School Consolidation and Student Performance: Evidence from Hungary

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Abstract

This paper analyzes the effect of class size and school size on student cognitive skills using the Hungarian National Assessment for Basic Competencies from 2007 to 2009. As a consequence of a policy change when the funding of primary schools changed remarkably, almost 20% of schools were consolidated or closed. This created an exogeneous increase in class size and establishment size which is expoited to measure their impact on math and reading test scores. The effect is negative on math score, increasing the class size by 1 reduces the students' test score by .01-.03 standard deviation but there is no effect on reading score. The effect of establishment size is mostly insignificant both for math and reading.

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Contents

1 Introduction

Mental skills that are used in the process of thinking and acquiring knowledge are jointly called cognitive skills. They include among other attention, memory, symbolic thinking, and self-regulation. These skills play an important role in many areas of life, among others, in economics.

First, they are notable from macro point of view as economic growth is related positively to average skills of the labor force. Earlier studies used average years of schooling such as Mankiw, Romer and Weil (1992) and Barro (1991) and found positive relationship between years of schooling and growth, but recently, using average test scores of various international student assessments – which measure cognitive skills more precisely than years of schooling – Hanushek and Woessmann (2009*a*) found positive causal relationship between growth rate and cognitive skills. Moreover, Hanushek and Woessmann (2009*b*) could explain the Latin-American growth puzzle, that despite the high average years of schooling, these countries growth less rapidly than other comparable nations. An OECD report quantifies the present value of higher economic growth due to various scenarios: bringing all students to a level of minimal proficiency is about 400% of current GDP, improving student performance to reach the level achieved by Finnland is about 600% of current GDP in case of Hungary (OECD, 2007).

But cognitive skills determine individual welfare, as well. Levy and Murnane (2004, p. 57-95.) revealed that acquiring „expert thinking" and „complex communications" skills during childhood is very important for later success on the labor market. Testing the importance of cognitive skills are usually performed by estimating a Mincer equation and then adding some measure of cognitive skill. Murnane et al. (2000) and Lazear (2003) relate earnings to test scores from school age and find that one standard deviation higher scores translates into 10-15% higher earnings.

These results all emphasize that cognitive skills are important, developing these skills is beneficial both from individual and social point of view. Therefore public policies that aim to facilitate the development of these skills should be advocated. As the return on investing in cognitive skills is higher in the early period of lifetime (Heckman, 2000) and children spend a considerable time of their life in schools, it is a plausible policy to raise the quality of schools in order to enhance the development of cognitive skills.

There is a vast literature on the educational production function, which tries to measure the effect of various school inputs on educational outcomes. One of these inputs is related to the number of children in class. As the amount of instructional time can be regarded as constant, in bigger classes teachers have less time to care for each children. Intuitively, because of the less attention paid to each children, one can expect that students in larger classes perform worse. However, using observational data it is hard to establish this negative causal relationship. Earlier studies summarized by Hanushek (1997) found no systematic negative relation between class size and student performance. Krueger (2003) points out that these papers use cross-sectional data and are subject to endogeneous sorting of students. Unobservable characteristics of the class, such as teacher quality and composition of students may correlate with the class size, therefore endogeneous sorting of students can happen. Using cross sectional data may provide even positive relationship between class size and student performance. Analyzing this question properly would need experimental or quasi-experimental data.

Krueger (1999) analyzed experimental data where students were randomly assigned to to different sizes of classes and found that attending small classes increases performance. Angrist and Lavy (1999) used an exogeneous variation of class size, known as the Maimonides rule. According to this rule, class size cannot be higher than 40, so schools can start one class with 40 children but they have to split the students into two classes if there are 41 students. This rule creates exogeneous jumps in class size which was exploited by a regression discontiunity approach. They found that attending smaller class significantly increase student performance. However, Urquiola and Verhoogen (2009) built a model to analyze whether regression discontiunity design is appropriate to use when schools are subject to class size caps and the number of their classrooms are fixed. Their finding is that schools adjust enrollment at the class size cap which result in discontiunities in the relationship between enrollment and family characteristics. This behavior of schools violates the assumptions of regression-discontiunity design.

Supporters of school consolidations often use the economies of scale argument as it enables increased specialization of teachers, and reduces average costs per student. However, bigger schools can have negative effects, as well. Strang (1987) drew attention to the possible alienating effect since children have more teacher but none of them knows the student well. Bradley and Taylor (1998) investigated the effect of school size on exam performance in secondary schools in England. They found nonlinear – inverted U-shape – causal link between the two. Estimating the effect of school size can be problematic for the same reason as estimating the effect of class size. To overcome the possible endogenity problem Kuziemko (2004) used instrumental variable approach. She examined this question for US public schools by using school closures and mergers to identify exogeneous variation in school size and found that students attending bigger schools performs worse on tests.

In 2007, there was a great policy change in Hungary. The amendment of the Public Education Act modified the funding of schools in three important aspects. First, it inaugurated a new funding method based on a novel performance indicator that takes into account differences in average class size, instruction time for students, teachers' statutory teaching hours per week and the type of education. Second, it created a new type of subsidy designed to nudge school service providers to form partnerships to maintain schools together. Third, it set a class size floor that has to observed.

As a result of the amendment of the Public Education Act, an unprecedented wave of school consolidation happened in 2007, between school year 2006/7 and 2007/8 and continued at a slower pace in 2008. In 2007, every fifth of the schools were affected somehow: either they were closed or consolidated. As a result, average class size and school size increased. Because of the nature of the policy change, it can be regarded as an exogeneous shock to average class size and school size. That's why this policy change can be exploited to estimate the effect of class size and school size. But there is a second reason for examining the consequences of the change of the Public Education Act. Recently, a comprehensive analysis on the Hungarian educational system was published as the *Green book for the renewal of public education in Hungary*. In its chapter on institutional structure and funding, Varga (2008) formulated policy recommendations which support school consolidations. This policy change creates an opportunity to analyze and gain experience on how school consolidations happen when the government uses monetary incentives.

I use the KIRSTAT database, the official registry of Hungarian schools, and the National Assessment for Basic Competencies (NABC) dataset for the analysis. As the KIRSTAT contains all educational institutions, it is appropriate to characterize the consolidations using this database. The analysis is conducted at establishment-level (where the teaching activity takes place) which is the adequate unit of observation for this analysis. I distinguish between two type of consolidations, merger, which is defined by the „fusion" of at least two different schools and reorganization, which affect only one school. Students' cognitive skills and other important characteristics are contained in the NABC. I use the NABC from 2007/8 to 2008/9 restricted to students attending elementary schools, moreover, children with special educational needs are excluded. In each of these years, almost all of the students were assessed in the 8th grade.

I first estimate reduced form models which capture the total effect of the consolidations. These results show that the consolidation reduced the cognitive skills of students measured by math tests. Then continue to assess the effect of increased class size and establishment size. Three variables are used as instruments: variables indicating mergers and reorganizations, and the number of such students whose previous school was closed. My estimates are negative, increasing class size by 1 reduce student performance by .01-0.3 standard deviation. Although the effect of establishment size is negative, it is insignificant in most specifications. In case of reading, neither class size nor establishment size has significant effect on the test score.

The rest of the paper is structured as follows. In the second section I briefly review the change of the Public Education Act, what were its main modifications and how it affected the funding of schools. The next section introduces the databases I use. With the help of the official registry of educational institutions the consolidations can be characterized. The forth section describes the identification strategy, why OLS is unlikely to yield consistent estimates and how this can be overcome by using instrumental variable approach. The fifth part of the paper presents the results. First, reduced form estimates are shown which tells us the total effect of the institutional changes. Then the results of the IV estimation are reported. The next section discusses the results, what are the potential problems with the identification strategy and what is the sign of these potential biases. The last section concludes.

2 Public Education Act

At the end of 2006, the Public Education Act was amended. The modification has three important features that contrast the previous regulation. First, the Act introduced a public education performance indicator. This indicator takes into account the average class size, instruction time for students, teachers' statutory teaching hours per week and the type of education (kindergarten, primary school or secondary school). The subsidy per student is calculated by multiplying this performance measure by a predermined price. In spite of the complexity of this performance indicator, this new funding scheme corresponds to the previous one (which based on headcount of the school) since all of the previously mentioned characteristics that are taken into account are countrywide averages, hence they are constant across schools. Therefore, the amount of money that a school receives depends only on the number of children. I calculated the subsidy using this new funding method and the old one and compared them. Table 1 shows the yearly subsidy per student by grades before and after the amendment. The new funding distinguishes among grades, subsidy for younger children have become smaller while it increased for students in the 4th, 7th and 8th grade.

