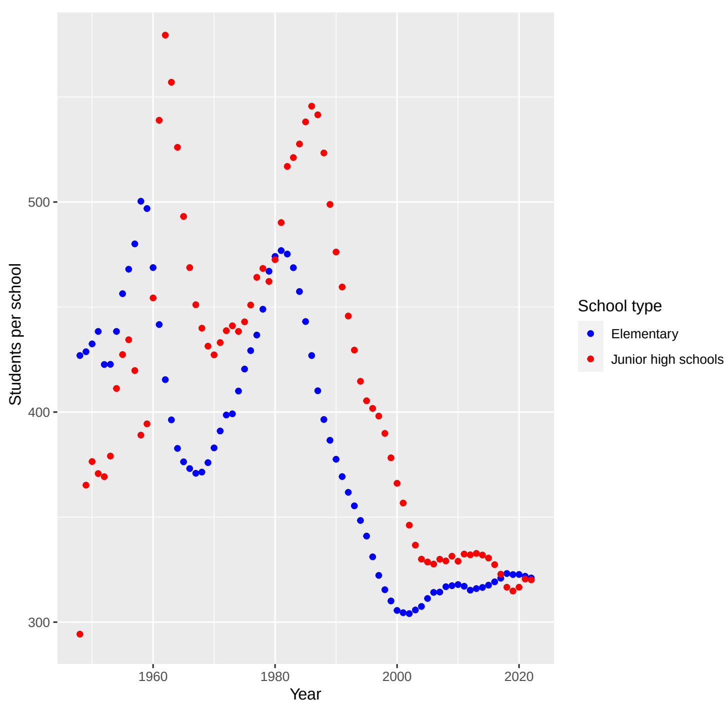


Figure 3: Students per school (1948-2022)

as shown in Figure 1, but there remains a general perception that schools are operating at an inefficiently small scale. Figure 3 shows the average number of students per school: for elementary schools, this is 36% below its peak in 1958, and for junior high schools this is 45% below its peak in 1962.

In addition to curriculum, several key features of local public schools are determined at the national level. During the period of interest, the maximum class size was set at 40 students, and classes larger than this are automatically split into two.[1] Appendix Figure 26 shows the distribution of class sizes for all local elementary in Japan in 2019. Particularly small grades may be combined into split grade classes, but this only occurs when the split grade class would have a total of 16 or fewer students across both grades (see Appendix Figure 25).[2] At the elementary level each class has exactly one teacher, with some additional teachers (such as the principal) not assigned to any class. At the junior high school level there are some additional specialist teachers who are not assigned to any particular class.

Japanese municipalities provide a large number of public services: education accounts for about 11% of total municipal spending overall. Although municipalities have some ability to charge lower or higher tax rates, most municipalities tax at the official minimum rate (Weese 2015). A useful approximation is thus that the total size of the municipal budget is fixed, as it is determined by a (*de facto*) fixed tax rate combined with a set of transfers from the national government.

This does not mean, however, that municipal spending on *education* is fixed. Municipalities have broad discretion to move spending across different categories, and money not spent on education could be used to build or maintain roads, provide additional social services, and so forth.

[1] Class size cap was reduced from 40 to 35 for elementary schools in Japan in 2021. The cap for first graders has been 35 since 2011. However, prefectures are allowed to reduce the cap using the additional fund to realize small classes from the national government. For example, in Tokyo, the cap for the first and second graders was reduced to 35 in 2010.

[2] Split grade classes can only have a maximum of 8 students if first grade elementary school students are included, or if the split grade class involves junior high school students. Prefectural education boards have some discretion implementing these limits. We do not observe split grades with class sizes greater than 15 in our data.

4.2 Survey Data

In order to determine the importance of distance and other characteristics, we use a stated-preference survey of randomly sampled individuals across Japan.[3] Stated-preference data is collected here rather than using revealed preference data because of major difficulties with obtaining reliable estimates based on a revealed preference approach. At the individual level, revealed preference estimates would likely be based on either a general equilibrium model of household location choice (where it would be difficult to identify the parameter specifically having to do with the cost of a school merger), or a reduced form model looking at the relationship between property values and school mergers (where identification would be difficult because actual mergers are generally predictable in advance, at least to a certain extent). At the jurisdiction level, estimates based on actually implemented closures may be influenced by local lobbying and fiscal externalities, effects that we want to examine explicitly rather than have bundled in with initial parameter estimates. We thus begin by collecting stated preference data over potential school mergers, but will later construct a simple decision-making model of municipal school closures that will allow us to verify the reasonableness of our stated-preference estimates.

4.2.1 Sample frame

We surveyed approximately 10,000 randomly sampled adults across Japan who

1. had children in public non-selective elementary or junior high schools,
2. did not live in a Specially Designated City or the Tokyo special ward area, and
3. knew the location of the "next closest" school to the school their child was attending.

We exclude residents of Specially Designated Cities (large cities with a population of more than 500,000) because these municipalities often have stable or rising populations and elementary schools with large enrollments, making school mergers uninteresting as a policy

[3] This is the "School Travel Cost Internet Survey", conducted by RIETI.

choice. Furthermore, these cities have additional budgetary responsibilities devolved from their prefectures, and thus the potential local government savings from closing a school are different. The special ward area of Tokyo prefecture (generally corresponding to pre-war Tokyo City) is excluded for the same reasons.

The final group we exclude from our survey is individuals who do not know the location of the next closest school to the school their child attends. This is because the survey questions about willingness-to-accept for a school merger are only meaningful if the respondent knows the location of the school that their children would be attending if the merger happened. In our case, we ask about a hypothetical merger with the next closest school, and thus exclude from our survey individuals who did not know where this school was. Less than 1% of potential respondents were excluded for this reason.

In cases where respondents had more than one child attending public elementary or junior high school, we asked them to respond with the youngest child in mind. 27% of respondents had other children attending the same school as this child: we control for this explicitly in the regressions that follow.

4.2.2 Survey questions

The main questions in our survey are one or more questions about the respondent's willingness-to-accept for a school merger. At the time the survey was conducted, almost all families in Japan with children in elementary or junior high school received a monthly "child allowance" payment from their local government.[4] We asked respondents to consider an increase in this payment in exchange for their local school being closed:

> Currently, families of students attending elementary or junior high school receive JPY 10,000 per month (JPY 15,000 for third and following children, some income limits apply). Suppose that your municipality is considering increasing this payment in relation to a school merger.

[4]This payment has now been eliminated completely for some high income parents (1% of families with the highest income and receiving the "child allowance").

For what increase in the child allowance would you consider a merger with the adjacent school to be acceptable?

Q5	児童手当の増額分（子供一人当たり）が月額で次の金額の時、あなたは隣接校との統合をおこなっても良いと思いますか。

%%#HQ5_3%%

		統合に反対	統合に賛成
増額なし	→	○	○
月額 5000円	→	○	○
月額 10000円	→	○	○
月額 15000円	→	○	○
月額 20000円	→	○	○
月額 50000円	→	○	○
月額 100000円	→	○	○

Either one monetary value or a full table of seven values was presented to the respondent.

We consider willingness-to-accept rather than willingness-to-pay in our survey because some of the amounts concerned are likely large relative to the total budget for the families in question: the largest option on our survey is JPY 100,000 per month, which annualized is over 20% of GDP per capita. As expenditure decisions such as housing are long term and have likely already been made, a question asking for such a large household budget reallocation may not lead to reasonable answers, whereas it is easier to envision how additional money added to the budget could be spent. Furthermore, there is no plausible government policy that would charge parents money, whereas there is a current policy where municipal governments provide transfers to parents.

In addition to the survey question regarding willingness-to-accept, we also asked several demographic questions. In particular, we asked for the respondent's postal code. These generally agreed with the postal code information respondents had provided to the survey firm previously, suggesting that the reported postal codes were accurate.[5] These postal codes are crucial for our analysis because they are generally contained in a single school

[5] We removed the 6,52% respondents who reported postal codes that were not the same as what they initially reported to the survey company.

district: Figure 4shows school districts in a part of Aichi prefecture, and Figure 5 shows postal codes reported by our respondents in this area. 59% of the time, a respondent's postal code uniquely identifies the elementary school their child is attending and 47% for junior high school.[6]

Finally, we asked a set of questions regarding travel to school, including method (walking, bike, car/public transit) and time required. We then asked how much time would be required if the same method were used to travel to the post-merger school.

Figure 4: Aichi school districts example

4.2.3 Distance calculations

We will examine the historical pattern of school mergers that occurred in various prefectures across Japan. The specific schools that closed are not part of our dataset and thus we have no survey responses for these schools. However, reported travel time to schools is closely related to geographic distance, and thus we can determine how attractive different schools are as merger targets by using GIS data on the population distribution of families in Japan.

[6]Neither postal codes nor school districts appear to be defined with reference to the other unit, and thus there are often tiny differences. 59% of postal codes have at least 98% of their area within a single school district (47% for junior high schools).

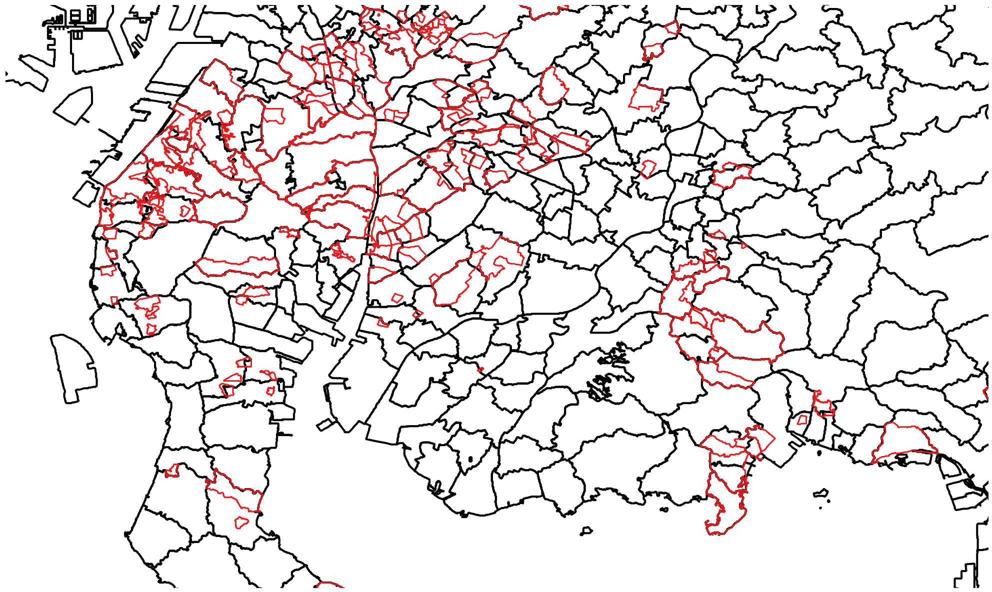


Figure 5: Aichi school districts and postal codes from the survey

This data is available at the 250 meter grid square level, and can be combined with GIS point data on the locations of the schools in question. For each survey respondent, we compute how far the average resident of their postal code would have to travel in order to attend the local elementary or junior high school. Details of these calculations are provided in Appendix 1.

Table 1 shows summary statistics for the survey data. We are particularly interested in the relationship between distance to school and the willingness to accept for school mergers. Appendix Figure 15 shows that the average elementary school student walks approximately 750m to school, although those in the very smallest schools (generally in remote areas) walk about 1km. Appendix Figure 16 shows that the situation is effectively identical for junior high school students.Appendix Figures 17 to 20 show travel time for students who bicycle or take public transit to school.

We might expect that the smallest schools remain open because parents of students attending those schools place great value on them. Somewhat surprisingly, this appears not to be the case. Figure 14 shows the average willingness to accept for a school merger of parents of students at different sizes of elementary schools. We see that willingness to accept

Table 1: Survey summary statistics

	Mean	SD	Max	Min
Elementary Data				
WTA	44436.40	56288.14	150000.00	0.00
Log of income	15.29	0.84	16.81	12.43
Dummy for married (1 is married)	0.93	0.26	1.00	0.00
Number of kids in elementary school	1.35	0.63	22.00	1.00
Age of the youngest child	3.48	1.69	6.00	1.00
Age of respondent	44.11	5.38	71.00	23.00
Additional time	14.24	20.70	300.00	0.00
Additional distance	957.09	895.65	16320.15	0.00
Weighted average distance to current school	878.71	657.09	13156.97	88.56
Weighted average distance to nearby school	1888.14	1360.25	22384.54	294.29
Walking time to current school	17.64	10.80	90.00	1.00
Walking time to nearby school	30.30	22.46	320.00	1.00
Gender of respondent (1 is female)	0.55	0.50	1.00	0.00
Gender of child (1 is female)	0.49	0.50	1.00	0.00
JHS Data				
WTA	52754.44	59567.29	150000.00	0.00
Log of income	15.26	0.88	16.81	12.43
Dummy for married (1 is married)	0.90	0.30	1.00	0.00
Number of kids in JHS	1.10	0.31	3.00	1.00
Age of the youngest child	7.98	0.81	9.00	7.00
Age of respondent	47.39	4.93	70.00	30.00
Additional time	16.73	26.59	350.00	0.00
Additional distance	1498.62	1418.18	15905.38	0.00
Weighted average distance to current school	1493.79	1144.07	13428.14	159.46
Weighted average distance to nearby school	3226.77	2239.52	26335.30	496.02
Walking time to current school	17.14	9.70	80.00	1.00
Walking time to nearby school	31.16	27.24	360.00	1.00
Gender of respondent (1 is female)	0.51	0.50	1.00	0.00
Gender of child (1 is female)	0.49	0.50	1.00	0.00

is if anything slightly lower at the smallest schools.

