ISSN 1503-299X

WORKING PAPER SERIES

No. 2/2012

School building conditions and student achievments: Norwegian evidence

Arnt Ove Hopland
Department of Economics, Norwegian University of Science and Technology

Department of Economics

Norwegian University of Science and Technology
N-7491 Trondheim, Norway
www.svt.ntnu.no/iso/wp/wp.htm

SCHOOL BUILDING CONDITIONS AND STUDENT ACHIEVEMENTS: NORWEGIAN EVIDENCE*

Arnt Ove Hopland
Department of Economics
Norwegian University of Science and Technology
NO-7491 Trondheim
Norway
e-mail: arnt.hopland@svt.ntnu.no

Abstract

This paper studies the effects from poor school building conditions on student achievements in Norwegian primary schools based on results from national tests in mathematics, English and Norwegian. The benchmark OLS results suggest a negative relationship, but the estimates are mostly insignificant. Further, a municipality fixed effects (MFE) and an instrumental variable approach (IV) is suggested as alternatives to OLS in order to battle potential endogeneity issues due to unobservable characteristics. The results from the OLS and IV-procedures are mostly similar to the OLS results.

Version of
October 26, 2011

* I would like to thank Lars-Erik Borge, Kåre Johansen and participants at a workshop in Trondheim and a staff seminar at the University of Bergen for useful comments and suggestions. I also thank Ivar Pettersen for organizing the dataset. This paper is part of a project funded by the Norwegian Ministry of local government and regional development. The author bears the full responsibility for the analysis and the conclusions that are drawn.

1. Introduction

As in many other countries, the condition of school buildings has been a heavily discussed topic in the public debate in Norway. The present paper is inspired by this debate and aims to investigate to which extent the condition of school buildings affects student achievements in Norwegian primary schools. Some studies suggest that improving environmental conditions may gain student achievements by reducing distractions and missed school days (literature reviewed by Earthman (2002) and Mendell and Heath (2005)). This may also benefit teachers by improving their morale and reducing absenteeism and turnover, indirectly affecting student achievements (Buckley et al., 2005). However, even though this paper settles into a large economist literature studying the effects from educational expenditures[1], this specific question has been granted little attention within this literature.

To the best of my knowledge, Hopland (2011) is the only study, apart from the present, that uses an educational production function approach to investigate potential effects from school building conditions on student achievements. That study focuses on the effects from poor school facilities in eight countries using data from the TIMSS 2003 database. The empirical strategy is to estimate how the condition of school facilities affects the school contribution to test scores, using OLS and matching on propensity score to control for observable characteristics. The findings suggest that there is a negative relationship between poor school facilities and student achievements in some of the countries, but that the link is mostly insignificant. Importantly it is, due to scarcity of data, not possible to control for any unobservable characteristics that may be correlated with both test scores and building conditions when studying the TIMSS data. Thus the discussion is restricted to one of possible associations rather than robustly identified causal effects.

[1] The debate between Hanushek and Card and Krueger on the effects of resources gives a good overview of the debate in the general school spending literature. Hanushek (1996) reviews more than 90 studies and concludes that simply increasing resources leaves little hope for improved student achievements. However, Hanushek's interpretation of the literature is disputed by Card & Krueger (1996). In recent years, the debate on class size has been central in the school resource debate (e.g. Krueger (1999), Angrist and Lavy (1999) and Leuven et al. (2008)).

Another recent and highly relevant study is Cellini et al. (2010). They study effects from investments in school facilities on housing prices and student achievements in Californian school districts, using a regression discontinuity design to obtain exogenous variation in the investments. Thus they study broad effects that include but are not restricted to student achievements. Interestingly, the long-run effects on student achievements are far from strong enough to explain the effect they identify on housing prices, and they find no effects in the short run. Furthermore, their estimates are imprecise and their evidence in favor of long-run effects is not unambiguous. Thus they conclude that there is, at best, weak evidence in favor of the hypothesis that increased investments in school facilities will boost student achievements even in the long run. An interesting implication of their findings is that the value of investments in school facilities is not restricted to improvement of scholastic achievements.

Even though their results regarding the long-run effects on student achievements are not unambiguous, it will be reasonable to expect that the effects from physical work conditions (and investments in such) will be stronger in the long run than in the short run. It is unlikely that performances will have a sudden boost when school facilities are improved, since a student's performances in earlier years obviously will affect his performances in the years ahead. Thus it will take some time before effects from the improved facilities are observed. We should also keep in mind that those students who are enrolled after the investment period will only have been exposed to the good facilities. If school facilities matter, these new students should then, all other things equal, perform better than students in earlier cohorts. Thus, the finding that effects from investment in school buildings on student achievements (if any at all) are stronger in the long run than in the short run should not come as a major surprise.