This new funding scheme was introduced gradually. From September 2007, the 1st and 5th grades were affected, and in the subsequent school years the the funding of the then 1st and 5th grades switched to this new funding method, therefore the complete switch is achieved by September 2010.

To demonstrate the effect of this policy change, the change in total expenditures are calculated. The total spending on primary schools decreased by 9.9 billion HUF, by almost 6% of total expenditures. Moreover, despite of the gradual introduction of this new funding, its effect is the biggest in the first year (if the switch had happened immidiately, the total subsidy would have decreased by 7%).

Table 1: Subsidy per student per year before and after the change of the Public Education Act in 2007 by grades

	subsidy in HUF		
grade	before	after	change
1st grade	204,000	146,000	-58,000
2nd and 3rd grade	204,000	183,000	-21,000
4th grade	204,000	222,000	18,000
5th grade	212,000	172,000	-40,000
6th grade	212,000	198,000	-14,000
7th and 8th grade	212,000	224,000	12,000

Source: Budget Act 2007

The second important change was that the Act required schools that they have to have 8 grades, and class size floor was introduced also (15 children). Fulfilling these conditions was not necessary to achieve immidiately, schools had a year to achieve it.

The third modification was that the government introduced a new kind of grant to prod the school service providers toward forming partnerships. Local governments had the responsibility to provide primary educationl services henceforward, but they were not required to do this by themselves, they could contract with other school maintainers. This new grant provided new resources, about 15% of the previous subsidy per student.

All three modification nudge the school maintainers toward consolidation. The new funding scheme and regulation motivate them to rethink their provision of educational services and if it is necessary, rationalize them. As a result, there were lots of school closures and mergers in 2007 and 2008, and about 8800 teachers were laid off and 1600 were superannuated in September 2007 Lannert (2008).

As the amendment of the Public Education Act and the Budget Act enacted by the end of 2006, when school year 2006/7 already started, and the new funding system took effect in September 2007, school maintainers could first respond to these modifications in 2007 summer. Hence, anticipatory adjustments were not possible, the impact of the amendment can be considered as an exogeneous shock.

3 Data

I use two databases for the analysis, the official registry of the educational institutions (KIRSTAT), and the Hungarian National Assessments for Basic Competencies (NABC). In the following, I introduce these datasets and describe how these were modified in order to prepare them for the analysis. In the last subsection I provide some desciptive statistics to characterize the policy change.

3.1 KIRSTAT

The official registry of the Hungarian educational institutions is the KIRSTAT database. The Ministry of Education is responsible for it, at the beginning of each school year, all kinds of educational institutions – including primary schools – are required to fill in a questionnaire. The structure of the survey changed in 2000 significantly, which resulted that the data is comparable across years from 2001 to nowdays. I use the waves of KIRSTAT from school year 2001/2 to 2008/9.

The observation units in KIRSTAT are schools and within schools the so-called locations which are the Cartesian product of the type of the school and the address (where the actual teaching activity is taken place). As an illustration let us assume that an institution has two buildings with different addresses, and at both addresses it has a primary school and a grammar school. Therefore it has four locations: a primary school and a grammar school at the first address and a primary school and a grammar school at the second address. Since the focus of this paper is on students primary schools, hence the sample is restricted to locations, which provide elementary educational services.

The database contains several important characteristics of the primary schools: number of teachers and the composition of the teacher force by education and by age, number of grades, number of students by grades, number of classes by grades, and some data on student characteristics.

School consolidations are central to this paper, hence it needs to be clarified what it means exactly and how it is defined in the database. Schools are required to fill in the questionnaire in autumn. Some of the questions are related to the situation of the school in that school year, e.g. the number of students. But some questions are related to the previous school year such as what was the proportion of students continuing their studies in various types of secondary schools. Therefore, if a school is closed in the summer then it will show up in the database at the beginning of the next school year despite the fact that it does not function any more. Moreover, closed schools have to provide information on how they ended their operation: was there a successor institution or not. This question enables me to define school mergers: a school merger happens when a school is closed and it has a successor.

Table 2 shows this statistics. Since school closures and mergers can be identified ex post, therefore the table should be interpreted carefully: in 2006/7, there were 3212 schools altogether. 561 schools were merged by 2007/8 and 108 schools were closed by 2007/8. That is, school mergers and school closures were actually happened before the start of 2007/8 school year, in the summer.[1]

Table 2: Number of institutional changes at school level by year

	type of institutional changes			
school year	no change	successor	closed	total
2001/2	3,424	14	6	3,444
2002/3	3,382	35	33	3,450
2003/4	3,302	105	29	3,436
2004/5	3,162	147	41	3,350
2005/6	3,072	85	29	3,186
2006/7	2,543	561	108	3,212
2007/8	2,383	163	28	2,574

Notes: Each row indicates the number of schools that will be affected by the beginnning of the next school year.

In many cases, where schools of small villages were merged, many characteristics of these schools have changed. However, from the point of view of teaching activity, it does not necessarily matter what are the overall characteristics of the school but the most important ones are the location-level characteristics. Moreover, school-level data is inappropriate to analyze school consolidation if more schools merged into one because before-after comparison

[1]It is uncommon that operating school are closed or merged in the midst of school year, moreover, I have no data to check this hypothesis.

can only be performed if the merged schools before the institutional change are treated as a single school. But this kind of aggregation may hide important variations.

Because of these reasons, I construct a location-level panel database by using the addresses of the locations.[2] In this database, the previous definition should be refined. The definition of consolidations for establishments is that the address of the establishment remains the same, so the actual place where the teaching happens is the same, but the institution's identifier is changed. This technical definition does not coincide with the notion of school merger used in common parlance, but it has good reason. In the KIRSTAT database, schools are required to give the successor institution if they are closed if there is any. However, there are cases when a school is closed and a new one start to operate at the same address. Technically speaking, it is not a consolidation, because there is no relation between the schools. But supposedly, students and the teacher force are mostly the same, it is not inadaquate to treat it as consolidation.

This is not necessarily coincide with the notion of school merger used in common parlance since it might happen that only the school's identifier changes. In many cases, only this kind of reorganization happened. Treating them as a type of school consolidation may seem inappropriate at first, however, these changes enable the management of the school to restructure the institution. One of the most important reason for such tpye of consolidation concerns the status of teachers. As they are public servants, reducing workforce by layoffs is difficult which makes any kind of the adaption hard, especially the adaption to the diminishing number of students. Therefore, consolidation can be used as a tool to overcome this problem Varga (2008).

The location-level mergers and closures are presented in Table 3. Between 2006/7 and 2007/8, more than 600 locations were merged and more than 250 were closed while the next year more than 200 locations were merged and more than 100 locations were closed. In 2008/9, there are no school mergers and closures since this information becomes available only in the next school year. It is also evident from this table that before the amendment of the Education Act, there were attempts to reorganize the school system but these are

[2] The process of constructing the panel database is described in Appendix A.

dependent on the will of the local authorities and were not actuated by the government.

Table 3: Number of institutional changes at establishment level by year

	type of institutional changes			
school year	No change	Change	Closed	Total
2001/2	3,741	7	96	3,844
2002/3	3,672	37	85	3,794
2003/4	3,537	117	92	3,746
2004/5	3,418	148	121	3,687
2005/6	3,451	97	66	3,614
2006/7	2,712	618	261	3,591
2007/8	3,095	201	113	3,409

Notes: Each row indicates the number of establishments that will be affected by the beginnning of the next school year.

As this type of institutional change can be different from the accustomed meaning of merger, I distinguish between the two. Mergers are defined as such institutional changes where at least two institutions are affected, mergers can be regarded as a fusions of schools while reorganizations affect only one institution. This definition can be formulated using the number of locations of schools (except some special cases). A merger happens when the number of locations of a school to which a given location belongs to is smaller before the change than the number of locations of the successor school of the same location. All other institutional changes are considered as reorganizations. To illuminate the difference between the two notions, consider two schools with two location belonging to each. If these are consolidated into a new school then it is considered to be a merge if the new school has at least three locations, if less, then it is a reorganization. In the following, I use the term consolidations for both kind of institutional change.

Table 4 shows the number of consolidations by these two categories. Throughtout this period, mergers dominate the consolidations, and this is especially true for the last two years: out of 618 consolidations there were 523 mergers and 95 reorganizations in 2006/7. In the next school year, there were 154 mergers out of 201 consolidations. The transition matrices for both years can be found in the Appendix.

Table 4: Type of institutional changes if there was a consolidation by school year

	type of change		
School year	reorganization	merger	total
2001/2	4	3	7
2002/3	16	21	37
2003/4	46	71	117
2004/5	30	118	148
2005/6	24	73	97
2006/7	95	523	618
2007/8	47	154	201

Notes: Each row indicates the number of establishments that will be affected by the beginnning of the next school year.