One aspect of expenditures that we do not currently include in our model is the Local Allocation Tax (*chihou koufuzei*) system. This is a transfer scheme that collects money through national level taxes and provides funding to municipalities on the basis of calculated "Standard Fiscal Need". The transfer formula used is complicated and occasionally counterintuitive: Appendix B of Weese [2015] provides an English language introduction to this system.

To the extent that LAT transfers received by municipalities depend on the number of elementary school classes or schools, municipalities may not have an incentive to consolidate schools as the costs of inefficiently small scale are de facto borne by the national government. The results in this paper thus represent an underestimate of the inefficiency in the school closure decision, as we consider only the fiscal externality present at the prefectural level (through teacher salaries), but not the externality at the national level through the LAT system.

4.3 School Expenditure Data

We are interested in the potential savings from merging a school with a neighbouring school. Our main data sources for this analysis are the *Gakkou Kihon Chousa* ("School Basic Survey") and the *Chihou Kyouikuhi Chousa* ("Survey on Local Education Expenditure"), both conducted by the Ministry of Education, Culture, Sports, Science and Technology. The former dataset provides information on staffing and student enrollment for all local elementary and junior high schools in Japan. The latter dataset provides information on different kinds of expenditures on local elementary and junior high schools at the municipal level. We consider three different methods for estimating the savings of closing a school: cross-sectional regression, panel data regression with fixed effects, and an event study specification. There is broad agreement between these three different methods on the cost savings from closing a school, although the panel data approach tends to give somewhat lower estimates and becomes too noisy in some specifications.

Figure 6 shows total spending on education for all municipalities in Japan. In general there is a close to linear relationship between the number of students for which education must be provided and the total expenditure on education. However, there remains substantial variation in spending between municipalities. Several groups of municipalities in this figure appear to have different spending levels: municipalities that are part of the Fukushima nuclear accident area, Specially Designated Cities, and Tokyo special wards. We exclude these groups of municipalities from the analysis that follows, but retain municipalities in Tokyo prefecture other than the special wards.

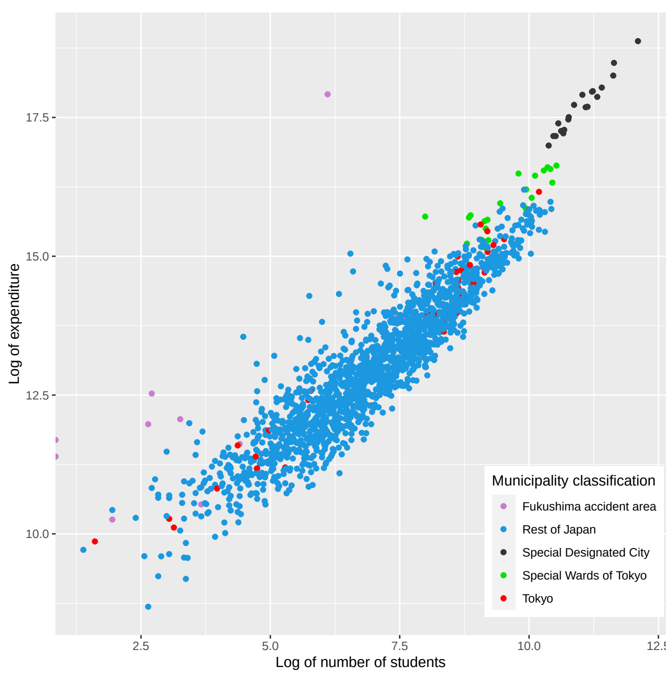


Figure 6: Expenditures vs students by municipality (Elementary)
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

We are particularly interested in the relationship between spending per capita on students and the average size of schools. Figure 7 shows that municipalities that have smaller per-school enrollment for elementary schools have greater spending per capita. (Appendix Figure 24 shows the same for junior high schools) This fact forms the basis for our examination of spending. Summary statistics for our expenditure regressions are shown in Table 2.

Table 2: Expenditure summary statistics

	Mean	SD	Min	Max
Elementary Data				
Expenditure	941016.23	1791420.51	3602	143050153
Current expenditure	444740.61	648451.74	3495	14089573
Capital expenditure	356529.69	1261292.33	0	128670328
Capital exp. (land)	9277.20	87558.19	0	3039568
Capital exp. (equip)	32426.86	87761.77	0	3207843
Capital exp. (build)	310767.45	1235058.88	0	128631866
Capital exp. (book)	4082.71	8161.85	0	450533
Number of schools	9.56	10.93	1	78
Number of Classes	121.10	170.28	1	1423
Number of opened schools	0.04	0.22	0	4
Number of closed schools	0.17	0.72	0	12
Number of students	2760.26	4376.76	1	33931
JHS Data				
Expenditure	546116.92	778641.31	409	12733523
Current expenditure	238242.44	323951.14	409	9675238
Capital expenditure	219056.34	450658.76	0	7978514
Capital exp. (land)	5918.92	67096.21	0	4042732
Capital exp. (equip)	19145.16	61315.70	0	3366706
Capital exp. (build)	191326.74	417629.03	0	7865711
Capital exp. (book)	2680.60	8966.30	0	889575
Number of schools	4.57	5.22	1	44
Number of Classes	51.66	71.90	2	526
Number of opened schools	0.02	0.14	0	5
Number of closed schools	0.06	0.35	0	9
Number of students	1390.74	2120.62	2	16468

Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

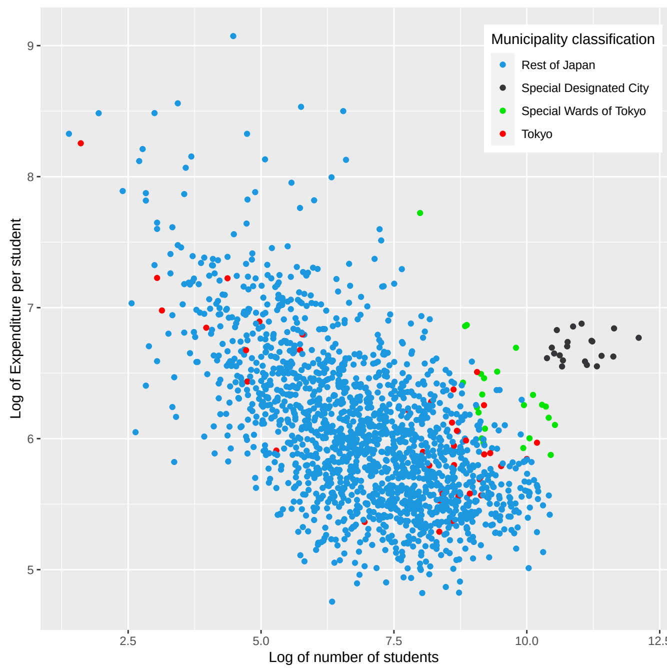


Figure 7: Expenditures vs students by municipality (Elementary)
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

4.4 School Closure Data

We are interested in the degree to which actual school consolidation decisions made by municipalities may not necessarily be the same as the preferences of residents. To examine this, we need to collect data on actual school closures. We do so using school enrollment data. We consider any school that is not listed in the *Gakkou Kihon Chousa* to be closed. We also consider any school that is listed, but reported to have zero students enrolled, to also be closed. For simplicitly, we currently analyze only one year of closures, 2017. Thus, in our dataset, a school is marked as consolidated if it had students enrolled in 2017 but then was closed in 2018. Summary statistics for the data used for this school closure analysis is shown in Table 3.

Table 3: School closure summary statistics

	Mean	SD	Min	Max
Elementary Data				
Closed schools (1 if the school is closed)	0.01	0.10	0.00	1.00
Additional distance (max 2km),	2.33	1.43	2.00	66.89
Savings per student (millions of JPY),	0.36	0.92	0.02	34.44
Financial stress index (by municipality),	0.67	0.26	0.06	2.18
Total student population (in thousands of students by municipality),	19.26	32.64	0.00	181.29
School population (as a % of municipality students population),	0.09	0.15	0.00	1.00

Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

5 Analysis and Results

Our analysis proceeds as follows. According to our simple theoretical model in Section 3, the major cost of a school consolidation is the increased distance that students must travel after their local school is closed. We begin our analysis with subsection 5.1 where we analyse our survey data to determine the extent of our survey respondents' willingness-to-accept for school mergers and how this varies depending on distance to the school that will be attended post-merger. In subsection 5.2 we then estimate the savings from school consolidations using our municipal panel data on school expenditures and teacher staffing numbers. Finally in subsection 5.3 we examine what may be influencing actual municipal school consolidation decisions by examining a set of actual consolidations.

5.1 Willingness-to-Accept for school mergers using survey data

Our main regression specification for analyzing survey respondent willingness to accept is based on the theoretical model in Section 3. We derive the regression equation from the utility function given in Equation 1. First, note that the point of indifference of individual i between keeping the currently attended school j_1 open, and closing j_1 and attending j_2

instead is given by

$$0 = \gamma(d(i, j_2) - d(i, j_1)) + (\tilde{x}_{j_2} - x_{j_1})\beta + T_i$$

and rearranging gives us our regression specification, with the minimum transfer that i is willing to accept in exchange for the closure of j_1 as our left hand variable. We add an idiosyncratic econometric error ε_i, giving us the regression specification

$$T_i = \gamma(d(i, j_1) - d(i, j_2)) + (x_{j_1} - \tilde{x}_{j_2})\beta + \varepsilon_i$$

where the scalar coefficient γ (giving the relative importance of distance) and the coefficient vector β (describing characteristics of the schools) are the coefficients of interest. In some specifications we also consider additional control variables.

Column I of Table 4 considers a regression specification that includes the average distance between the respondent's postal code and the school that they currently attend, as well as the average distance between the respondent's postal code and the next closest school. We see that the willingness to accept is increasing in distance to the next closest school. The estimated coefficient implies that a 1000m increase in distance would be associated with a 2290 JPY increase in monthly willingness to accept, equivalent to an annual increase of $2290 \times 12 = 27480$ JPY. The model in Section 3 implies that the coefficient on distance to current school should be the same magnitude and opposite sign to the coefficient on distance to post-merger school. Thus, in Column II we combine these two variables, and consider a specification where the *increase* in distance due to the merger is considered. The resulting coefficient estimate here is very similar to Column I. Column III shows that inclusion of the age of the student in question makes little difference to this result.

Columns IV through VI of Table 4 consider the same set of specifications as Columns I to III, except using reported walking time from survey respondents rather than computed average distance. Unsurprisingly (given that respondents know exactly where they live, whereas our computations are averaged across an entire postal code), statistical significance is higher in Columns IV to VI than for the equivalent specifications in Columns I to III, and the coefficient on child age becomes statistically significant in Column VI showing that parents are less concerned about travel time for children that are older. We also see some evidence that richer parents have generally higher willigness to accept values; however, this result is statistically significant at only the 10% level.

Column VII provides a simple falsification check. Our computed distance is intended to be a proxy variable for travel time, needed because we can observe distance for all families and schools in Japan, including those that were open in the past but have since been closed. On the other hand, we only know travel time for our survey respondents. We will thus use computed distance instead of reported travel time in regression specifications in the sections that follow; however, there may be concerns that these variables are not actually measuring the same thing, and thus computed distance may not be an appropriate proxy variable. To examine this possibility, we include both variables in Column VII and verify that there appears to be no (statistically significant) effect of computed distance when reported travel time is also included as a control variable. This is exactly the behaviour that would be expected of a proxy variable.