Interestingly, the studies by Hopland and Cellini et al. reach similar conclusions even though they differ substantially both with respect to research questions and empirical strategies. However, there is still need for more research on this topic since Hopland's study is suffering from uncertain identification and Cellini et al., are not studying effects from building conditions directly. In this paper I aim to study the effects from school building conditions on 5th grade students in Norwegian primary schools.[2] Most 5th grade students in the highly rigid

[2] 5th grade is the third last year in Norwegian primary school.

Norwegian school system have spent all their years of schooling within the same school, giving the building conditions time to affect their achievements. I will use unique survey data for building conditions, combined with test scores from national tests in mathematics, Norwegian and English and register data. In addition, I will include school and municipality specific control variables in the regressions.

Similar to the study by Hopland, this paper investigates direct effects of building conditions rather than investments in such. Investments will obviously be correlated with building conditions, but far from perfectly, since the daily maintenance expenditures will also be an important determinant for the condition of facilities. Thus, where investments in school facilities may serve as a proxy for the quality of the school facilities, this paper studies the effects from a direct measure. I will combine OLS with and without municipality fixed effects and an instrumental variable approach in order to obtain unbiased effects of school building conditions on student achievements.

The remainder of the paper is organized as follows: Section 2 presents the data and some descriptive statistics. Section 3 presents the empirical strategies. OLS regressions act as the benchmarks while municipality fixed effects (MFE) and an instrumental variable (IV) approach is presented as alternatives in order to battle possible endogeneity due to unobservable characteristics. The results are presented in Section 4, before some concluding remarks are offered in Section 5.

2. A first look at the data

The key explanatory variable is from a survey on public school buildings performed by The Auditor General of Norway (*Riksrevisjonen*). A questionnaire was mailed to the department responsible for school buildings in 129 local governments. All large local governments (population size above 20,000) were included. For the rest a stratified random sample was drawn, with stratification based on population size and local government revenue. The response rate was as high as 85 percent and in total I have building condition data for 464 schools in 107 Norwegian municipalities.

The school building condition data are from a rather small sample of the Norwegian municipalities (107 of 430). However, the selection process conducted by The Auditor

General should guarantee a fairly representative sample, except for the skew towards more populous municipalities mentioned above. This skew in the sample should, however, not be of such magnitude that it makes generalization problematic. Each of the local governments was instructed to report between one and ten school buildings built prior to 1985.[3] New schools were excluded from the survey because the aim was to study whether maintenance was sufficient over time. Municipalities with more than ten schools were instructed to pick schools in alphabetical order. This was in order to avoid selection based on building condition, or any other potential grounds for selection.

The Auditor General survey dates from 2004. Thus, the school building conditions can be interpreted as the conditions the 5th grade students taking the test in 2009 faced when arriving on their first day at school (they started in 1st grade in fall 2005). Further, building conditions in general develop quite sluggishly and it will be fair to assume that a large majority of the students have not switched schools during their four years of completed schooling prior to the tests. Hence, most students have been exposed to the same school building conditions throughout their 'career' in primary school.

The building conditions are reported using a highly standardized four step scale, which is widely used in classification of building conditions in Norway.[4] Zero indicates a building in very good condition, in practice new buildings, while three indicates a building in severely deteriorated condition. In the econometric specification I will use two different formulations based on this index. Firstly, I will apply a flexible formulation where I include dummies for each of the categories, using the best buildings as reference category. Secondly, I will introduce a poor buildings dummy (pbuild) which equals one if the school is reported to be in category 2 or 3. Buildings in categories zero or one are in general considered to be in good condition, giving this dummy variable presentation an intuitive interpretation. We then simply compare all school buildings which are not in optimal condition to those reported to be more

[3] Among the schools that were reported are also lower secondary schools, which are also owned and operated by the local government. These are excluded from the analysis because the national tests in lower secondary school are performed in the first year (8th grade). Hence, an analysis of their test scores will to a large extent capture potential effects from the condition of the buildings in their primary school (which I cannot identify) rather than their present school. Thus, all 464 schools in the sample are either primary schools (1.-7. grade) or combined schools (1.-10. grade).

[4] Norwegian Standard 3424 building Condition Analysis (NS3424 BCA).

or less flawless, asking: Do children in poor school buildings have lower test scores than those in good school buildings?

Table 1 summarizes the different categories of the building condition index and presents descriptive statistics for the poor buildings dummy. We observe that buildings in category 2 are the most often observed, with 42 percent of the students. These buildings are considered to be in an unsatisfying condition with some need for upgrading, but the flaws are not necessarily considered as critical. The second most observed category is category 1, which indicates that the building has some signs of wear and tear, but is in good working condition. The important cut-off for this study will be between these two categories. This is because whereas category 1 buildings are considered to be in a satisfying condition, category 2 buildings are considered as being in an unsatisfying condition.