3.2 NABC

The other database that is used is the Hungarian National Assessment for Basic Competencies (NABC). The assessment started in 2001 and its goal is to measure the cognitive skills of students in mathematics and in reading. At the end of each school year in May, students are required to write the assessment. The tests are designed to measure the cognitive skills of students by focusing on problem solving and not on how good they know the curriculum.

The test scores are complemented with background questionnaires. Each student receives a questionnaire asking the most important characteristics of her and her family, but this is not mandatory to fill in. Moreover, schools and establishments of school also receive questionnaires, however, they are not required to fill these in either.

NABC has similar structure to KIRSTAT as the unit of observation is so-called establishment, which is equivalent to location from my point of view since only primary schools are analyzed. Therefore mergers and reorganizations can be identified in the same way as in KIRSTAT. However, the two datasets cannot be merged perfectly, hence I use the number of students in the 8th grade to proxy the establishment size.

As the test scores will be my outcome variables and the effect of class size will be measured in terms of test scores, it is worth to describe these. The assessment uses standardized tests, which makes it possible to compare the results across schools and over time. The average of the test scores was set to 500 and the standard deviation was set to 100 for both mathematics and reading in 2003. Later, the averages may have changed (along with the standard deviations) but these can be interpreted as improvements or deteriorations.

The assessment measures the skills of students in four grades: 4th, 6th, 8th and 10th. In the early years of NABC, only a sample of students were tested in some grades, but after 2006, almost the entire 8th grade was tested. Therefore, my sample consists of the 8th graders from 2006/7 to 2008/9. It is important to emphasize that different students are writing the tests in different school years, the cognitive skills of a given student are measured only once during this three years. So it is a pooled panel database, which implies that value-added measures cannot be used for the analysis.

I use a restricted sample. First, my focus is on primary schools, therefore only students attending elementary schools are considered. Students can enter secondary schools in 5th, 7th and 9th grades. Those who started secondary school in 5th or 7th grade are excluded. Second restriction is that those students are excluded whose test scores are not used for computing national averages. These students are mostly children with special educational needs. Although almost all students are required to write the test, in case of children with special educational needs these scores are only used to inform them and their teachers about their performance.

Third, as the NABC is a survey, lots of students do not fill in the background questionnaires. Hence the sample is restricted to those students whose most important characteristics are known such as age, sex, parents' education, number of books at home, internet connection, whether the family receives aid for the student and previous math grade.

3.3 Descriptive Statistics

It is evident from Table 3 that the order of magnitude of the consolidation in 2007 is not comparable to the previous years. But it is more appropriate to examine the number of affected students than focusing on the number of institutional changes since smaller schools may have greater benefit from consolidation hence the share of affected students may be much less than the number of affected establishments. Table 17 shows these statistics for students of the 8th grade by school year. Before the amendment of the Public Education

Act, less than 5% of the children were affected by school mergers or closures in each year, however, in 2006/7, almost 18,000 children, 17% of the students were affected somehow. Most of the students attended establishments that were merged, and slightly more than 3000-3000 children were affected by either reorganization or closure.

Table 5: Number of students in 8th grade affected by year

	type of institutional changes				
school year	no change	reorganization	merger	closure	total
2001/2	110,150	99	9	534	110,792
2002/3	107,226	316	622	1,002	109,166
2003/4	105,725	1,265	1,892	1,495	110,377
2004/5	108,992	747	1,962	998	112,699
2005/6	109,817	427	1,121	667	112,032
2006/7	89,023	3,070	11,626	3,126	106,845
2007/8	98,113	1,031	3,293	1,301	103,738

Notes: Each row indicates the number of students that will be affected by the beginnning of the next school year.

It is important to know in what respect the merged and reorganized and non-affected establishments were different from each other and how the consolidation affected these characteristics. Table 6 shows summary statistics about the number of students and the average class size in the 8th grade for the two waves of consolidations. Reorganized and merged establishments are compared to other nonclosed establishments, that is, closed ones are not considered in the non-affected category. For each category, the change of the characteristics is tested whether it is significantly different from zero, and the t-statistics is reported.

The average number of 8th graders is increased both at reorganizationed and merged establishments by five students in 2007, however the change is significant only for mergers. The pattern is similar when the establishment size is examined, the total number of children increased by more than 40 at reorganized establishments and by almost 30 at merged establishments but only the mergers are significant. The average class size increased by more than one at consolidated establishments but this change is significant for merged ones. Although the change is significant at non-affected establishments as well but its magnite is much smaller, it is 0.5. The changes that happened in 2008 are all insignificant except the change in the number of 8th graders at non-affected establishments.[3]

Table 6: Number of students and average class size, before and after the consolidation, establishment averages

		2007			2008		
# students, 8th grade		before	after	t-statistics	before	after	t-statistics
	no change	36.31	36.10	-0.29	36.51	35.17	-2.00
	reorg.	34.11	39.44	1.12	25.77	29.26	0.72
	merger	26.54	31.60	2.97	27.21	27.78	0.22
# students, 1-8th grade							
	no change	276.71	274.04	-0.51	275.39	269.46	-1.18
	reorg.	239.96	282.59	1.30	192.3	233.11	1.05
	merger	196.13	224.83	2.38	209.53	207.04	-0.13
Av. class size, 8th grade							
	no change	19.47	19.98	3.07	19.99	19.95	-0.24
	reorg.	18.72	19.55	0.85	19.57	19.60	0.02
	merger	17.11	18.89	3.86	18.32	18.44	0.15

In the KIRSTAT database, there is information also on teacher characteristics such as education and age (which could be a proxy for teaching experience). However, these are very rough measures of pedagogic qualities, the differences between good and bad teachers can hardly be captured by these dimensions. But if schools that try to spare money because of the reduced subsidies lay off more educated or more experienced and hence more expensive teachers, one should detect changes in these characteristics of the teacher force. As these differences are mostly insignificant, these are reported in the Appendix.

Student composition is also an important factor. Children among better, motivated classmates performs better, hence it is relevant to check whether the consolidation altered the student composition. Mother's education is used as a proxy of that. Shares of various types of education for establishments are examined whether the student composition changed significantly due to consolidation. In most of the cases the differences are insignificant, hence the consolidation did not affect the composition of students (see Appendix).

Based on the statistics presented, it seems that the school consolidations affect only the size of establishments and the class size, the other characteristics of schools that can have

[3]For the average class size, a more detalied information is avaible in KIRSTAT. In these, the classes are categorized based on the number of students. Calculating the share of classes in each categories gives similar patterns, these tables can be found in the Appendix A.

an effect on student outcomes did not change significantly.

4 Identification strategy

I would like to estimate the effect of class size and establishment size on student performance. Educational outcomes such as testscores can be thought of as a function of two different sets of variables Duncombe and Yinger (1999). The first set consists of the student related characteristics, denoted by E. The most important ones are ability and various aspects of family background of students (such as parents' education, family income), peer effect, etc. They are called jointly environmental factors since schools cannot influence these. The second set of variables contains the school inputs, S. School maintainers can more or less freely determine these, such as average class size, composition of teacher force, etc. Based on these two components, consider a simple model for educational outcomes in which the following equation describes the student outcome:

$$Q = f(S, E)$$

where Q denotes the student outcome. In this model, mergers and reorganizations have no direct effect on student performance, but they can be regarded as changes within the establishments that affects the school inputs directly. Hence equation (1) can considered as a reduced form regression:

$$y_{ijt} = \beta_0 + \beta_1 X_{ijt} + \beta_2 F_i + \beta_3 T_t + \delta_1 R_{j,t-1} + \delta_2 M_{j,t-1} + \epsilon_{ijt} \quad (1)$$

where y_{ijt} denotes the test score of student j at establishment i at time t, X is the vector of individual control variables (sex, relative age to the median, mother's education, father's education, dummy variables indicating the number of books at home, dummy variable for Internet connection at home, dummy variable indicating whether the family receives aid after the student and math grade at the end of the previous school year). F_i is 1 for establishment i and zero otherwise. Its parameter is the establishment fixed effect, it captures all observable and unobservable characteristics of a given establishments that is constant across years., T_t

is a dummy variable indicating the school year, it is 1 in school year t and 0 otherwise, $t = \{2006/7, 2007/8, 2008/9\}$. R and M stand for reorganization and merger, respectively. They are equal to 1 if the institutional change happened in the sample period and 0 if there was no change at the establishment during these three school years. The error term is ϵ, and the βs and δs are the parameters.

The δ_i coefficients show the overall effects of mergers and reorganizations. It is not known how – through which channels – the mergers and reorganizations affected student outcomes from this regression. Institutional changes may correlate with several school inputs, hence this equation captures the net effect of various school input changes.