Table 4: Survey regressions

	DV: Willingness to accept (JPY) Elementary school observations						
	OLS	OLS	OLS	OLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Weighted avg. dist. current school	−2.80						
	(2.33)						
Weighted avg. dist. nearby school	2.29**						
	(0.89)						
Additional distance		2.35***	4.96**				−1.45
		(0.89)	(1.97)				(1.15)
Additional dist. * age of child			−0.78				
			(0.52)				
Walking time to current school				−231.81***			
				(89.82)			
Walking time to nearby school				270.87***			
				(41.10)			
Additional time					265.96***	449.84***	295.86***
					(42.20)	(116.79)	(48.65)
Additional time*age of child						−59.87**	
						(25.08)	
Additional time*female respondent						44.96	
						(85.91)	
Additional time*female child						−9.33	
						(85.88)	
Log of income	1,126.56	1,133.21	1,129.18	2,099.38*	2,012.61*	2,000.72*	2,038.21*
	(989.62)	(989.03)	(988.92)	(1,097.92)	(1,108.19)	(1,107.92)	(1,098.06)
Dummy for married (1 is married)	−293.54	−294.07	−217.82	−2,909.24	−3,101.17	−3,030.49	−2,888.98
	(3,272.71)	(3,272.17)	(3,272.16)	(3,679.11)	(3,697.90)	(3,697.23)	(3,680.37)
Number of kids in elementary school	959.69	959.65	888.13	2,025.75	1,987.73	1,998.05	2,069.58
	(1,375.32)	(1,375.10)	(1,375.77)	(1,460.41)	(1,462.16)	(1,461.65)	(1,461.49)
Age of the youngest child	−1,381.38***	−1,378.55***	−630.63	−1,209.27**	−1,201.73**	−344.20	−1,189.41**
	(524.68)	(524.55)	(726.50)	(573.72)	(573.83)	(677.20)	(573.30)
Age of respondent	986.13***	986.02***	980.18***	967.47***	935.80***	929.44***	960.93***
	(157.26)	(157.23)	(157.26)	(172.51)	(182.40)	(182.53)	(172.57)
Gender of respondent (1 is female)					−907.79	−1,544.76	
					(1,904.47)	(2,243.75)	
Gender of child (1 is female)					−216.93	−169.76	
					(1,749.02)	(2,130.24)	
Observations	4,907	4,907	4,907	3,979	3,979	3,979	3,979

Note: *p<0.1; **p<0.05; ***p<0.01
For respondents who walk

Table 5: Survey regressions

	DV: Willingness to accept (JPY)						
	OLS	OLS	OLS	OLS	OLS		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Weighted average distance to current school	−0.72						
	(4.63)						
Weighted average distance to nearby school	1.34						
	(1.42)						
Additional distance		1.50	−16.75				0.35
		(1.44)	(14.40)				(1.60)
Additional distance and age of child			2.25				
			(1.77)				
Walking time to current school				−219.81			
				(263.08)			
Walking time to nearby school				181.72**			
				(82.64)			
Additional time					182.51**	−414.19	172.26**
					(83.12)	(845.90)	(85.27)
Additional time*age of child						61.79	
						(110.54)	
Additional time*female respondent						65.77	
						(197.10)	
Additional time*female child						242.77	
						(181.91)	
Log of income	4,024.30	4,024.28	4,030.42	3,884.22	4,521.57*	4,492.99	3,834.38
	(2,482.45)	(2,480.41)	(2,479.49)	(2,687.82)	(2,733.73)	(2,734.02)	(2,690.54)
Dummy for married (1 is married)	816.71	908.03	1,288.80	−806.51	674.72	47.76	−740.41
	(7,200.43)	(7,185.09)	(7,188.65)	(7,777.95)	(7,800.21)	(7,818.27)	(7,801.21)
Number of kids in junior high school school	−12,781.00*	−12,790.48*	−12,518.02*	−11,035.91	−11,046.72	−10,256.71	−11,170.43
	(6,971.67)	(6,962.70)	(6,963.41)	(7,654.42)	(7,628.47)	(7,642.89)	(7,653.00)
Age of the youngest child	−63.07	−76.46	−3,341.88	918.10	588.06	−468.61	956.04
	(2,657.59)	(2,653.55)	(3,689.36)	(2,948.39)	(2,942.17)	(3,384.76)	(2,945.98)
Age of respondent	1,487.08***	1,487.36***	1,496.07***	1,316.11***	1,559.31***	1,559.27***	1,326.37***
	(426.00)	(425.47)	(425.37)	(466.20)	(486.13)	(486.11)	(467.38)
Gender of respondent (1 is female)					6,272.09	4,826.13	
					(4,843.84)	(5,752.16)	
Gender of child (1 is female)					9,115.47**	5,074.44	
					(4,420.42)	(5,337.53)	
Observations	847	847	847	677	677	677	677

Note: *p<0.1; **p<0.05; ***p<0.01
For respondents who walk

5.2 Savings from school closures based on expenditure data

We consider the following specification for educational spending:

$$expend_k = \beta_1 * students_k + \beta_2 * schools_k + \beta_2 * classes_k + \epsilon_k \tag{2}$$

Here $students_k$ is the total number of students in the municipality, $schools_k$ is the total number of schools, and $classes_k$ is total number of classes. For our RHS variable $expend_k$, we will consider different specifications that use total expenditure, capital expenditure, and current expenditure.

We first consider only the 2019 cross-section of municipal expenditure data. Results for a regression based on Equation 2 are shown in Table 6. Column I shows results for expenditures on elementary schools, while Column II shows expenditures on junior high schools. This table shows only municipal expenditures, and thus does not include expenditures on teachers, which are paid for by prefectures.

Table 6 shows that municipal spending on education appears to depend mainly on the total number of schools and total number of classes. In Column I we see that there is no relationship between number of elementary students and amount of spending on elementary education once we control for number of classes and number of schools. In terms of magnitude, the estimated per school cost of JPY 12,360,000 is roughly three times Japanese GDP per capita (approximately JPY 4,000,000).[7] The estimated per class cost of JPY 6,571,000 is relatively large compared to the per school cost: the official ”standard size” for an elementary school in Japan is between 12 and 18 classes, and these coefficient estimates thus suggest that of the explained portion of municipal spending on elementary education, less than 20% is attributable to the number of schools and over 80% is attributable to the number of classes. This suggests that reduction in the number of classes is likely the major mechanism by which savings are obtained in closing schools, which further suggests that the

[7] During the 2011-2021 period considered by this paper, the USD-JPY exchange rate varied between JPY 76 and JPY 114 to the USD. JPY 100 $\simeq$ \$1 is a useful rule of thumb for most of the period in question.

fiscal externality is likely to be important, as each class is associated with a teacher, paid for by the prefectural rather than municipal government.

Table 6: 2019 regression

	DV: Expenditures (in thousands of JPY)	
	Total Expenditure (Elementary) OLS	Total Expenditure (JHS) OLS
	(1)	(2)
Number of students	−16.44	190.31***
	(26.18)	(12.01)
Number of schools	12,360.16***	50,004.70***
	(4,427.17)	(4,235.91)
Number of classes per student	6,570.98***	3,514.77*
	(856.31)	(1,878.18)
Observations	1,644	1,634
R^2	0.91	0.76
Adjusted R^2	0.91	0.76
Note:		*p<0.1; **p<0.05; ***p<0.01

Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

The lack of importance of the number of students is a plausible result given that adding a marginal student to a class does not increase the amount of floor space in use, and thus should not increase operational costs for the school building by a substantial amount. The most obvious additional expenditure associated with adding another student to an existing class is the marginal cost of an additional school lunch. A portion of this cost is usually borne by the student (about JPY 44,000 per year), and given the standard error on the student coefficent plausible values for the remaining portion of the cost are small enough that they could not be detected by the regression run.

Column II of Table 6 shows results for expenditures on junior high schools. Here the number of classes appears to be less important. This may be because any operating junior high school requires substantial facilities (e.g. science labs) that are independent of the number of classes at the school.

Cross-sectional OLS regressions of expenditure data are often not accurate representations of actual efficiencies of scale in the provision of public goods. For example, if richer municipalities choose to spend more on education per capita and separately also choose to have smaller schools, then it may appear that small schools are associated with additional spending, but this cross-sectional correlation is not causal. We thus consider a panel data specification, where we can account for municipality and time fixed effects. For this, our main specification becomes

$$\frac{expend_{kt}}{students_{kt}} = \beta_1 * \frac{schools_{kt}}{students_{kt}} + \beta_2 * \frac{classes_{kt}}{students_{kt}} + \beta_3 * \frac{opened_{kt}}{students_{kt}} + \beta_4 * \frac{closed_{kt}}{students_{kt}} + \alpha_k^{muni} + \alpha_t^{time} + \epsilon_{kt} \tag{3}$$

Here the additional variable $opened_{kt}$ is total number of schools opened in municipality k at time t, and likewise $closed_{kt}$ is total number of schools closed in k at time t. We use a per student specification for expenditures here because there is substantial heteroskedasticity in the ϵ_{kt} error term: using per student costs rather than total costs substantially reduces this heteroskedasticity. The interpretation of the coefficients in unchanged in this "per student" specification: β_1 still represents the cost to a municipality of operating one additional school, and so forth.

Table 7 shows the regression results for this panel data specification for elementary schools using data from 2011 to 2019. For comparison purposes, Column I of the table shows a pooled OLS specification with no fixed effects. We see that the pooled OLS specification (and the cross-sectional specification in Table 6) are not statistically significantly different from the estimates with fixed effects reported in Column II. In Columns III and IV we examine whether closing or opening schools in a given year is associated with greater expenditures. We find that closing schools appears to be expensive: closing a school is associated with expenditures roughly equivalent to the annual cost of running a "standard" elementary school with 12 classes. Most of these closure costs are capital expenditures: current expenditure costs associated with closing a school are much lower than total costs, as seen by comparing Columns III and IV.

Table 7: School enrollment/expenditure panel data (2011-2019)

	DV: Expenditures (in thousands of JPY)			
	Total Expenditure		Current Expenditure	Total Expenditure
	(1)	(2)	(3)	(4)
Number of schools	10,702.14***	12,457.22***	14,061.29***	12,707.14***
	(925.54)	(1,196.28)	(214.19)	(1,170.72)
Number of classes	7,090.21***	7,590.49***	361.47***	8,299.39***
	(338.43)	(714.80)	(128.10)	(700.21)
Number of opened schools			−4,639.08	40,967.35*
			(4,011.13)	(21,924.47)
Number of closed schools			9,401.62***	111,470.20***
			(1,308.95)	(7,154.58)
Constant	33.31**			
	(16.97)			
Fixed Eff. (muni and year)	No	Yes	Yes	Yes
Observations	13,981	13,981	13,981	13,981
R^2	0.20	0.05	0.39	0.09
Note:				*p<0.1; **p<0.05; ***p<0.01
				Expenditure includes only elementary expenditure

Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

Table 8: School enrollment/expenditure panel data (2011-2019)

	DV: Expenditures (in thousands of JPY)				
	Capital expenditure	Capital Land expenditure	Capital Equip expenditure	Capital Building expenditure	Capital Book expenditure
	(1)	(2)	(3)	(4)	(5)
Number of schools	−701.67	−9.38	1,759.58***	−3,076.61***	623.47***
	(1,100.53)	(34.41)	(58.93)	(1,087.44)	(34.66)
Number of classes	7,661.19***	23.37	−259.21***	7,962.28***	−63.87***
	(658.22)	(20.58)	(35.25)	(650.42)	(20.73)
Number of opened schools	54,288.99***	−656.02	−1,442.15	56,271.02***	116.23
	(20,609.98)	(644.38)	(1,103.59)	(20,364.64)	(649.04)
Number of closed schools	98,892.11***	56.53	3,523.30***	95,284.44***	29.05
	(6,725.63)	(210.28)	(360.13)	(6,645.57)	(211.80)
Fixed Eff. (muni and year)	Yes	Yes	Yes	Yes	Yes
Observations	13,981	13,981	13,980	13,980	13,980
R^2	0.05	0.0003	0.09	0.05	0.04

Note: *p<0.1; **p<0.05; ***p<0.01
Expenditure includes only Elementary schools

Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

Table 8 provides a further breakdown of capital expenditures. Comparing Column IV and Column I, we see that effectively all capital expenditures are "building" expenditures. Anecdotal evidence suggests that municipalities rarely sell or purchase land when merging schools. The negative coefficient on number of schools in Column IV may indicate that, in the years when a municipality had relatively more schools operating, the municipality decided not to fix maintenance problems as they arose: with schools underenrolled, broken fixtures could simply be left out of service (with students using the remaining working ones) rather than repaired.

Tables 7 and 8 examine only municipal expenditures. Teacher's salaries, however, are a major cost of providing education. We now consider how the number of teachers deployed in a municipality depends on enrollment in that municipality. Our specification here is the same as that of Equation 3. Specifically,

$$\frac{teachers_{kt}}{students_{kt}} = \beta_0 + \beta_1 * \frac{schools_{kt}}{students_{kt}} + \beta_2 * \frac{classes_{kt}}{students_{kt}} + \beta_3 * \frac{opened_{kt}}{students_{kt}} + \beta_4 * \frac{closed_{kt}}{students_{kt}} + \alpha_k^{muni} + \alpha_t^{time} + \epsilon_{kt}, \tag{4}$$

where $teachers_{kt}$ is the total number of teachers working in municipality k during year t.

Table 9 shows results of this regression for elementary schools. We see that the coefficient on number of classes is somewhat greater than 1 in Column I (pooled cross-section), and somewhat less than 1 in Column II (panel specification with municipality and year fixed effects). In general we would expect there to be exactly 1 teacher assigned to each class in an elementary school. The coefficient in Column I might exceed 1 because some extra administrative positions are added to schools as the number of classes at the school increases. Conversely, the coefficient in Column II might be less than 1 because if enrollment is not perfectly predicted by the municipality in advance, then the number of teachers initially requested may be different than the final reported number of classes, and changes in number of teachers may sometimes not occur in exactly the same year as changes in the number of classes. Regression results for the coefficient on classes in Table 9, however, are broadly

Table 9: School enrollment/teachers panel data (2011-2019)

	DV: Teachers		
	Teachers		
	(1)	(2)	(3)
Number of schools	1.78***	2.02***	2.02***
	(0.02)	(0.02)	(0.02)
Number of classes	1.21***	0.78***	0.78***
	(0.01)	(0.01)	(0.01)
Number of opened schools			−0.12
			(0.28)
Number of closed schools			−0.16*
			(0.09)
Constant	0.01***		
	(0.0003)		
Fixed Effects (municipality and year)	No	Yes	Yes
Observations	13,981	13,981	13,981
R^2	0.95	0.85	0.85
Note:	*p<0.1; **p<0.05; ***p<0.01		
	Elementary schools		

consistent with 1 teacher being assigned to each class.