The share of students in flawless buildings (category 0) is somewhat higher than the share of students enrolled in schools with buildings in the worst category (category 3), but the shares are quite low for both categories. This indicates that a low share of the students attend schools that have buildings that are either totally flawless or in a severely deteriorated condition and that much of the distinction between good and poor school buildings will be based on the mid-categories. Finally we note that 53 percent of the students attend schools in category two or three. This gives that the poor buildings dummy has an average value of 0.53. When using this dummy in the analysis, we thus have a treatment group (students in poor school buildings) which is roughly the same size as the control group (students in good school buildings).

Table 1 About here

The remaining data is generated through that the Norwegian Directorate for Education and Training transferred the test results (with identification of the individual student) to Statistics Norway, which connected register data to the test results. Statistics Norway then anonymized the students and schools, but not the municipality in which the schools are located before making them available for research purposes. Since it is possible to identify the municipalities, I have also been able to connect more municipality specific control variables. Descriptive statistics for the control variables are given in Appendix Table A1 and they will be more closely discussed as they are introduced in the analysis. Summary statistics for the test scores in the surveyed schools are presented in Table 2. We note from the descriptive statistics that the different tests have somewhat different scaling, a point one should keep in mind when interpreting the coefficients in the empirical study. The average scores are 54 percent, 62 percent and 56 percent of the maximum value for the tests in mathematics, Norwegian and English respectively.

Table 2 About here

Finally, a brief discussion about the usefulness of the data from the Auditor General is required. There are two main concerns associated with these data. The first is a simple question of relevance due to the time gap between the survey and the tests. If many of the schools in my sample were subject to massive upgrading early in this period, my key explanatory variable will not be especially interesting at all. The second concern is related to sample selection bias, due to the fact that I in most cases only have a sample of the schools in a municipality rather than all. These concerns must be addressed properly before moving on to the empirical analysis.

To check the relevance of the building condition data, I have contacted the local governments and asked whether any of the reported schools were subject to major upgrading between the survey (2004) and the tests (2009). As discussed in the introduction, it is likely that it will take some time from an investment in improved building conditions until student achievements are improved. Hence, it will only be problematic if major renovation projects have been performed fairly early in this period. Since I contacted the local governments after Statistics Norway had connected the school building conditions to the test score data base, I am unfortunately unable to remove those schools that have been upgraded from the sample. This is due to the anonymization of the schools implemented by Statistics Norway when connecting these data. However, the feedback from the local governments indicates that this is a problem for less than 10 percent of the schools in my sample. Thus this should not corrupt the results critically.

Another potential flaw of the data is that I for a majority of the municipalities do not have the full population of schools. These 68 municipalities are in general more populous than those which have reported all schools, something which is clearly illustrated by the number of students in these municipalities. Of the roughly 13,500 students that are enrolled in the surveyed schools, more than 11,000 are from one of these 68 municipalities. The selection process specified by the Auditor General should ensure that the municipalities do not perform strategic reporting. However one may still have that the reported schools differ from the non-reported, since only schools built prior to 1985 has been reported. Thus, I need to investigate the possibility of a sample selection bias. To check for this I utilize the fact that even though I have building conditions for only a sample of the schools, my data set includes both test scores as well as all the control variables for the full population of schools. The test goes as follows: I have estimated test scores using a municipality fixed effects model using the 68 municipalities from which I have building conditions for only a sample of the schools, including also the schools for which I do not have building condition data. The model includes a dummy that equals one if the school was not reported to the survey and the variables that are most likely to be associated with sorting.

Any significant estimates for the dummy indicating that the school was not reported will then indicate that I have sample selection issues that are not captured by the observable control variables. This will then make generalization of the results difficult, since a positive (negative) estimate for the dummy variable would imply that my sample has an overweight of poorer (better) performing students. However, the results from Table 3 indicate that this is not a problem, since the dummy does not have a significant impact on any of the three test scores and the sign of the coefficient is not even consistent. Hence, it seems safe to assume that the reported schools are representative for their respective municipalities (conditioned on observables), and thus that the analysis will not suffer from problems related to sample selection.[5]

Table 3 About here

3. Empirical strategies

[5] Appendix Table A2 presents a different test. There I place the dummy indicating that the school has not been reported on the left hand side and estimate a linear probability model with municipality fixed effects. The idea then is to test whether the probability that the school was not reported is dependent upon observable characteristics. With two exceptions, all the included ‘sorting variables’ come out as insignificant. We only observe some fairly small effects from school size and the educational level of the students’ mothers. Thus, also this test indicates that the analysis will not be plagued by a sample selection bias.