One method to explore the channels through which school consolidation affect performance is to include different school characteristics in regression (1). If the effects of merger and reorganization drop and become insignificant after the inclusion of a covariate then that is a sign of correlation between consolidation and the included school characteristics. As the reported descriptive statistics show significant changes only in class size and establishment size, one can expect that their inclusion in equation (1) would result in insignificant effects of school consolidation:

$$y_{ijt} = \beta_0 + \beta_1 X_{ijt} + F_i + \beta_3 T_t + \delta_1 R_{j,t-1} + \delta_2 M_{j,t-1} + \gamma_1 Class_{ijt} + \gamma_2 (Establishment - Class)_{ijt} \epsilon_{ijt} \tag{2}$$

$Class$ denotes class size and $Establishment - Class$ is the difference between the establishment size and the class size for student j at establishment i at time t. It is worth to explain why the difference of establishment and class size is included instead of establishment size itself. I would like to measure the effect of an extra student in the class on math scores, holding other variables fixed. However, if establishment size is included, it cannot be constant if the class size increases. Therefore, I require their difference to be constant. This means that if the size of a class within an establishment increases, the establishment size rises only because of this change, the size of other classes within the establishment have to be constant.

If the parameters of merger and reorganization becomes insignificant they have an effect on test scores through class size and establishment size. However, it is certain that the coefficients of class size and the difference will be inconsistent because there is free school choice in Hungary. Parents can directly respond to quality differences when choosing school. As better-off families are likely to be better informed on school quality and they are more likely to bear the cost of choosing a distant school, environmental factors can correlate with school quality. In case of class size this means that in better schools the composition of students is better, moreover, as some of the students attending these schools are coming from farer school districts, the average class size is higher than in worse schools. Therefore student performance and class size are expected to be correlated positively.

This argument makes it clear that OLS is inadaquate for estimating the effect of class size because of endogeneous sorting of students. As the NABC is an establishment-level panel dataset, one can include establishment fixed effects to control for unobserved heterogeneity and mitigate this problem, however, it is not certain that this would give an unbiased estimate.

Instead of the OLS, I use instrumental variable approach that could help to overcome the endogeneity problem. A candidate for the instrument is the policy change itself. There are two requirements for a valid instrumentum: it should correlate with the endogeneous variable but it cannot correlate with the error term. First, descriptive statistics show that the average class size increased in consolidated establishments, during the mergers of 2007. The second requirement in this setting means that consolidation could only affect the class size and could not alter any factors that have an impact on student performance. In the previous section, it was demonstrated that the most important factors such as quality of the teacher force and student composition were not changed because of the consolidation that's why school consolidation is a valid instrument.

Another consequences of the policy change were school closures. Children attending such schools have to find another school. This phenomenon is a second candidate for instrument. Fortunately, the questionnaire of NABC asks whether students attend the same school where they started school and if there was a change what was the reason for it. However, this does not tell us when this happened. School closures could have happened in the previous school year or years before.

The positive relationship of class size and the number of children in the class whose previous schools were closed is obvious. The exogenity criterion is discussed below.

First, these children are likely to be different from an average student because closed schools are not random. Smaller schools are more likely to be closed and in these schools the disadvantaged children are overrepresented. Hence, the composition of students may be altered within class despite the fact that at the establishment-level significant change could not be detected.

Table 7 shows the mother's education of those students who had changed school. Among those children who did not change school the share of students whose mother has diploma is almost 19% while among the switchers because of school change this share is slightly more than 10%. This confirms that these students are worse on average. Therefore, the arrival of these new students in a class would surely alter the composition of students, the newcomers would worsen it.

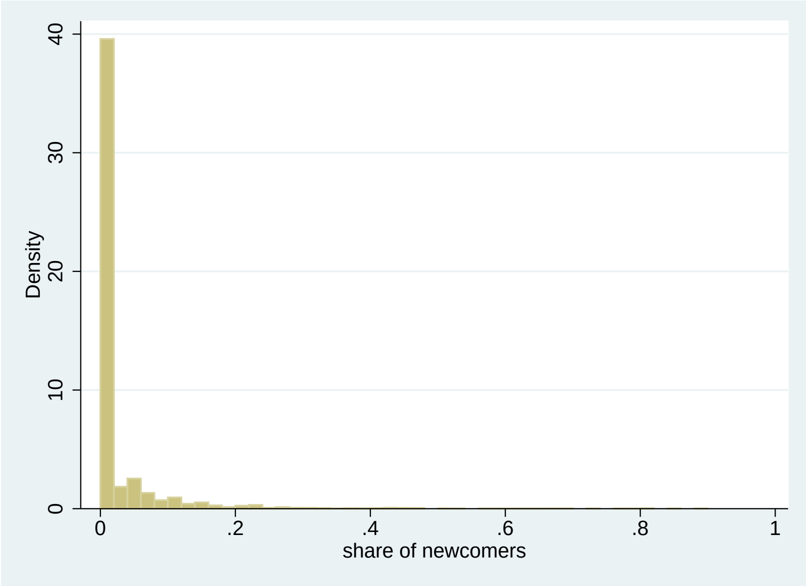
Table 7: The share of students by reason of school change and mother's education in 2007/8

	Reason of school change					
Mother's education	no change	moved	4 grades school	school closure	other	Total
less than 8 grade	1.44	1.76	4.34	2.30	1.35	1.58
8 grade	16.48	20.40	31.06	26.39	15.02	17.47
technical school	6.15	8.50	6.46	6.94	6.93	6.47
vocational school	22.97	23.02	28.84	28.44	20.59	23.10
high school graduate	34.40	30.73	21.97	25.51	33.03	33.25
college	14.17	11.12	6.41	7.99	16.51	13.69
university	4.39	4.46	0.92	2.43	6.57	4.44

As the smallest schools were closed, few new students are unlikely to change the composition remarkably. Figure 1 shows the histogram of the share of these newcomers in the class. It is evident, that in most of the cases, their share remains below 20%. So if only those cases are considered where the share of these children are low in the class, one could argue for the exogenity.

Another question is how the new students are allocated within establishment to classes.

Figure 1: Histogram of share of newcomers in the class if their previous school was closed



It is unlikely that the class of the newcomers is chosen randomly since segregation is common in Hungary (Kertesi and Kézdi, 2009). To overcome this problem the average number of newcomers per class is used to instrument the class size. Therefore establishment-level varioation is used to insdtrument the class size and not class-level.

As argued before, the OLS is unlikely to provide consistent estimates, hence class size and establishment size are instrumented with the institutional changes, the average number of newcomers per class and the total number of newcomers at the establishment.

In the first stage class size and establishment size are regressed on the dummy variables indicating institutional changes. Average number of newcomers per class and total number of newcomers at the establishment variables as the other instruments are also included along with the other exogeneous covariates. Using the predicted values of the class size and the difference between establishment size and class size, the second stage can be estimated.

5 Results

The reduced form estimates are presented in Table 30 for mathematics.[4] In these regressions, the variables of interest are whether the student's school was merged or reorganized ever, after the policy change, that is, all mergers and reorganizations are treated equivalently, irrespectively of the time of the consolidation and of the time elapsed after the consolidation. This specification has the advantage that it captures the effect of the policy change with two variables, however, it assumes that the policy change has permanent effect.

Establishment fixed effects are included in the regressions and the standard error estimates are robust to heteroskedasticity and clustering at the establishment-level.

The results show that both kind of institutional changes have negative impact on student performance in math. Merger decreased the test score by 3.5 points and reorganizations reduced it by 2.5 points, 3.5% and 2.5% of the standard deviation, respectively. The effect of merger is significant only at the 10% significance level in specification (6) and it is sensitive to the inclusion of various control variables. In the case of reorganization, the impact is insignificant.

The reported descriptive statistics on mergers and reorganizations have shown that only average class size and average establishment size changed significantly. Therefore, if these variables are those school inputs that caused the reduction of test scores then including them in the previous regression should make the coefficients of merger and reorganization insignificant.

Table 26 presents this estimate. The negative effect of merger has become insignificant as expected, even at 10% level of significance. [5] Class size has positive effect on student performance but this estimate is intuitively wrong. The effect of the difference between the establishment size and class size is negative and significant, however, this estimate can be biased because of endogeneity, despite the fact that it is negative as expected. That's why these two variables are instrumented with the type institutional change and the average

[4]All results for reading are presented in the Appendix.

[5]However, this result depend on the specification. If institutional changes are defined differently (e.g. whether they happened last year, assuming only short-term effect), including class size and the difference between establishment size and class size does not make the effect of merger and reorganization insignificant.