The coefficient on number of schools in Table 9 is somewhat less than 2 in Column I and statistically indistinguishable from 2 in Column II. This is consistent with each school being assigned two administrators that do not teach a class: in general, this would be the principal and the head of education. Because Equation 4is in per student terms, the constant in Column I corresponds to the effect of the number of students on the number of teachers. The coefficient here is very small: adding 100 additional students to a school would only result in one additional teacher being assigned to the school. The simplest model of teacher assignment to schools would suggest that this coefficient should have been zero; however, if larger schools have more administrators that do not teach classes, or if there is measurement error in the number of classes reported (and total school enrollment is more accurate), then this could explain why we see a positive sign on the coefficient on number of students here.

Column III of Table 9 shows that at the municipal level there appears to be no delay in adjusting to a school merger: there is no separate effect of opening a new school or closing an existing school on the total number of teachers employed by a municipality, beyond the direct effect through the change in the total number of schools. We thus conclude that all adjustment costs for school closures are borne by the municipalities: these costs were mainly capital costs due to "building" expenses, and showed up mainly in Column IV of Table 8.

Comparing the results in Tables 6 to 8 versus Table 9 suggests a particular mechanism where the closure of schools could be delayed by inefficient decision-making. When a school is closed, prefectures enjoy an immediate budgetary benefit corresponding to the two administrators that were previously running the now-closed school, plus a number of classroom teachers corresponding to the number of classes under the 40 student cap that can be combined after the merger. The municipality, however, which is actually responsible for closing schools, bears a substantial adjustment cost as the post-merger school building must be renovated. These adjustment costs may result in the municipality avoiding mergers that might have been beneficial if the prefectural budget savings were internalized.

Tables 10 to 12 report similar regressions for municipal expenditures on junior high schools and number of teachers assigned to junior high schools. Pooled cross-section results in Column I of Table 10 are similar to the regression results for elementary schools. In Column II, however, the coefficient estimates with panel fixed effects show an unexpected negative coefficient on the number of classes and a much larger positive coefficient on the number of schools. Looking at Column III we see that this negative coefficient is not being driven by current expenditure, and is thus due to capital expenditures. Table 11 shows that this appears to be building expenditures. One possibility is that reductions in number of classes are generally accompanied by renovations in the new classrooms, and thus there

Table 10: School enrollment/teachers panel data (2011-2019)

	DV: Expenditures (in thousands of JPY)			
	Total Expenditure		Current Expenditure	Total Expenditure
	(1)	(2)	(3)	(4)
Number of schools	8,625.80***	24,318.34***	13,570.34***	30,058.10***
	(1,883.58)	(3,165.53)	(2,387.86)	(3,137.32)
Number of classes	6,783.33***	−5,758.15***	122.06	−7,013.59***
	(794.31)	(1,306.15)	(981.97)	(1,290.17)
Number of opened schools			−4,822.50	1,454.14
			(14,667.51)	(19,271.12)
Number of closed schools			−693.38	126,979.00***
			(7,046.34)	(9,257.94)
Constant	263.04***			
	(29.18)			
Fixed Eff. (muni and year)	No	Yes	Yes	Yes
Observations	13,866	13,866	13,866	13,866
R^2	0.09	0.01	0.01	0.03

Note: *p<0.1; **p<0.05; ***p<0.01
Expenditure includes only junior high school expenditure

Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

is actually new expenditure at the municipal level when classes are reorganized. As with elementary school expenditure, we see substantial additional capital spending when schools are closed.

Table 11: School enrollment/teachers panel data (2011-2019)

	DV: Expenditures per student (in thousands of JPY)				
	Capital expenditure	Capital land expenditure	Capital equip. expenditure	Capital build. expenditure	Capital books expenditure
	(1)	(2)	(3)	(4)	(5)
Number of schools	17,600.19***	123.41	971.91***	16,360.27***	144.65***
	(2,021.81)	(133.26)	(149.22)	(1,983.10)	(26.12)
Number of classes	−8,112.01***	−31.47	6.09	−8,093.81***	7.14
	(831.43)	(54.80)	(61.36)	(815.52)	(10.74)
Number of opened schools	9,308.88	507.01	2,501.29***	6,328.18	−33.13
	(12,419.03)	(818.57)	(916.61)	(12,181.41)	(160.46)
Number of closed schools	125,372.20***	743.25*	2,632.67***	121,887.90***	112.37
	(5,966.16)	(393.25)	(440.35)	(5,852.11)	(77.09)
Fixed Effects (municipality and year)	Yes	Yes	Yes	Yes	Yes
Observations	13,866	13,866	13,865	13,865	13,865
R^2	0.07	0.001	0.02	0.07	0.01

Note: *p<0.1; **p<0.05; ***p<0.01
Expenditure includes only junior high school expenditure

Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

Table 12 shows regression results for the number of teachers deployed in junior high schools in each municipality. Here results are broadly similar to elementary schools, although the coefficients are somewhat larger in general. Panel data results with fixed effects (Columns II and III) suggest that each junior high school requires about 4 administrators or other non-classroom teachers to run, and each class requires 1.4 teachers. This latter number is greater than 1, which (unlike in the elementary case) is to be expected: specialist teachers such as math and science are required at the junior high school level, and thus there is more than one teacher responsible for each class.

We now consider an event study specification for examining school closures. We will consider elementary and junior high schools separately. In addition, we will consider separately the case where there was exactly one school closure in a municipality, versus municipalities where there were multiple school closures. Where the number of observations permits, we will also consider separately cases where a municipality had multiple school closures but only in one single year. Our specification follows Sandler and Sandler (2014). Specifically,

$$y_{kt} = \sum_{d=-D, d\neq -1}^{D} 1(t - e^k = d)\beta_d + \alpha_t + \gamma_k + \epsilon_{kt} \tag{5}$$

$$y_{kt} = \sum_{r}^{R_k} \sum_{d=-D}^{D} 1(t - e_r^k = d)\beta_d + \alpha_t + \gamma_k + \epsilon_{kt} \tag{6}$$

d_t is a dummy variable that takes the size of the event (number of schools closed) and indicates the distance from the event (therefore d_0 is the period where the event happened)

We present results from this event study specification in graphical form. We begin by restricting attention to elementary schools, and use as our observations only municipalities that closed exactly one elementary school in the 2011-2019 period. Figure 8 shows the estimates for the β_d parameters for this sample. By construction, β_{-1} is fixed to 0 rather than estimated, and thus the coefficient estimate for β_0 provides the event study estimate of the effect of closing exactly one elementary school. We see that the associated decrease in

Table 12: School enrollment/teachers panel data (2011-2019)

	DV: Teachers		
	Teachers		
	(1)	(2)	(3)
Number of schools	1.72***	3.88***	3.91***
	(0.04)	(0.04)	(0.04)
Number of classes	2.41***	1.45***	1.44***
	(0.02)	(0.02)	(0.02)
Number of opened schools			0.89***
			(0.25)
Number of closed schools			0.18
			(0.12)
Constant	−0.01***		
	(0.001)		
Fixed Effects (municipality and year)	No	Yes	Yes
Observations	13,866	13,866	13,866
R^2	0.94	0.88	0.88
Note:	*p<0.1; **p<0.05; ***p<0.01		
	Junior High Schools		

Source: Own elaboration based on School Basic Survey
Carried out by the Ministry of Education, Culture , Sports , Science and Technology

the number of teachers is 4; however, there does not appear to be any effect on expenditures.

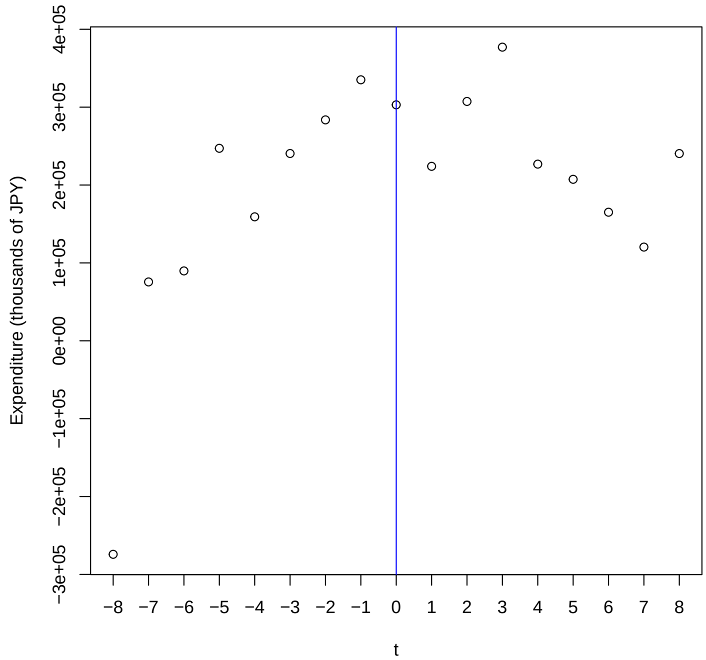
Figure 9 shows estimates using only municipalities where there were two or more school closures but all these closures happened in a single year. Again we see an obvious and sharp decrease in the number of teachers, but no obvious decrease in expenditures (the decrease from t=0 to t=1 is one year than would be expected, and is not large relative to the noise in the parameter estimates). Finally, we consider municipalities where multiple elementary schools were closed in multiple different years (Figure 10). Here there is the same sharp decrease for teachers, and for expenditures we see a sharp single-year *increase* in spending.

In broad terms, these event study results agree with the panel data regression results: a school closure clearly decreases the number of teachers used in following years, but there is substantial additional municipal spending associated with the closure, and thus municipal expenditures may not decrease in the same way. For the number of teachers, the coefficient shown in Figure 8 for a single school closure is broadly in line with panel data regression results in Table 9 as a school closure is likely associated with reductions of several classes. For municipalities with multiple school closures the coefficient estimates in the event study are not quite as high as would have been expected given the panel data regression results.

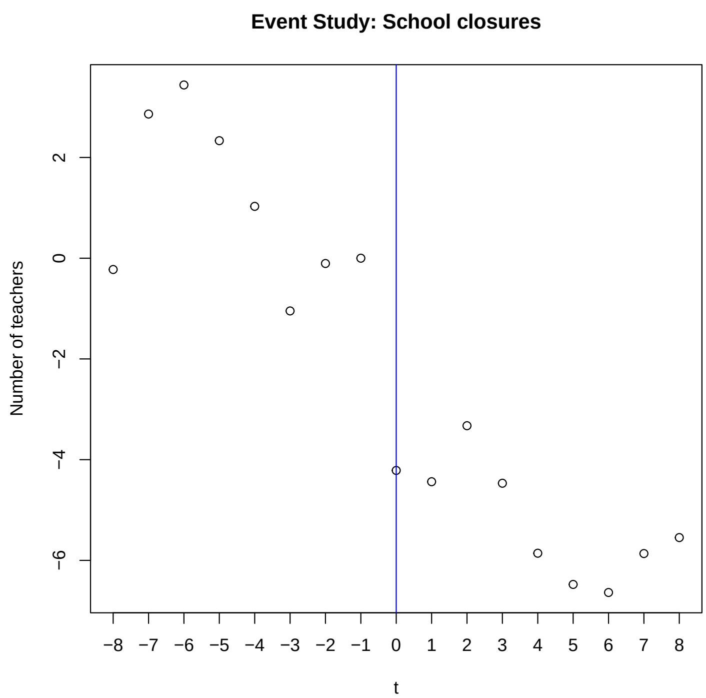
Results for event studies using junior high schools are broadly similar. Figures 11 to 13 show that there are sharp declines in the number of teachers deployed to a municipality when a school is closed, but no particular change in expenditures.

5.3 Actual school consolidations

For our final analysis, we estimate revealed preference parameters based on the model in Section 3 for municipal decision-makers using a set of actual school closure decisions. Currently we use data on schools that were closed at the end of the academic year in March 2017; however, our results are substantively unchanged if we use 2018 data instead. For this

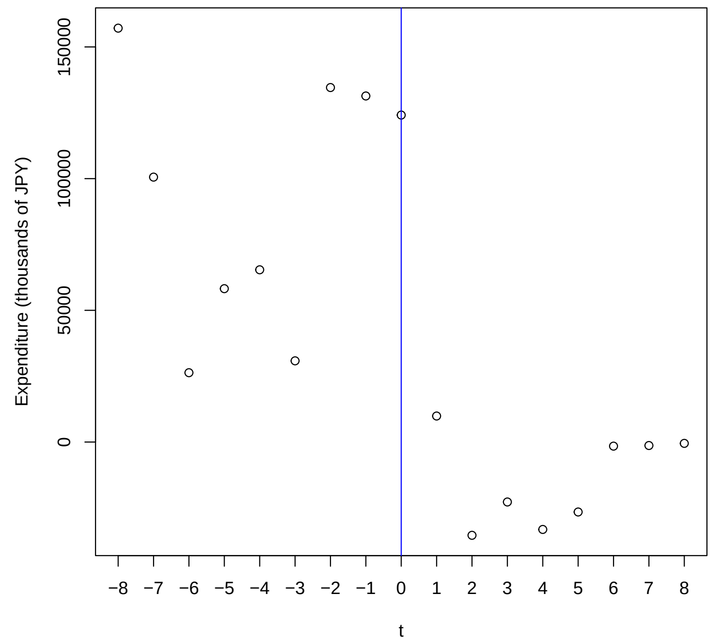


(a) Expenditures

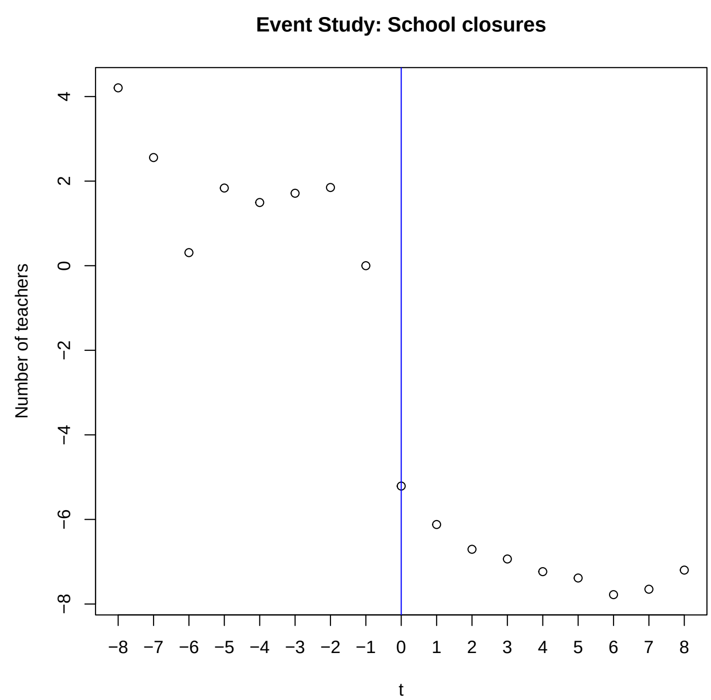


(b) Teachers

Figure 8: Event study: Elementary districts with exactly one school closure in one year
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

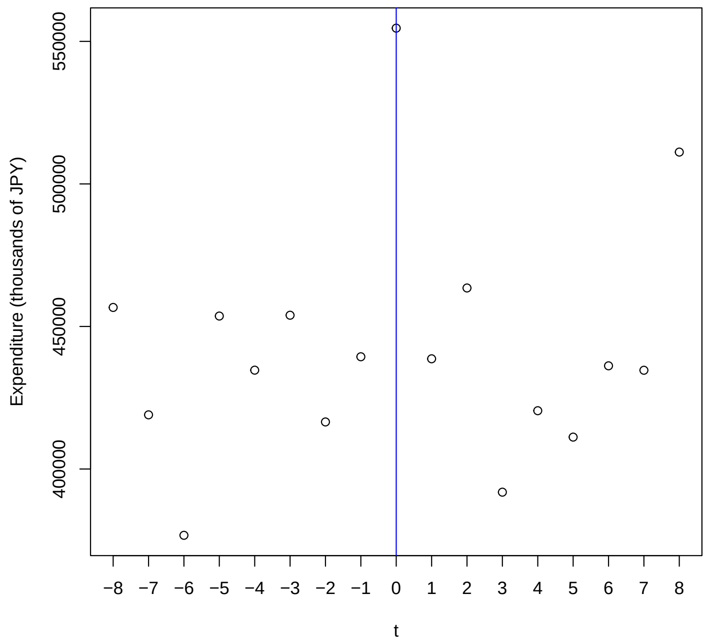


(a) Expenditures

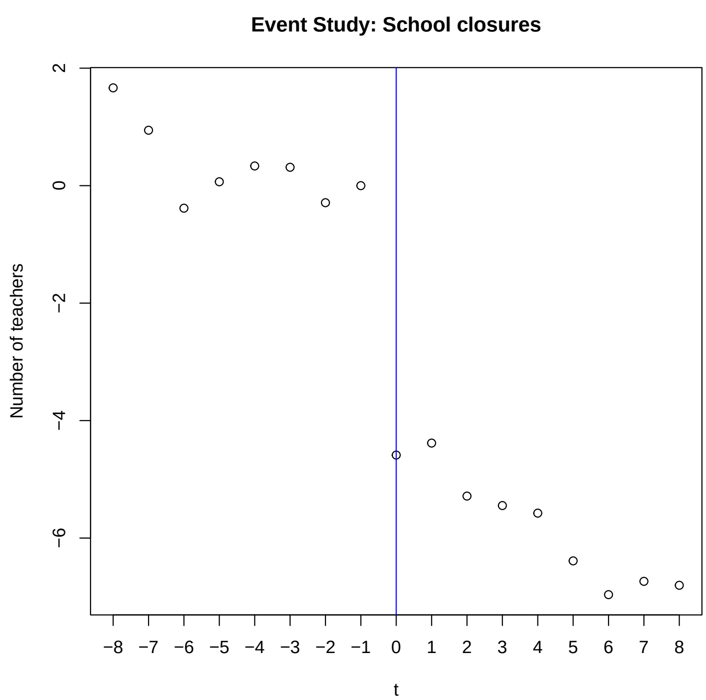


(b) Teachers

Figure 9: Event study: Elementary districts with two or more school closures in one year
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology



(a) Expenditures



(b) Teachers

Figure 10: Event study: Elementary districts with school closures in multiple years
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

data, our analysis is conducted using a logit specification:

$$closed_j = \beta_1 additionaldistance_j + \beta_2 savings_j + X_j\Gamma + \varepsilon_j. \quad (7)$$

Here $additionaldistance_j$ is the additional distance that students currently attending school j would have to travel in order to attend the closest school to school j (assumed to be the merger partner after j is closed).[8] $savings_j$ is the estimated savings from closing school j, based on our regression results in Column II of Table 8.[9] Results are shown in Table 13.

Examining the coefficients in Table 13, we see that the coefficient on additional distance is -0.12. This coefficient is interpretable via comparison with the coefficient on savings, which will allow us to express the value that municipal decision makers appear to place on additional travel distance in money terms. We see that the coefficient on savings is 0.45, indicating that savings of one million JPY is equivalent to an increase in additional distance of $0.45/0.12 = 3.75$ km. This indicates that the value of 1km additional distance travelled expressed in money terms would be about JPY 267,000.

This result is surprising because it is an order of magnitude higher than the response given by respondents to our survey. According to Column II of Table 4, respondents would be willing to accept 1km of additional distance on average for a monthly payment of $2.35 * 1000 = 2350$ JPY. Changed to annual terms this is only 11% of the revealed preference estimate we have just obtained based on actually observed mergers.

It thus appears that municipalities are reluctant to consolidate schools when it would result in sending students any appreciable distance to a new school. It is unclear, however, why this is the case. One possibility may be that local parents can lobby the municipal government not to close a school. If so, these parents would act as a lobby group, and their

[8] In our current specification we cap this distance at 2km.

[9] Specifically, we use the coefficient on the number of schools in Table 8, and then add to this the coefficient on the number of classes, multiplied by the number of classes on average should be closed by consolidating a school of this size. To obtain this latter number we conduct a simulation using all schools in the same decile of size, considering a merger with the closest adjacent school, and computing how many classes could be eliminated given the maximum class size constraints.

effectiveness would likely depend on their relative size. Specifically, if the school is too small, the lobby group would not be able to have any influence; however, on the other hand, if there is only one school in town, then the lobby group would consist of all parents in town and it would effectively cease to be a special interest group.

In Column III we show that a phenomenon such as this appears to be occurring: the schools that are the least likely to be closed are those that are of an intermediate size: large enough to have a special interest lobby but not so large to be providing education for the entire municipality. Unfortunately, it is currently difficult to be sure of what exact mechanism is at work for this effect: further research may be needed in this area.

It is also difficult to calculate exactly the optimal pattern of school closures because there is a dynamic aspect to the closure decision: keeping a school open at time t preserves an option to consolidate the school in a different (and potentially less expensive) consolidation pattern at time t-1, whereas closing the school at time t involves some adjustment costs that cannot be recovered later even if additional schools are closed. For example, consider a municipality with four elementary schools. In the presence of adjustment costs, it may be more efficient to wait and close three schools at once, rather than merging pairs of schools initially and then at a later date merging the remaining two schools.

Notwithstanding the fact that it is difficult to calculate the optimal partition, we can see that approximately 20% of elementary schools appear as though they should be merged with neighbouring schools. About half of this is explicable via the fiscal externality that we discuss in this paper. For the smallest 10% of elementary schools, the municipalities in question should want to merge the schools even in the presence of this externality. For these schools, there thus needs to be an additional reason that they remain open, such as lobbying by parents or other internal local political considerations.

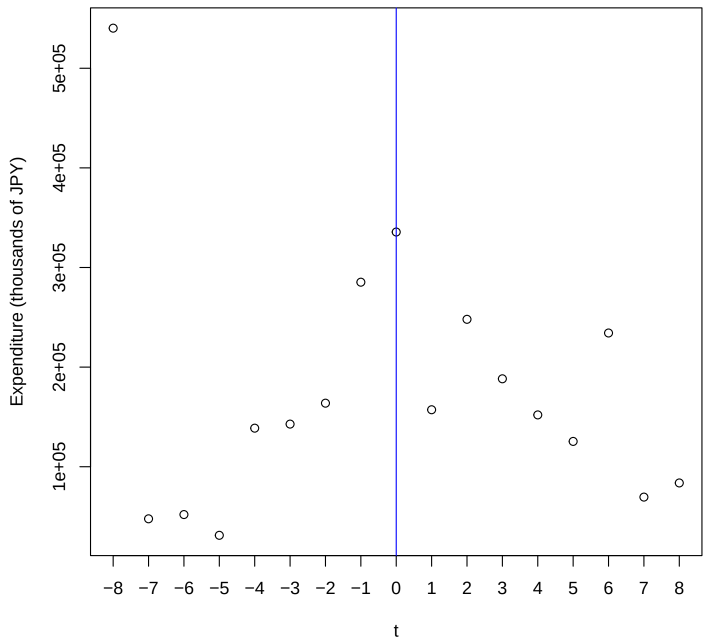
Table 13: Dependent variable is school closure

	DV: Closed schools (1 if closed)		
	Closed schools		
	(1)	(2)	(3)
Additional distance (if current school closed)	-0.12^{**}	-0.12^{**}	-0.14^{**}
	(0.06)	(0.06)	(0.06)
Savings (millions of JPY)	0.45^{***}	0.45^{***}	0.29^{***}
	(0.05)	(0.05)	(0.04)
Financial stress index (by municipality)	-1.84^{***}	-1.10^{**}	-2.05^{***}
	(0.40)	(0.46)	(0.54)
Total student population (in thousands of students by municipality)		-0.02^{***}	-0.05^{***}
		(0.01)	(0.01)
School population (as a % of municipality students population)			-22.83^{***}
			(2.86)
School population squared (as a % of municipality students population)			21.28^{***}
			(2.85)
Municipalities fixed effects			
Observations	19,342	19,342	19,342
Log Likelihood	−926.11	−921.56	−862.86
Akaike Inf. Crit.	1,952.21	1,945.11	1,831.72
Note:			*p<0.1; **p<0.05; ***p<0.01

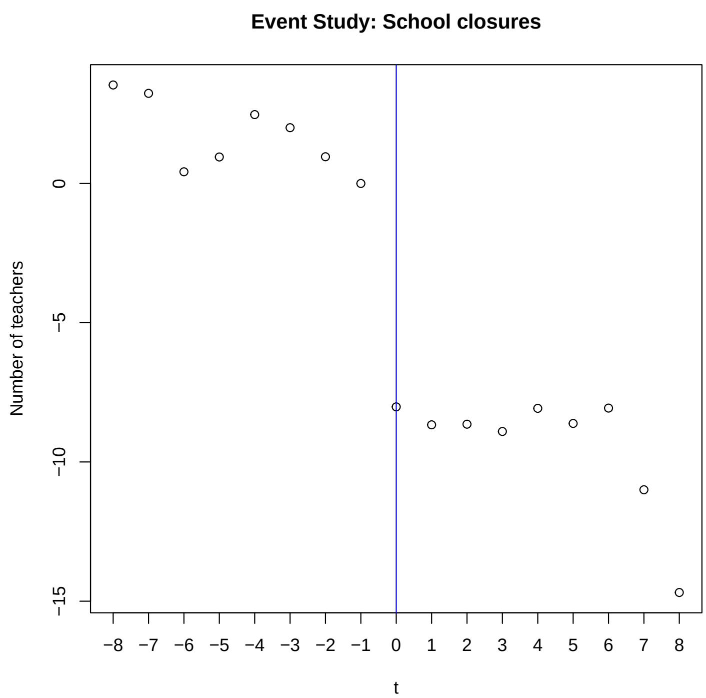
Source: Own elaboration based on School Basic Survey
Carried out by the Ministry of Education, Culture , Sports , Science and Technology

6 Conclusion

We have presented a very simple theoretical framework that illustrates how local decisions may be made inefficiently because of a fiscal externality. We also suspect that there may be a problem with lobbying. We find that the fiscal externality is very large: much of the savings is due to class reductions, and about half the savings here is at the prefectural level rather than the municipal level. Furthermore, we find circumstantial evidence of substantial local lobbying: schools far away from neighbouring schools are unlikely to be closed compared to what would be expected based on stated preference survey data.