Table 8: The effect of mergers and reorganizations on math scores

	(1)	(2)	(3)	(4)	(5)	(6)
merger	-4.933**	-2.796	-3.762*	-2.937	-3.204	-3.508*
	(2.008)	(2.136)	(2.188)	(2.140)	(2.153)	(2.063)
reorganization	-6.233	-2.989	-5.112	-2.223	-2.575	-2.475
	(3.894)	(4.000)	(4.054)	(3.789)	(3.827)	(3.618)
year	-	yes	yes	yes	yes	yes
type of maintainer	-	-	yes	yes	yes	yes
ages	-	-	-	yes	yes	yes
sex	-	-	-	yes	yes	yes
mother's educ	-	-	-	yes	yes	yes
father's educ	-	-	-	yes	yes	yes
# of books	-	-	-	-	yes	yes
internet	-	-	-	-	yes	yes
aid	-	-	-	-	yes	yes
previous math grade	-	-	-	-	-	yes
establishment fixed effect	yes	yes	yes	yes	yes	yes
Observations	195,786	195,786	195,786	195,786	195,786	195,786
R-squared	0.179	0.182	0.182	0.296	0.316	0.548

Notes: Cluster robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

newcomer per class and total number of newcomers. The strength of the instruments are tested using Cragg-Donald Wald F statistics, and it above the well above the critical values (Murray, 2006). The first stage regressions can be found in the Appendix.

The IV estimates are reported in Table 10. Specification (1) estimates the effect when students whose schools were closed are excluded. Specification (2) restrict the sample of (1) to those classes where the share of newcomers is less than 0.1. The increase in class size and establishment size was more robust in 2007, hence the previous two specifications are reestimated when school year 2008/9 is exluded.

Higher class size reduces student performance in all specifications and it is significant except (3). The effect ranges from 1.2 to 3 points in absolute value. The effect is stronger when school year 2008/9 is not used for the estimation, the possible reason for it is that the policy change had stronger effect on the schools in the first year.

The effect of the difference between establishment and class size is negative in all specifications, however, it is mostly insignificant. The absolute value of this effect is higher in

Table 9: The effect of mergers and reorganizations on math scores

	(1)	(2)	(3)	(4)	(5)	(6)
mergeer	-5.326***	-2.442	-3.336	-2.688	-2.976	-3.361
	(2.066)	(2.185)	(2.239)	(2.170)	(2.182)	(2.084)
reorganization	-8.032**	-4.064	-6.220	-2.874	-3.147	-2.793
	(3.922)	(4.028)	(4.077)	(3.813)	(3.838)	(3.652)
estab-class	-0.116*	-0.195***	-0.197***	-0.153***	-0.151***	-0.146***
	(0.0600)	(0.0613)	(0.0612)	(0.0580)	(0.0575)	(0.0563)
class	1.586***	1.542***	1.540***	0.862***	0.760***	0.412***
	(0.139)	(0.137)	(0.137)	(0.118)	(0.116)	(0.105)
year	-	yes	yes	yes	yes	yes
type of maintainer	-	-	yes	yes	yes	yes
ages	-	-	-	yes	yes	yes
sex	-	-	-	yes	yes	yes
mother's educ	-	-	-	yes	yes	yes
father's educ	-	-	-	yes	yes	yes
# of books	-	-	-	-	yes	yes
internet	-	-	-	-	yes	yes
aid	-	-	-	-	yes	yes
previous math grade	-	-	-	-	-	yes
establishment fixed effect	yes	yes	yes	yes	yes	yes
Observations	195,786	195,786	195,786	195,786	195,786	195,786
R-squared	0.179	0.182	0.182	0.296	0.316	0.548

Notes: Cluster robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 10: The effect of class size and establishment size on math scores, 2nd stage

	(1)	(2)	(1)	(2)
class	-1.167*	-0.636	-1.993**	-3.013**
	(0.695)	(0.754)	(0.867)	(1.472)
establishment-class	-0.0828	0.00929	-0.312*	-0.219
	(0.136)	(0.141)	(0.182)	(0.185)
year	yes	yes	yes	yes
type of maintainer	yes	yes	yes	yes
ages	yes	yes	yes	yes
sex	yes	yes	yes	yes
mother's educ	yes	yes	yes	yes
father's educ	yes	yes	yes	yes
# of books	yes	yes	yes	yes
internet	yes	yes	yes	yes
aid	yes	yes	yes	yes
previous math grade	yes	yes	yes	yes
establishment FE	yes	yes	yes	yes
Observations	189,946	179,696	130,483	124,312
R-squared	0.447	0.450	0.462	0.455

Notes: Cluster robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

(1): sample restricted to those who did not change school because of closure

(2): sample restricted to (1) and to those classes where the share of newcomers are less than 0.1

(3): sample restricted to (1) and to school year 2006/7 and 2007/8

(4): sample restricted to (2) and to school year 2006/7 and 2007/8

the last two specification, the explanation is probably the same as before.

Interestingly, the estimates on reading scores are very different (reported in the Appendix). In the reduced form model, reorganization has significant negative effect. However, the neither the class size nor the difference between the establishment and class size are significant, altough the parameters are mostly negative.

6 Discussion

In this section I examine the potential threats to the identification strategy and compare my results to the findings in the literature.

The validity of the instruments were discussed in Section 4, I do not recapitulate them. Instead, I examine other issues that may affect my results.

First one is selection. Although students have to write the tests of the assessment, they are not required to fill in the background questionnaire. As I use these characteristics as control variables, my sample size is reduced due to blank questionnaires. If the non-responding students are nonrandom, e.g. they are more likely to send back blank questionnaire in merged establishments then that would cause a bias.

Table 11 shows the average math scores by institutional change and by sample in school year 2007/8. Sample of item-non-response contains those children who have math score, however at least one of their characteristics is missing that was used as a control in the estimation. The other sample is the one that was used for the estimation.

Table 11: The average math scores by institutional change and by sample in 2007/8

	no change	merger	reorganization
sample (item-non-response)	479.45	468.68	452.79
sample (estimation)	497.36	486.98	472.81

There are remarkable differences between the two samples, however, the important thing is whether the difference between the scores of students at non-affected and merged establishments in the first sample compared to the differences between the non-affected and merged establishments in the second sample is significant different (similarly to the diff-in-diff method). The results show insignificant differences, hence the item-non-response does not affect the estimates.

A second issue is interpretation. Although the policy change enables me to identify the effect of adding a student to a class, this is not exactly the effect of class size. Even if the composition of students is unchanged, the arrival of a new student to the class may cause disruption, children have to adapt to the new situation. Moreover, teachers may be affected by the consolidation as well. Kyriacou and Harriman (1993) document that teachers are stressed during mergers hence they might not be able to concentrate completely on teaching. Although student performance is measured at the end of the school year, months after the consolidation, it is possible that estimates are greater in absolute value than the true effect of class size because of reasons.

This is partly confirmed if a different specification of the reduced form is used which distungiushes among short-term and medium-term effects. Table 12 shows these esimates. Let Z_a^b be 1 if Z happened to the establishment, $Z = \{merger, reorganization\}$, in year a, b years after the institutional change and 0 otherwise. E.g. $merger_7^2$ is 1 for those establishments which were merged in 2007 and it is two years after this change. Then one can distinguish among short-term and medium-term effects of institutional changes happened in 2007 and short-term effects for changes happened in 2008.

School consolidation has negative effect only in the short-run, moreover, the second wave of the consolidation has no significant effect. This evidence strengthen the previous argument about disruption but using these variables as instruments does not alter the effect of class size remarkably.