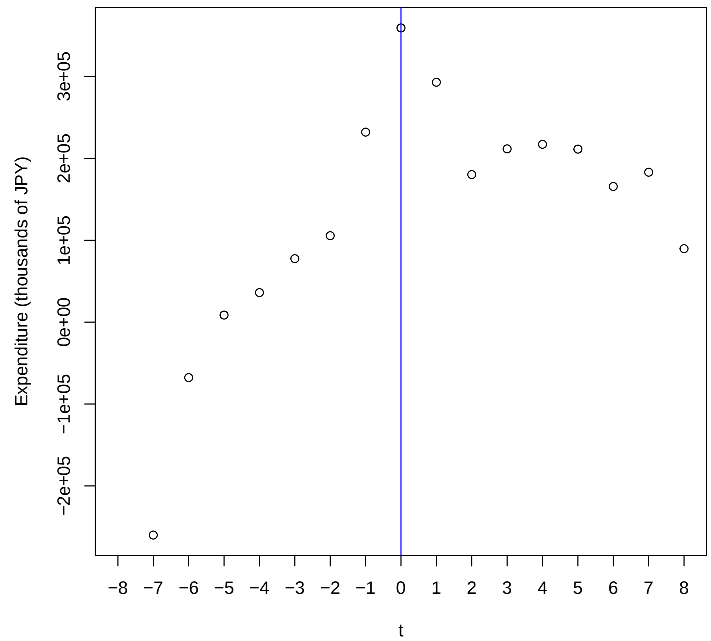


(a) Expenditures

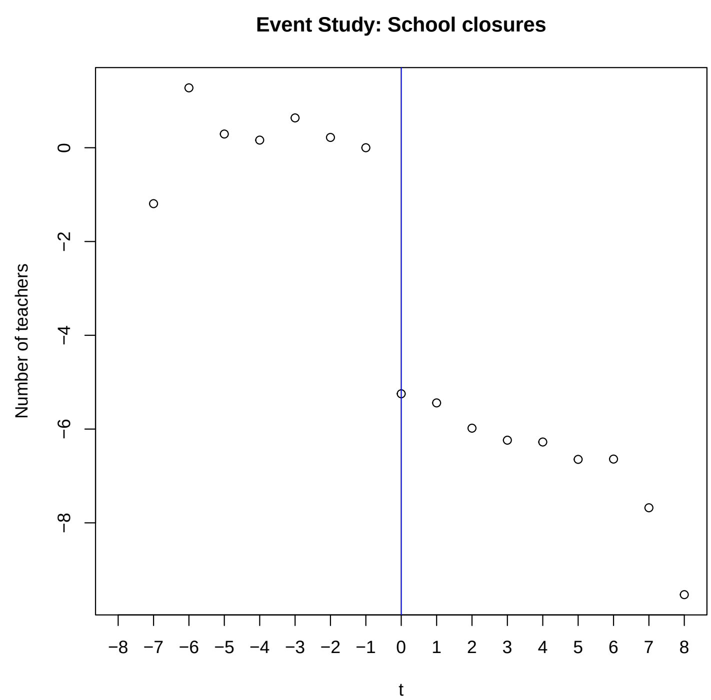


(b) Teachers

Figure 11: Event study: JHS districts with exactly one school closure in one year
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

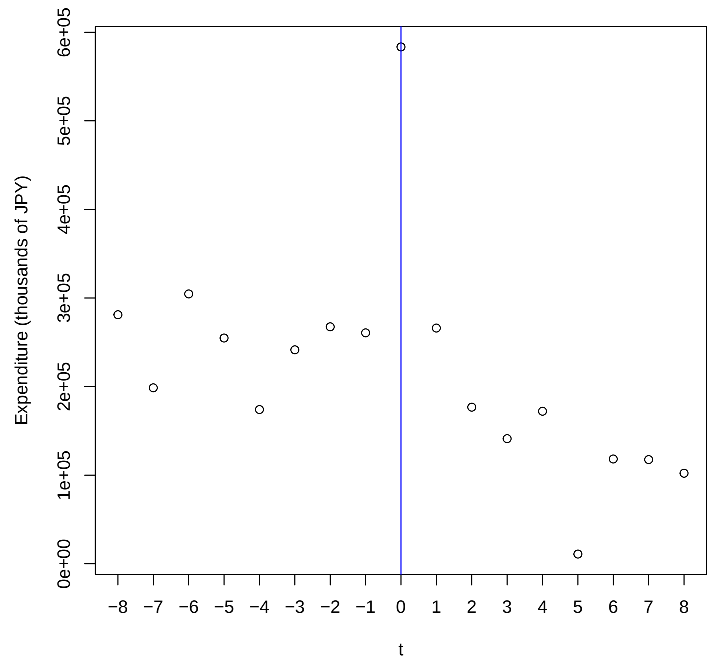


(a) Expenditures

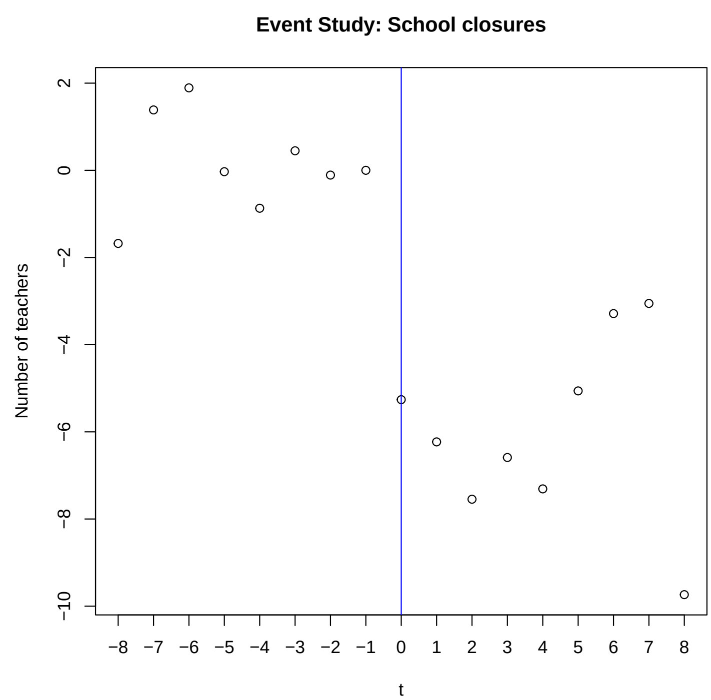


(b) Teachers

Figure 12: Event study: JHS districts with two or more school closures in one year
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology



(a) Expenditures



(b) Teachers

Figure 13: Event study: JHS districts with two or more school closures in one year
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

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A Figures and Tables

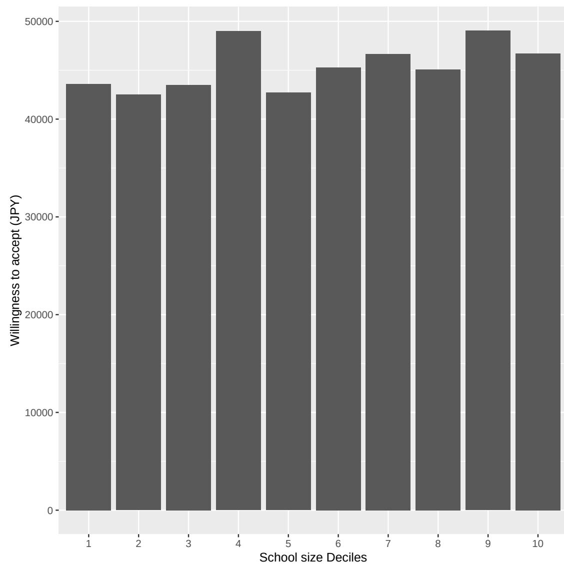

Figure 14: Willingness to accept (Elementary)

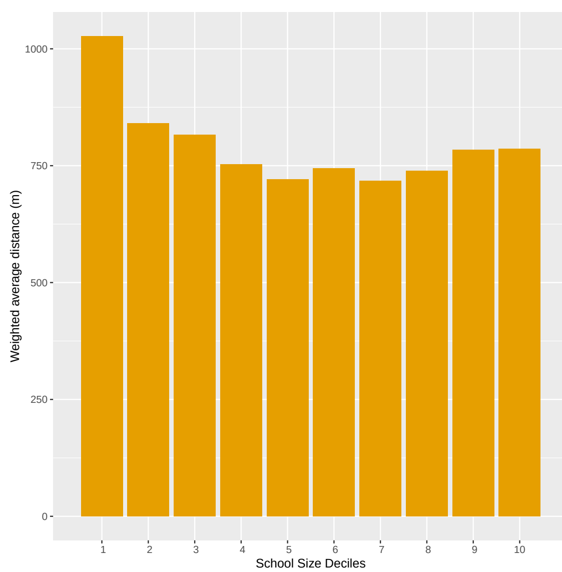

Figure 15: Distance to school (Elementary, walks to school)

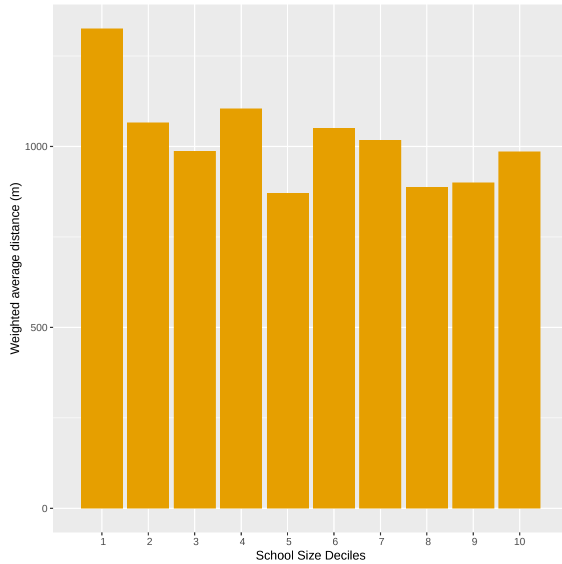

Figure 16: Distance to school (Junior, walks to school)

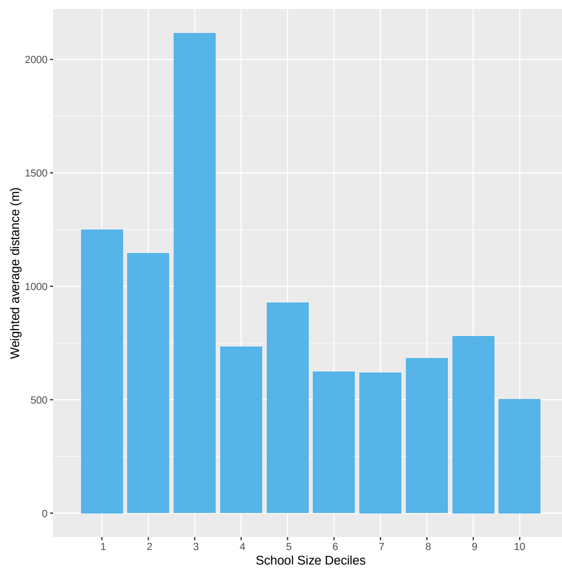

Figure 17: Distance to school (Elementary, bikes to school)

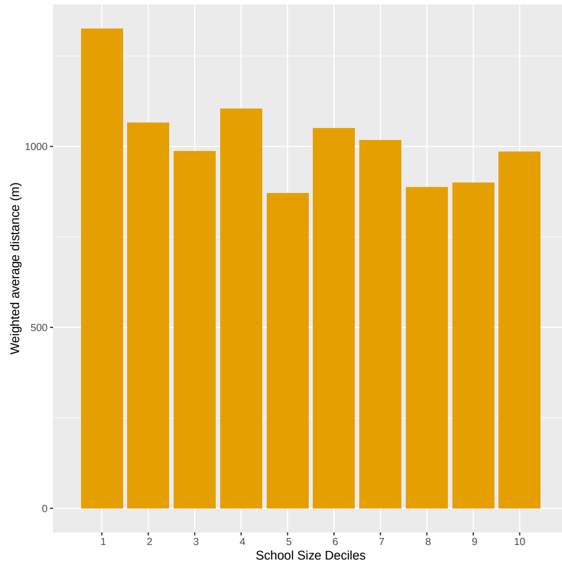

Figure 18: Distance to school (Junior, bikes to school)

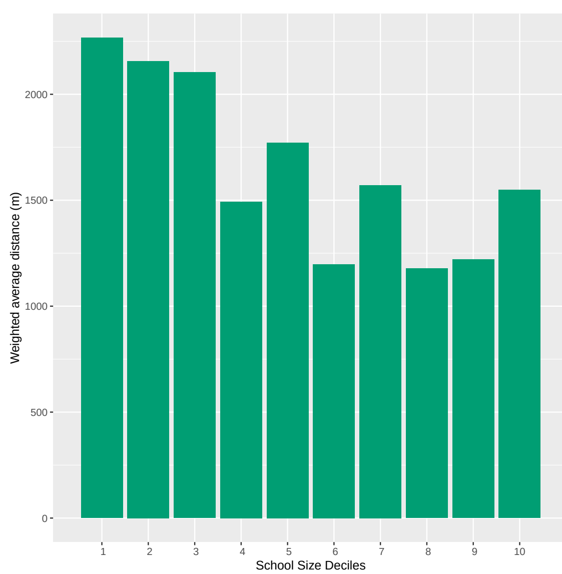

Figure 19: Distance to school (Elementary, uses public transit etc.)

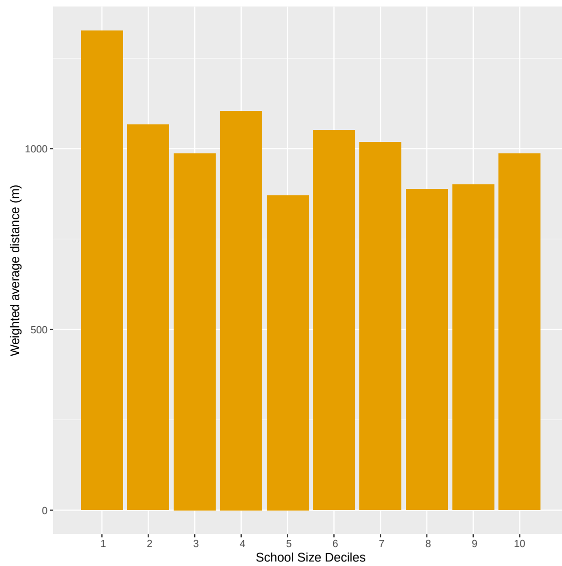

Figure 20: Distance to school (Junior, uses public transit etc.)

B Appendix

B.1 Appendix: Building the distances

This appendix describes the method used to construct the necessary variables to run our model. The process needs several databases, the main data is the survey we conducted.

We updated the survey using a postal codes database which has the geographical information for every postal code in Japan in order to estimate:

- Straight-line distance to school attended
- Straight-line distance to closest school to school attended (potential post-merger school)
- Increase in distance due to merger (difference of above values)

We can see our survey map in figure 21.

In order to calculate the walking distances to schools we need to know the population distribution, since survey respondents provided their location at postal code level, we will aggregate up census grid square statistics to calculate the total population in each postal code. As the grids areas are small compared to the postal codes areas the result will show

Figure 21: Survey postal codes

different intersections ($m-th$ intersections for every postal code c). For example, if one observation has an intersection with 8 grids, then the result will show 8 different intersections.

We proceed to estimate the population for the intersection m between the postal code c and grid g:

$$p_m(c) = p_g \cdot \frac{a_{gc}}{a_g} \tag{8}$$

$p_m(c)$ is the estimated population

p_g is the population of the grid square g

a_g is the total area of grid square g be

a_{gc} is the area of grid square g that intersects with postal code c

We can obtain the estimated population for a postal code by aggregating the estimated population $\hat{p}_m(c)$ for every intersection inside the same postal code c

$$p(c) = \sum_{m \in M(c)} p_m(c) \tag{9}$$

Finally, the weight is:

$$weight_m(c) = \frac{p_m(c)}{p(c)} \tag{10}$$

To obtain an aproximated location of the respondents we calculate the centroids for each intersection as shown in figure 22.

Next, we can proceed to find the distance to the correspondent and closest neighbor school, to do this we use the database containing the schools location (school points) and the school district correspondent to each school. Ideally we would know which school the children of each respondent attend. To increase response rates to our survey, however, instead of asking the name of the school we asked only for the respondent's postal code In general, the postal code uniquely identifies the school that children would attend.

With this information we proceed to calculate and select the distances between every centroid m and the school j (current school and nearby school)

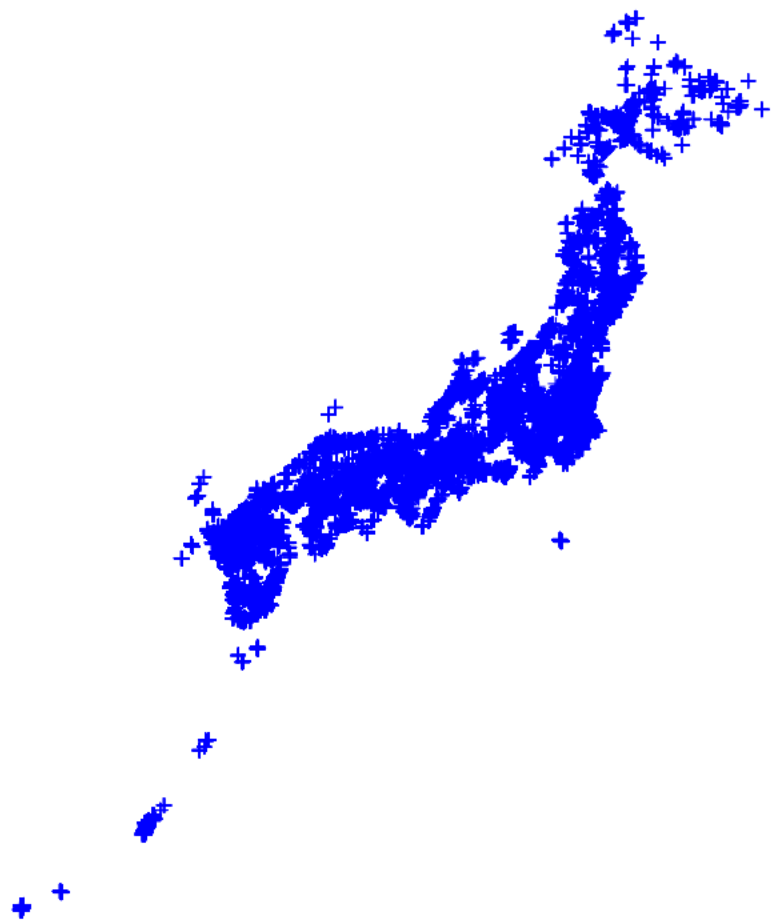

Figure 22: Survey centroids

The final step is to estimate the weighted average distance for each respondent.

$$wad_{ij} = \frac{\sum_{a=1}^{m} dist_{aj} * weight_a}{\sum_{a=1}^{m} weight_a} \tag{11}$$

Where

wad_{ij} is the weighted average distance for respondent i that goes to school j

$weight_m$ is the weight we estimated for the intersection associated with each centroid.

B.2 Appendix: Junior high school expenditure vs students

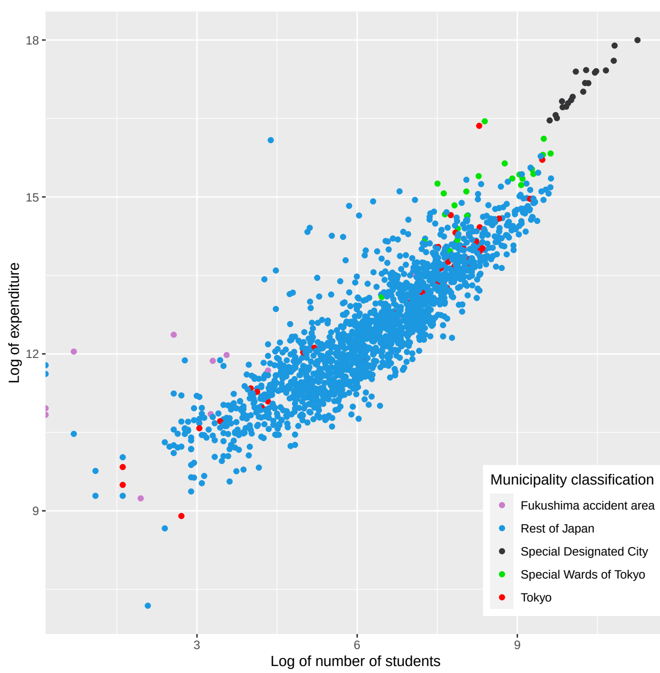

Figure 23: Histogram Class Size (Compound classes)
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

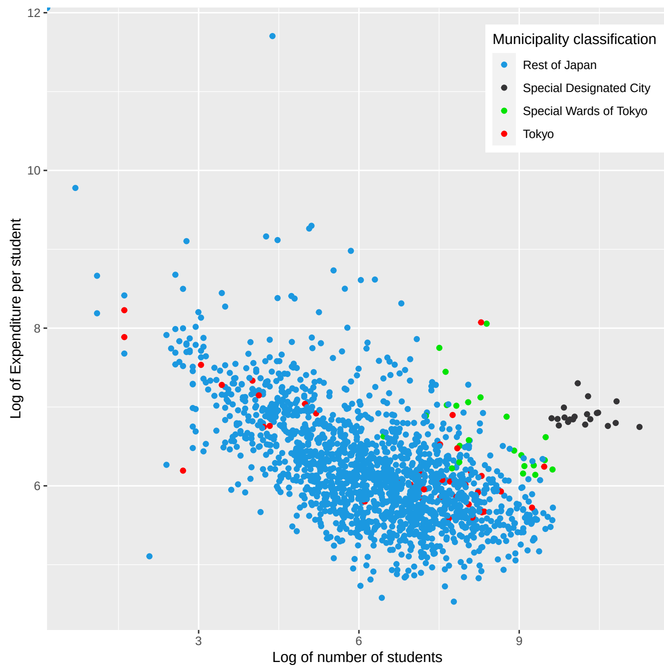

Figure 24: Histogram Class Size (Compound classes)
Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology

Table 14: Logit regression fixed effects

	DV: Closed schools (1 if closed)		
	Closed schools		
	(1)	(2)	(3)
Prefecture_1	-3.56^{***}	-3.69^{***}	-1.78^{***}
	(0.37)	(0.37)	(0.42)
Prefecture_2	-4.21^{***}	-4.42^{***}	-2.57^{***}
	(0.75)	(0.76)	(0.78)
Prefecture_3	-2.62^{***}	-2.85^{***}	-1.14^{**}
	(0.39)	(0.40)	(0.44)
Prefecture_4	-2.64^{***}	-2.84^{***}	-0.92^{*}
	(0.45)	(0.45)	(0.49)
Prefecture_5	-3.33^{***}	-3.53^{***}	-1.78^{***}
	(0.63)	(0.63)	(0.66)
Prefecture_6	-2.80^{***}	-3.06^{***}	-1.10^{**}
	(0.48)	(0.48)	(0.53)
Prefecture_7	-3.02^{***}	-3.31^{***}	-1.35^{***}
	(0.46)	(0.47)	(0.52)
Prefecture_8	-1.74^{***}	-2.16^{***}	-0.04
	(0.39)	(0.42)	(0.48)
Prefecture_9	-2.64^{***}	-3.05^{***}	-1.19^{**}
	(0.54)	(0.56)	(0.60)
Prefecture_10	-19.08	-19.44	-17.24
	(1,006.59)	(1,007.31)	(969.41)
Prefecture_11	-4.27^{***}	-4.65^{***}	-2.31^{***}
	(0.80)	(0.81)	(0.85)
Prefecture_12	-3.90^{***}	-4.25^{***}	-2.05^{***}
	(0.68)	(0.69)	(0.73)
Observations	19,342	19,342	19,342
Log Likelihood	-926.11	-921.56	-862.86
Akaike Inf. Crit.	1,952.21	1,945.11	1,831.72
Note:			*p<0.1; **p<0.05; ***p<0.01

Source: Own elaboration based on School Basic Survey
Carried out by the Ministry of Education, Culture , Sports , Science and Technology

Table 15: Logit regression fixed effects

	DV: Closed schools (1 if closed)		
	Closed schools		
	(1)	(2)	(3)
Prefecture_13	−4.69***	−4.76***	−2.93***
	(0.64)	(0.65)	(0.67)
Prefecture_14	−18.62	−18.26	−15.68
	(606.56)	(562.44)	(523.67)
Prefecture_15	−2.89***	−3.08***	−1.45***
	(0.43)	(0.43)	(0.47)
Prefecture_16	−2.49***	−2.82***	−0.81
	(0.59)	(0.60)	(0.64)
Prefecture_17	−2.53***	−2.82***	−0.79
	(0.53)	(0.54)	(0.59)
Prefecture_18	−19.33	−19.69	−17.62
	(1,270.46)	(1,274.17)	(1,222.77)
Prefecture_19	−3.06***	−3.38***	−1.22*
	(0.65)	(0.66)	(0.70)
Prefecture_20	−4.20***	−4.47***	−2.32***
	(0.77)	(0.77)	(0.81)
Prefecture_21	−19.43	−19.76	−17.68
	(918.79)	(921.61)	(862.48)
Prefecture_22	−3.88***	−4.21***	−1.88**
	(0.81)	(0.81)	(0.86)
Prefecture_23	−4.91***	−5.15***	−2.74**
	(1.08)	(1.09)	(1.13)
Prefecture_24	−3.07***	−3.39***	−1.54***
	(0.54)	(0.55)	(0.59)
Observations	19,342	19,342	19,342
Log Likelihood	−926.11	−921.56	−862.86
Akaike Inf. Crit.	1,952.21	1,945.11	1,831.72
Note:	*p<0.1; **p<0.05; ***p<0.01		

Source: Own elaboration based on School Basic Survey
Carried out by the Ministry of Education, Culture , Sports , Science and Technology