To evaluate my results, I compare my estimates to the literature. (Krueger, 1999) used percentile ranking instead of standardized scores hence his estimates are not directly comparable. Finn and Achilles (1990) used the same experiment and they report effects sizes of about .13-.27 standard deviation if class size is reduced by 8 students. (Angrist and Lavy, 1999) found similar results for 5th graders and half as big effect for 4th graders. My estimates regarding the effect of class size is between -1.2 and -3 points (1.2% and 3% of the standard deviation), therefore increasing the class size by 8 would result in .09-.25 standard

Table 12: The dynamics of the effect of mergers and reorganizations on math scores

	(1)	(2)	(3)	(4)	(5)	(6)
$merger_7^1$	1.981	-5.064**	-5.942**	-5.306**	-5.334**	-5.623**
	(2.329)	(2.519)	(2.674)	(2.571)	(2.558)	(2.423)
$merger_7^2$	-10.02***	-2.472	-3.555	-2.800	-3.207	-2.957
	(2.817)	(2.986)	(3.149)	(3.044)	(3.068)	(3.008)
$merger_8^1$	-9.203**	1.415	0.211	1.344	0.780	-0.272
	(4.642)	(4.709)	(4.438)	(4.475)	(4.478)	(4.466)
$reorg_7^1$	-4.982	-12.03**	-14.58***	-12.26**	-13.03**	-14.75***
	(5.405)	(5.489)	(5.498)	(5.249)	(5.332)	(5.334)
$reorg_7^2$	-1.789	5.565	3.001	5.047	3.545	6.707
	(5.445)	(5.528)	(5.449)	(5.246)	(5.179)	(5.010)
$reorg_8^1$	-10.93	-1.541	-2.683	1.893	3.104	2.223
	(6.822)	(6.886)	(7.001)	(5.944)	(5.937)	(5.407)
year	-	yes	yes	yes	yes	yes
type of maintainer	-	-	yes	yes	yes	yes
ages	-	-	-	yes	yes	yes
sex	-	-	-	yes	yes	yes
mother's educ	-	-	-	yes	yes	yes
father's educ	-	-	-	yes	yes	yes
# of books	-	-	-	-	yes	yes
internet	-	-	-	-	yes	yes
aid	-	-	-	-	yes	yes
previous math grade	-	-	-	-	-	yes
establishment fixed effect	yes	yes	yes	yes	yes	yes
Observations	195,786	195,786	195,786	195,786	195,786	- 195,786
R-squared	0.179	0.182	0.182	0.297	0.316	0.549

Notes: Cluster robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

deviation drop in math scores which is quite similar.

Concerning the effect of establishment size, my results are not directly comparable to the papers' in the literature since I used the number of children in the 8th grade to proxy the establishment size. Apart from this, it is odd that an OLS using establishment fixed effects resulted in significant negative effects but IV estimates found no significant impact. This is even more strange as (Kuziemko, 2004) used school closures and mergers as an intrument and found negative effects.

7 Conclusion

In this paper I analyzed the effect of class size and the impact of establishment size on student cognitive skills. Using observational data, these effects cannot be measured consistently since school quality can correlate with both class size and establishment size. The amendment of the Public Education Act created an exogeneous variation in these variables, as many schools were consolidated or closed. The exogeneous increase in these variables which can be exploited to overcome the endogenity problem. My estimates show significant negative effects of class size, increasing the class size by 1 would result in .01-.03 standard deviation decrease in math scores. However, the estimates are not significant in the case of reading scores.

One possible area of further research is to let the class size affect children with various characteristics differently since disadvantaged children may suffer more from increased class size.

A second extension could be to analyze why class size has no effect on reading scores. Does class size truly have no impact or some relevant factor was neglected that would explain this phenomenon.

References

Angrist, Joshua D., and Victor Lavy. 1999. "Using Maimonides' rule to estimate the effect of class size on scholastic achievement." *The Quaterly Journal of Economics*, 114(2): 533–575.

Barro, Robert J. 1991. "Economic Growth in a Cross Section of Countries." *The Quaterly Journal of Economics*, 106(2): 407–443.

Bradley, Steve, and Jim Taylor. 1998. "The Effect of School Size on Exam Performance in Secondary Schools." *Oxford Bulletin of Economics and Statistics*, 60(3): 291–324.

Duncombe, William, and John Yinger. 1999. "Performance Standards and Educational Cost Indexes: You Can't Have One Without the Other." In *Equity and adequacy in education finance.* , ed. Helen F. Ladd, Rosemary Chalk and Janet S. Hansen. Washington D.C.:National Academy Press.

Finn, Jeremy D., and Charles M. Achilles. 1990. "Answers and Questions About Class Size: A Statewide Experiment." *American Educational Research Journal*, 27: 557–577.

Hanushek, Eric A. 1997. "Assessing the effects of school resources on student performance: an update." *Educational Evaluation and Policy Analysis*, 19(2): 141–64.

Hanushek, Eric A., and Ludger Woessmann. 2009*a*. "Do Better Schools Lead to More Growth? Cognitive Skills, Economic Outcomes, and Causation." National Bureau of Economic Research Working Paper 14633.

Hanushek, Eric A., and Ludger Woessmann. 2009*b*. "Schooling, Cognitive Skills, and the Latin American Growth Puzzle." National Bureau of Economic Research Working Paper 15066.

Heckman, James J. 2000. "Policies to foster human capital." *Research in Economics*, 54: 3–56.

Kertesi, Gábor, and Gábor Kézdi. 2009. "Általános iskolai szegregáció Magyarországon az ezredforduló után." *Közgazdasági Szemle*, LVI: 959–1000.

Krueger, Alan B. 1999. "Experimental Estimates of Education Production Functions." *The Quaterly Journal of Economics*, 114(2): 497–532.

Krueger, Alan B. 2003. "Economic Considerations and Class Size." *Economic Journal*, 113(485): F34–F63.

Kuziemko, Ilyana. 2004. "Using shocks to school enrollment to estimate the effect of school size on student achievement." *Economics of Education Review*, 25(1): 63–75.

Kyriacou, Chris, and Phillip Harriman. 1993. "Teacher Stress and School Merger." *School Leadership & Management: Formerly School Organisation*, 13(3): 297–302.

Lannert, Judit. 2008. "The effects of demographic change on the public education budget." In *Green Book for the Renewal of the Public Education in Hungary.* , ed. Júlia Varga, János Köllő and Károly Fazekas, 275–292. Budapest:ECOSTAT.

Lazear, Edward P. 2003. "Teacher Incentives." *Swedish Economic Policy Review*, 10(3): 179–214.

Levy, Frank, and Richard J. Murnane. 2004. *The New Division of Labor.* Princeton University Press and Russell Sage Foundation.

Mankiw, N. Gregory, David Romer, and David N. Weil. 1992. "A Contribution to the Empirics of Economic Growth." *The Quaterly Journal of Economics*, 107(2): 407–437.

Murnane, Richard J., John B. Willet, Yves Duhaldeborde, and John H. Tyler. 2000. "How important are the cognitive skills of teenagers in predicting subsequent earnings?" *Journal of Policy Analysis and Management*, 19(4): 547–568.

Murray, Michael P. 2006. "Avoiding Invalid Instruments and Coping with Weak Instruments." *The Journal of Economic Perspectives*, 20(4): 111–132.

OECD. 2007. *Education at a Glance.* Paris:OECD.

Strang, David. 1987. "The Administrative Transformation of American Education: School District Consolidation, 1938-1980." *Administrative Science Quarterly*, 32(3): 352–366.

Urquiola, Miguel, and Eric Verhoogen. 2009. "Class-Size Caps, Sorting, and the Regression-Discontinuity Design." *The American Economic Review*, 99(1): 179–215.

Varga, Júlia. 2008. “Institutional structure and funding in education.” In *Green Book for the Renewal of the Public Education in Hungary.* , ed. Júlia Varga, János Köllő and Károly Fazekas, 235–258. Budapest:ECOSTAT.

A Data cleaning

First, the administrative database, KIRSTAT, has to be cleaned. The reason for it is that it contains all the locations[6] of schools, moreover, „location spells” could be identified since the databse contains information on whether the location is new, operating or closed. This comes particularly handy as in some cases the address of the locations changes, however, these teaching units are the same as before.

A shortcoming of the database is that locations are identified within schools, but these identifiers can change from year to year even if the school's identifier remains unchanged. Therefore, in order to create identifiers for panel data, one has to standardize the addresses of the locations. In some cases, as the address of the location changes, it requires to create fake addresses. Once it is done, school mergers can be identified as double observations for the same year (one is indicating the closure and the other is indicating the start of the new location).

B Tables and figures

[6]Locations are defined by address and type of school.

Table 13: Transition matrix of number of establishments of schools between 2006/7 and 2007/8

# of estab. after	**# of establishments before** 1	2	3	4	5	6	7	Total
1	1,904	35	6	2	0	0	1	1,948
2	326	373	29	4	2	0	0	734
3	136	66	82	18	6	0	0	308
4	61	16	13	28	4	0	0	122
5	37	8	9	12	10	0	0	76
6	15	5	3	0	0	12	0	35
7	9	5	0	1	4	0	0	19
8	13	5	6	2	0	5	0	31
9	9	0	0	0	0	0	0	9
10	16	1	0	0	0	0	6	23
13	19	1	1	0	0	0	0	21
Total	2,545	515	149	67	26	17	7	3,326

Notes: For each establishment, it compares the number of of establishment of schools to which it belonged between 2006/7 and 2007/8, the unit of observation is establishment.

Table 14: Transition matrix of number of establishments of schools between 2007/8 and 2008/9

# of estab. after	**# of establishments before** 1	2	3	4	5	6	7	8	9	10	13	Total
1	1,732	29	0	1	0	1	0	0	0	0	2	1,765
2	114	612	25	7	0	0	0	0	0	2	1	761
3	32	51	246	10	0	0	0	0	0	0	1	340
4	11	7	24	100	8	0	0	0	0	0	4	154
5	11	4	12	7	55	0	5	0	0	0	0	94
6	4	4	0	4	15	18	0	0	0	0	0	45
7	7	2	6	0	0	6	14	0	0	0	0	35
8	0	0	0	0	0	6	0	24	0	0	1	31
9	3	6	0	0	0	0	0	8	9	9	0	35
10	1	0	0	0	0	0	0	0	0	9	0	10
12	4	0	0	0	0	0	0	0	0	8	0	12
14	1	0	0	0	0	0	0	0	0	0	13	14
Total	1,920	715	313	129	78	31	19	32	9	28	22	3,296

Notes: For each establishment, it compares the number of establishment of schools to which it belonged in 2006/7 and 2007/8, the unit of observation is establishment.

Table 15: Total number of students in 1-8th grades by type of institutional change

	type of institutional changes				
school year	no change	reorganization	merger	closure	total
2001/2	935398	806	96	7615	943915
2002/3	914272	2710	5425	8768	8768
2003/4	874767	10697	14443	12110	912017
2004/5	860562	5624	14662	8858	889706
2005/6	844203	3449	8730	5039	861421
2006/7	694703	21909	89591	24630	830833
2007/8	763889	7891	26501	10166	808447

Table 16: Average number of students in 1-8th grades by institutional change at the establishments

	type of institutional changes				
school year	no change	reorganization	merger	closure	total
2001/2	250.10	201.5	32	79.32	245.61
2002/3	248.98	169.37	258.33	103.15	245.43
2003/4	247.31	232.54	203.42	131.63	243.46
2004/5	251.77	187.46	124.25	73.20	241.30
2005/6	244.62	143.70	119.58	76.34	238.35
2006/7	256.15	230.62	171.30	94.36	231.36
2007/8	246.81	167.89	172.08	89.96	237.15

Notes: Each row indicates the number of students that will be affected by the beginnning of the next school year.

Table 17: Average number of students in 8th grade by institutional change at the establishments

	type of institutional changes				
school year	no change	reorganization	merger	closure	total
2001/2	29.45	24.75	3	5.56	28.82
2002/3	29.20	19.75	29.61	11.78	28.77
2003/4	29.89	27.5	26.64	16.25	29.46
2004/5	31.88	24.9	16.62	8.24	30.56
2005/6	31.82	17.79	15.35	10.10	30.99
2006/7	32.82	32.31	22.22	11.97	29.75
2007/8	31.70	21.93	21.38	11.51	30.43

Notes: Each row indicates the number of students that will be affected by the beginnning of the next school year.

Table 18: Average class size in 8th grade by institutional change at the establishments

	type of institutional changes				
school year	no change	reorganization	merger	closure	total
2001/2	18.78	21.25	9	15.21	18.76
2002/3	18.90	21.25	20.75	20.72	18.93
2003/4	19.11	20.59	17.67	18.72	19.09
2004/5	19.23	16.75	16.05	16.97	19.10
2005/6	19.46	16.02	16.75	14.63	19.36
2006/7	19.47	18.72	17.11	16.16	19.00
2007/8	19.99	19.57	18.32	16.22	19.84

Notes: Each row indicates the number of students that will be affected by the beginnning of the next school year.

Table 19: Share of classes by number of students and type of institutional change in 2007

		2007		
		before	after	t-statistics
Share of classes with less than 11 students				
	no change	.056	.054	-0.36
	reorganization	.108	.106	-0.05
	merger	.154	.089	-2.65
Share of classes with 11-20 students				
	no change	.478	.448	-2.12
	reorganization	.508	.424	-1.13
	merger	.524	.469	-1.52
Share of classes with 21-25 students				
	no change	.294	.305	0.89
	reorganization	.266	.254	-0.20
	merger	.192	.270	2.75
Share of classes with 26-30 students				
	no change	.146	.164	1.88
	reorganization	.109	.168	1.27
	merger	.108	.157	2.13
Share of classes with 31-35 students				
	no change	.021	.026	1.09
	reorganization	.006	.045	1.86
	merger	.019	.010	-0.95
Share of classes with more than 35 students				
	no change	.001	.000	-0.46
	reorganization	0	0	0
	merger	.001	.003	0.56

Table 20: Share of classes by number of students and type of institutional change in 2008

		2008		
		before	after	t-statistics
Share of classes with less than 11 students				
	no change	.052	.053	0.17
	reorganization	.081	.062	-0.29
	merger	.149	.092	-1.30
Share of classes with 11-20 students				
	no change	.446	.447	0.04
	reorganization	.459	.589	1.12
	merger	.496	.574	1.20
Share of classes with 21-25 students				
	no change	.305	.301	-0.28
	reorganization	.306	.185	-1.25
	merger	.232	.194	-0.75
Share of classes with 26-30 students				
	no change	.169	.168	-0.03
	reorganization	.126	.146	0.26
	merger	.108	.117	0.22
Share of classes with 31-35 students				
	no change	.025	.027	0.47
	reorganization	.027	.015	-0.35
	merger	.013	.021	0.56
Share of classes with more than 35 students				
	no change	.001	.030	0.09
	reorganization	0	0	0
	merger	0	0	0

Table 21: Share of teachers by age and type institutional change in 2007

		2007		
		before	after	t-statistics
Share of teacher under age 25				
	no change	.018	.017	-0.34
	reorganization	.025	.024	-0.13
	merger	.022	.023	0.33
Share of teacher between age 25-30				
	no change	.096	.092	-1.34
	reorganization	.108	.111	0.13
	merger	.112	.105	-0.72
Share of teacher between age 31-35				
	no change	.120	.119	-0.09
	reorganization	.108	.121	0.75
	merger	.120	.121	0.11
Share of teacher between age 36-40				
	no change	.142	.142	0.09
	reorganization	.122	.132	0.57
	merger	.148	.147	-0.04

Table 22: Share of teachers by age and type institutional change in 2008

		2008		
		before	after	t-statistics
Share of teacher under age 25		before	after	t-statistics
	no change	.018	.0159	-1.66
	reorganization	.031	.017	-1.12
	merger	.025	.020	-0.55
Share of teacher between age 25-30				
	no change	.093	.083	-3.36
	reorganization	.129	.117	-0.46
	merger	.105	.090	-0.98
Share of teacher between age 31-35				
	no change	.120	.117	-0.68
	reorganization	.107	.115	0.29
	merger	.111	.133	1.90
Share of teacher between age 36-40				
	no change	.142	.132	-2.90
	reorganization	.129	.141	0.43
	merger	.178	.142	-1.88

Table 23: Share of math teachers with no qualification by institutional change in 2007 and in 2008

	2007			2008		
	before	after	t-statistics	before	after	t-statistics
no change	.029	.025	-1.07	.026	.021	-1.36
reorganization	.026	.022	-0.22	0	.029	1.55
merger	.024	.030	0.66	.018	.028	0.65

Table 24: Share of students by mother's education, before and after the consolidation, establishment averages

		2007			2008		
		before	after	t-statistics	before	after	t-statistics
less than 8 grade	no change	.022	.023	0.09	.022	.025	1.88
	reorganization	.017	.014	-0.44	.034	.014	-0.83
	merger	.020	.027	1.26	.036	.024	-1.17
8 grade	no change	.207	.206	-0.21	.207	.209	0.43
	reorganization	.245	.277	0.89	.269	.283	0.33
	merger	.231	.231	-0.03	.275	.291	0.61
technical school	no change	.066	.065	-0.76	.064	.066	1.05
	reorganization	.074	.050	-2.44	.092	.079	-0.46
	merger	.061	.067	1.22	.070	.088	1.91
vocational school	no change	.232	.234	0.57	.236	.249	3.32
	reorganization	.265	.268	0.13	.270	.284	0.41
	merger	.271	.256	-1.51	.261	.257	-.20
high school graduate	no change	.307	.307	-0.12	.310	.293	-3.73
	reorganization	.273	.259	-0.58	.230	.243	0.35
	merger	.291	.296	0.43	.238	.235	-0.12
college	no change	.122	.122	-0.01	.120	.117	-1.13
	reorganization	.105	.103	-0.12	.090	.069	-0.96
	merger	.094	.102	1.19	.094	.085	-0.73
university	no change	.039	.040	0.30	.038	.037	-0.29
	reorganization	.017	.026	0.80	.012	.024	1.25
	merger	.028	.019	-2.54	.022	.016	-0.93