Table 16: Logit regression fixed effects

	DV: Closed schools (1 if closed)		
	Closed schools		
	(1)	(2)	(3)
Prefecture_25	−4.40***	−4.74***	−2.68**
	(1.12)	(1.11)	(1.11)
Prefecture_26	−3.48***	−3.57***	−1.56**
	(0.65)	(0.65)	(0.68)
Prefecture_27	−3.41***	−3.46***	−1.23**
	(0.55)	(0.54)	(0.59)
Prefecture_28	−4.56***	−4.73***	−2.80***
	(0.77)	(0.77)	(0.79)
Prefecture_29	−21.01	−21.15	−17.54
	(1,103.28)	(1,118.15)	(1,177.48)
Prefecture_30	−4.82***	−5.03***	−2.98***
	(0.94)	(0.93)	(0.87)
Prefecture_31	−19.59	−19.82	−17.85
	(1,589.80)	(1,591.28)	(1,512.11)
Prefecture_32	−19.89	−20.08	−18.37
	(1,250.86)	(1,252.44)	(1,205.86)
Prefecture_33	−3.36***	−3.56***	−1.85***
	(0.52)	(0.52)	(0.55)
Prefecture_34	−3.60***	−3.73***	−1.95***
	(0.58)	(0.58)	(0.61)
Prefecture_35	−4.26***	−4.54***	−2.81***
	(0.80)	(0.81)	(0.80)
Prefecture_36	−2.65***	−2.93***	−0.98*
	(0.52)	(0.53)	(0.58)
Observations	19,342	19,342	19,342
Log Likelihood	−926.11	−921.56	−862.86
Akaike Inf. Crit.	1,952.21	1,945.11	1,831.72
Note:	*p<0.1; **p<0.05; ***p<0.01		

Source: Own elaboration based on School Basic Survey
Carried out by the Ministry of Education, Culture , Sports , Science and Technology

Table 17: Logit regression fixed effects

	DV: Closed schools (1 if closed)		
	Closed schools		
	(1)	(2)	(3)
Prefecture_37	−8.79***	−9.19***	−4.19***
	(1.79)	(1.79)	(1.57)
Prefecture_38	−3.93***	−4.15***	−2.32***
	(0.64)	(0.65)	(0.63)
Prefecture_39	−4.26***	−4.45***	−2.52***
	(0.78)	(0.78)	(0.80)
Prefecture_40	−3.26***	−3.39***	−1.26**
	(0.46)	(0.45)	(0.50)
Prefecture_41	−19.67	−19.92	−18.00
	(1,392.27)	(1,395.12)	(1,318.38)
Prefecture_42	−3.27***	−3.43***	−1.89***
	(0.47)	(0.47)	(0.49)
Prefecture_43	−2.18***	−2.35***	−0.30
	(0.36)	(0.36)	(0.41)
Prefecture_44	−4.55***	−4.78***	−2.88***
	(0.92)	(0.93)	(0.81)
Prefecture_45	−19.76	−19.96	−18.05
	(1,147.40)	(1,147.51)	(1,090.63)
Prefecture_46	−3.96***	−4.12***	−2.56***
	(0.46)	(0.46)	(0.48)
Prefecture_47	−37.00	−37.18	−23.77
	(46,087.05)	(46,895.24)	(1,178.41)
Observations	19,342	19,342	19,342
Log Likelihood	−926.11	−921.56	−862.86
Akaike Inf. Crit.	1,952.21	1,945.11	1,831.72
Note:	*p<0.1; **p<0.05; ***p<0.01		

Source: Own elaboration based on School Basic Survey
Carried out by the Ministry of Education, Culture , Sports , Science and Technology

B.3 Appendix: Logit regression municipalities fixed effects

B.4 Appendix: Class size Histograms

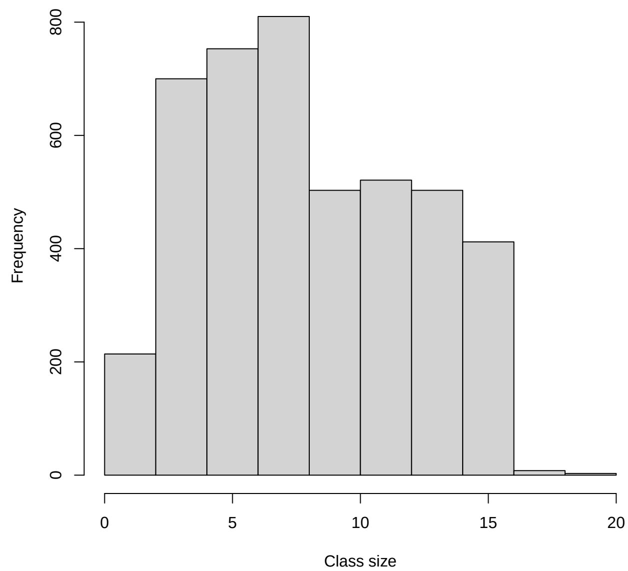

Figure 25: Histogram Class Size (Compound classes)

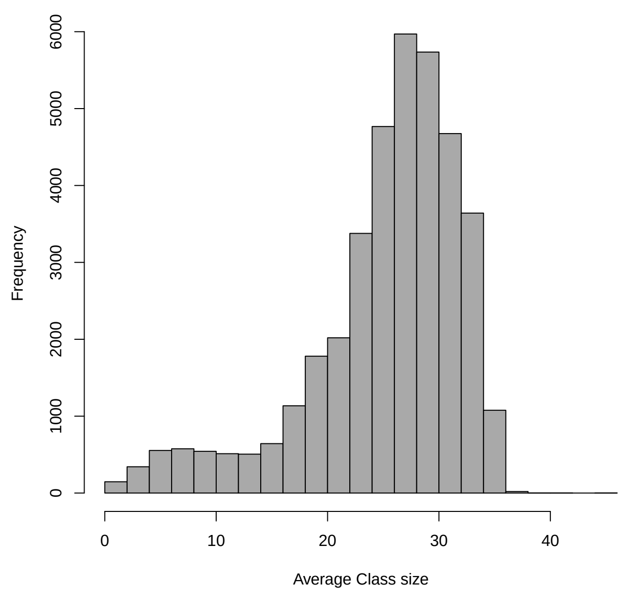

Figure 26: Histogram Class Size (Single classes)

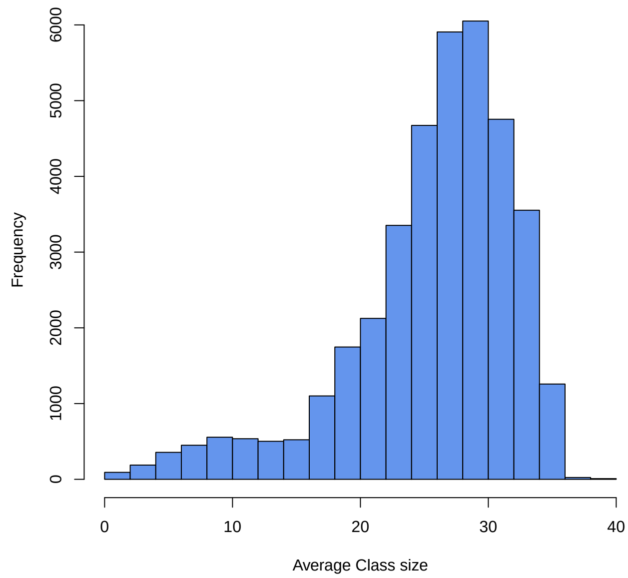

Figure 27: Histogram Class Size (Single classes)

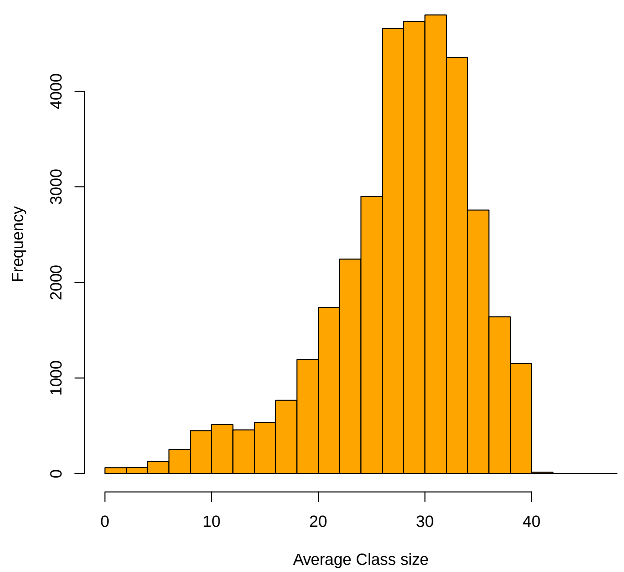

Figure 28: Histogram Class Size (Single classes)

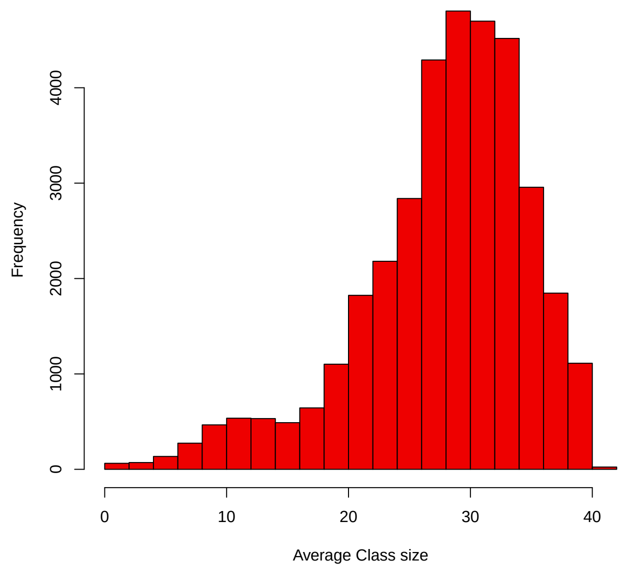

Figure 29: Histogram Class Size (Single classes)

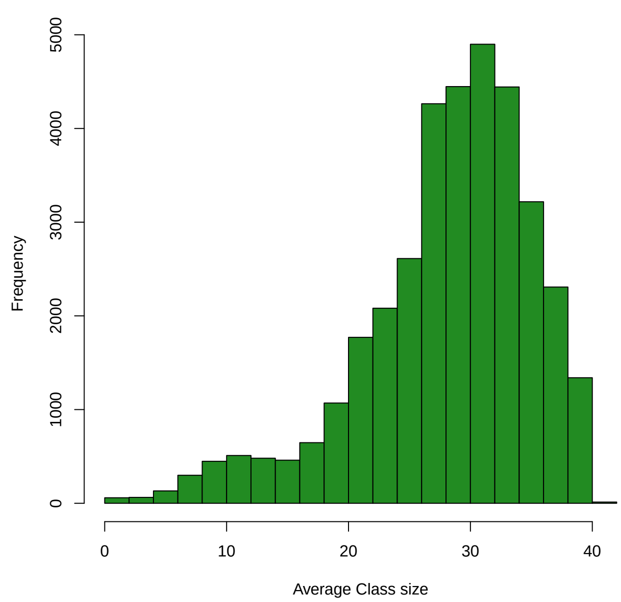

Figure 30: Histogram Class Size (Single classes)

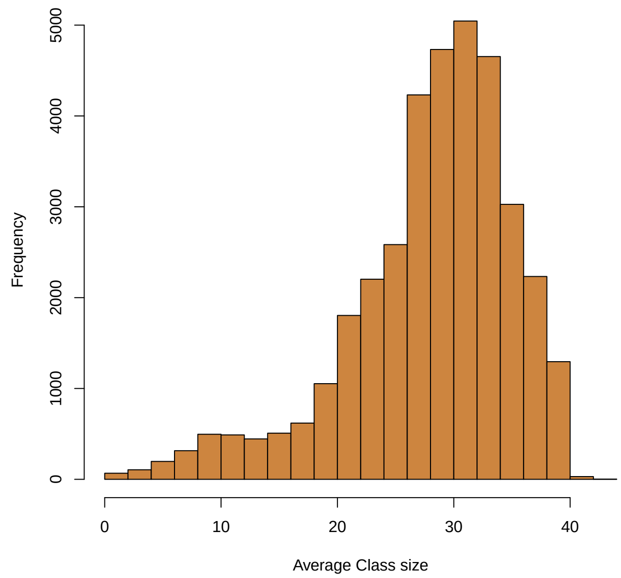

Figure 31: Histogram Class Size (Single classes)

C Appendix: Cross section 2019 regression augmented

Table 18: 2019 regression

	DV: Expenditures (in thousands of JPY)	
	Total Expenditure (Elementary)	Total Expenditure (JHS)
	OLS	OLS
	(1)	(2)
Number of students	−9.76	204.69***
	(26.24)	(12.22)
Number of schools	9,240.35**	37,665.55***
	(4,561.56)	(4,798.48)
Number of classes	6,497.40***	3,322.02*
	(855.02)	(1,863.01)
Constant	42,283.52***	79,023.43***
	(15,370.54)	(14,851.92)
Observations	1,644	1,634
R^2	0.87	0.65
Adjusted R^2	0.87	0.65
Residual Std. Error	454,950.00 (df = 1640)	442,072.80 (df = 1630)
F Statistic	3,642.14*** (df = 3; 1640)	992.52*** (df = 3; 1630)
Note:		*p<0.1; **p<0.05; ***p<0.01

Source: Own elaboration based on Survey on Local Education Expenditure and School Basic Survey Carried out by the Ministry of Education, Culture , Sports , Science and Technology