Table 25: The effect of mergers and reorganizations on reading scores

	(1)	(2)	(3)	(4)	(5)	(6)
merger	5.449***	-0.343	-0.594	-0.668	-0.613	-1.023
	(1.597)	(1.650)	(1.648)	(1.539)	(1.514)	(1.485)
reorganization	-3.084	-8.282**	-8.965***	-5.689*	-5.210*	-7.597***
	(3.308)	(3.340)	(3.382)	(3.019)	(3.072)	(2.826)
year	-	yes	yes	yes	yes	yes
type of maintainer	-	-	yes	yes	yes	yes
ages	-	-	-	yes	yes	yes
sex	-	-	-	yes	yes	yes
mother's educ	-	-	-	yes	yes	yes
father's educ	-	-	-	yes	yes	yes
# of books	-	-	-	-	yes	yes
internet	-	-	-	-	yes	yes
aid	-	-	-	-	yes	yes
previous math grade	-	-	-	-	-	yes
establishment FE	yes	yes	yes	yes	yes	yes
Observations	195,771	195,771	195,771	195,771	195,771	195,771
R-squared	0.171	0.173	0.173	0.308	0.333	0.501

Notes: Cluster robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 26: The effect of mergers and reorganizations on math scores

	(1)	(2)	(3)	(4)	(5)	(6)
merger	4.364**	-0.926	-1.440	-0.717	-1.020	-1.302
	(1.732)	(1.845)	(1.894)	(1.750)	(1.736)	(1.694)
reorganization	-1.308	-5.770	-7.079*	-2.723	-2.962	-2.702
	(3.945)	(3.972)	(4.104)	(3.531)	(3.441)	(3.464)
establishment-class	-0.206***	-0.191***	-0.192***	-0.151***	-0.148***	-0.145***
	(0.0496)	(0.0487)	(0.0486)	(0.0440)	(0.0432)	(0.0422)
class	1.746***	1.709***	1.709***	0.948***	0.837***	0.537***
	(0.139)	(0.137)	(0.137)	(0.118)	(0.116)	(0.105)
year	-	yes	yes	yes	yes	yes
type of maintainer	-	-	yes	yes	yes	yes
ages	-	-	-	yes	yes	yes
sex	-	-	-	yes	yes	yes
mother's educ	-	-	-	yes	yes	yes
father's educ	-	-	-	yes	yes	yes
# of books	-	-	-	-	yes	yes
internet	-	-	-	-	yes	yes
aid	-	-	-	-	yes	yes
previous math grade	-	-	-	-	-	yes
establishment FE	yes	yes	yes	yes	yes	yes
Observations	195,771	195,771	195,771	195,771	195,771	195,771
R-squared	0.175	0.177	0.177	0.310	0.334	0.502

Notes: Cluster robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 27: IV estimation 1st stage, on class size

	(1)	(2)	(1)	(2)
number of newcomers in the estab	-.3398***	-.5081***	-.3216***	-.3503***
	(.0441)	(.0757)	(.0557)	(.0852)
av. number of newcomer per class	1.3941***	2.0264***	1.3492***	1.4313***
	(.1122)	(.2359)	(.1597)	(.2987)
merger	-.2205	-.2340	-.1262	-.0770
	(.2341)	(.2451)	(.2845)	(.3000)
reorganization	.4586	.5063	1.0980*	1.1156*
	(.3988)	(.4199)	(.5797)	(.6402)
year	yes	yes	yes	yes
type of maintainer	yes	yes	yes	yes
ages	yes	yes	yes	yes
sex	yes	yes	yes	yes
mother's educ	yes	yes	yes	yes
father's educ	yes	yes	yes	yes
# of books	yes	yes	yes	yes
internet	yes	yes	yes	yes
aid	yes	yes	yes	yes
previous math grade	yes	yes	yes	yes
establishment FE	yes	yes	yes	yes
Observations	189,931	179,681	130,483	124,312
R-squared	0.036	0.024	0.036	0.018

Notes: Cluster robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

(1): sample restricted to those who did not change school because of closure

(2): sample restricted to (1) and to those classes where the share of newcomers are less than 0.1

(3): sample restricted to (1) and to school year 2006/7 and 2007/8

(4): sample restricted to (2) and to school year 2006/7 and 2007/8

Table 28: IV estimation 1st stage, on establishment-class size

	(1)	(2)	(1)	(2)
number of newcomers in the estab	2.0659***	2.4752***	1.9927***	2.3396***
	(.1541)	(.2281)	(.1887)	(.2622)
av. number of newcomer per class	-2.3061***	-3.7719***	-1.9655***	-3.2098***
	(.31736)	(.6705)	(.3625)	(.7899)
merger	-.0568	.0535	.0378	.3680
	(.8044)	(.8265)	(.9953)	(1.0075)
reorganization	-.2357	-.0875	1.6505	1.1517
	(1.2418)	(1.3033)	(1.8711)	(1.9592)
year	yes	yes	yes	yes
type of maintainer	yes	yes	yes	yes
ages	yes	yes	yes	yes
sex	yes	yes	yes	yes
mother's educ	yes	yes	yes	yes
father's educ	yes	yes	yes	yes
# of books	yes	yes	yes	yes
internet	yes	yes	yes	yes
aid	yes	yes	yes	yes
previous math grade	yes	yes	yes	yes
establishment FE	yes	yes	yes	yes
Observations	189,931	179,681	130,483	124,312
R-squared	0.133	0.120	0.142	0.018

Notes: Cluster robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

(1): sample restricted to those who did not change school because of closure

(2): sample restricted to (1) and to those classes where the share of newcomers are less than 0.1

(3): sample restricted to (1) and to school year 2006/7 and 2007/8

(4): sample restricted to (2) and to school year 2006/7 and 2007/8

Table 29: The effect of class size and establishment size on reading scores, 2nd stage

	(1)	(2)	(1)	(2)
class	-0.605	0.437	-0.817	-1.112
	(0.521)	(0.686)	(0.680)	(1.270)
establishment-class	-0.0564	0.0360	-0.206	-0.115
	(0.107)	(0.118)	(0.140)	(0.146)
year	yes	yes	yes	yes
type of maintainer	yes	yes	yes	yes
ages	yes	yes	yes	yes
sex	yes	yes	yes	yes
mother's educ	yes	yes	yes	yes
father's educ	yes	yes	yes	yes
# of books	yes	yes	yes	yes
internet	yes	yes	yes	yes
aid	yes	yes	yes	yes
previous math grade	yes	yes	yes	yes
establishment FE	yes	yes	yes	yes
Observations	189,931	179,681	130,483	124,312
R-squared	0.396	0.396	0.398	0.130

Notes: Cluster robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

(1): sample restricted to those who did not change school because of closure

(2): sample restricted to (1) and to those classes where the share of newcomers are less than 0.1

(3): sample restricted to (1) and to school year 2006/7 and 2007/8

(4): sample restricted to (2) and to school year 2006/7 and 2007/8

Table 30: The dynamics of the effect of mergers and reorganizations on reading scores

	(1)	(2)	(3)	(4)	(5)	(6)
$merger_7^1$	8.736***	-0.793	-1.310	-1.075	-1.080	-1.244
	(2.130)	(2.275)	(2.408)	(2.226)	(2.191)	(2.110)
$merger_7^2$	3.844*	-1.530	-2.117	-0.746	-1.186	-0.984
	(2.286)	(2.453)	(2.570)	(2.360)	(2.344)	(2.348)
$merger_8^1$	-0.415	-1.290	-1.988	-0.653	-1.263	-2.099
	(3.448)	(3.520)	(3.335)	(3.250)	(3.198)	(3.245)
$reorg_7^1$	2.067	-7.463	-8.996*	-5.086	-5.883	-7.419*
	(4.618)	(4.687)	(4.831)	(4.298)	(4.359)	(4.137)
$reorg_7^2$	7.396	2.037	0.494	3.237	1.627	4.439
	(5.619)	(5.684)	(5.807)	(5.248)	(5.053)	(5.401)
$reorg_8^1$	-6.710	-7.716	-8.377	-3.244	-1.828	-2.750
	(7.189)	(7.260)	(7.341)	(5.969)	(5.828)	(5.476)
year	-	yes	yes	yes	yes	yes
type of maintainer	-	-	yes	yes	yes	yes
ages	-	-	-	yes	yes	yes
sex	-	-	-	yes	yes	yes
mother's educ	-	-	-	yes	yes	yes
father's educ	-	-	-	yes	yes	yes
# of books	-	-	-	-	yes	yes
internet	-	-	-	-	yes	yes
aid	-	-	-	-	yes	yes
previous math grade	-	-	-	-	-	yes
establishment FE	yes	yes	yes	yes	yes	yes
Observations	195,771	195,771	195,771	195,771	195,771	195,771
R-squared	0.171	0.173	0.173	0.308	0.333	0.501

Notes: Cluster robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1