I start out by estimating a standard educational production function using OLS

$$y_{ijm} = \beta_0 + \boldsymbol{\alpha}_{jm}\text{Condition}_{jm} + \boldsymbol{x}_{ijm}\boldsymbol{\beta}_x + \boldsymbol{\theta}_{jm}\boldsymbol{\beta}_\theta + \boldsymbol{\delta}_m\boldsymbol{\beta}_\delta + u_{ijm} \tag{1}$$

where y_{ijm} is the test score for student *i* in school *j* located in municipality *m*. $\boldsymbol{\alpha}_{jm}$ captures the effect from the included measure(s) of building condition. $\boldsymbol{x}_{ijm}$ is a vector of individual and family characteristics, $\boldsymbol{\theta}_{jm}$ is a vector of school specific controls and $\boldsymbol{\delta}_m$ is a vector of variables describing the municipality. The OLS estimates may still be suffering from bias due to omitted variables, even when controlling for the full set of observable characteristics. However, it is not given in which direction OLS will be biased, as illustrated by the following examples.

It is unlikely that all characteristics of a good teacher are observable in the data. Thus, if good teachers have a positive effect on student achievements and sort themselves into schools with good buildings, OLS will tend to overestimate negative effects from poor building conditions. A similar effect will occur if resourceful parents sort their children into schools with good building conditions, since it is unlikely that the controls capture all relevant characteristics of the family background and peer effects.[6]

Compensatory or regressive policies are other potential causes of bias. If policy makers believe that school building conditions are important for student achievements, this may lead them to upgrade school buildings where achievements are low. This will tend towards an underestimation of negative effects from poor school buildings when using OLS. Regressive policies could occur if politicians observe that voters in school districts with poor student achievements are less likely to vote and will tend to bias OLS in the opposite direction.

As we see, there are good reasons to expect that the OLS analysis will be plagued by endogeneity due to unobservable characteristics. Furthermore we have seen that it is not clear in which direction the OLS estimates will be biased. The endogeneity problems may arise in

[6] The Norwegian school district regulations are highly rigorous, in practice reducing the possibility for parents to affect the choice of public school to physically moving to another school district. The possibility to assign children to private schools is also very limited in Norway. Thus parental sorting between schools may not be a very serious issue when dealing with Norwegian data. However, I cannot completely rule it out.

two dimensions, between municipalities and between schools within a municipality. The first of these may be handled by including municipality fixed effects. All variables in the $\boldsymbol{\delta}_m$ vector will then be placed in a municipality specific constant term, giving us equations of the form

$$y_{ijm} = \phi_m + \boldsymbol{\alpha}_{jm}\text{Condition}_{jm} + \boldsymbol{x}_{ijm}\boldsymbol{\beta}_x + \boldsymbol{\theta}_{jm}\boldsymbol{\beta}_\theta + u_{ijm} \tag{2}$$

where ϕ_m captures the municipality fixed effects. This effectively rules out bias caused by omitted municipality specific variables. What then remains of the omitted variable problem is the possibility for sorting based on unobservable characteristics between schools within each municipality.

Importantly, we will see in the next section that the data indicates that sorting across municipalities is not an important problem for this study. This is consistent with studies of teacher turnover in Norway which indicate that teachers are more likely to move between schools within the same municipality than to move across municipalities (see Bonesrønning et al. (2005) and Falch and Strøm (2005)). Similar geographical constraints will also apply for parents. Hence, it is also likely that parental sorting to a large extent will take place within municipalities. Thus, the main worry for the analysis will be related to sorting between schools within the municipalities. Such within municipality sorting based on school building conditions will bias both the OLS and MFE estimates if the control variables do not capture all relevant effects of teacher quality, individual characteristics and family background. To solve this I need to find an instrumental variable (IV) that removes the bias due to such sorting.

Akerhielm (1995) and Wößmann and West (2006) use the average class size in the school and cohort respectively as instrument for actual class size, utilizing that this removes causality problems related to within school sorting.[7] Analogue to this, I use the average school building condition in the municipality as instrument for the individual school's building condition to remove endogeneity due to within municipality sorting.

[7] Wößmann and West utilize information about two cohorts in each school, allowing them to also control for school fixed effects. Akerhielm does not control for school fixed effects in her paper.

There are two requirements that must be fulfilled in order for an instrument to be valid. Firstly, it must be strongly correlated with the endogenous explanatory variable. Secondly, it must not have any effects on the dependent variable apart from the indirect effect it has through the endogenous explanatory variable. The first requirement is obviously fulfilled; the average school building conditions are as observed from Table 4 strongly correlated with the poor buildings dummy. Further, it will also remove the problems related to sorting of teachers or students to the schools with the best building conditions within each municipality, since we utilize the average of the reported schools. Table 4 presents, in addition to the correlation between the instrument and the poor buildings dummy, descriptive statistics for the instrument.

Table 4 About here

Importantly, the average school building condition in a municipality will be exogenous to the individual student achievements. It is reasonable to assume that the average building condition only affects the students through that the condition of their school building is a part of the average. A further advantage by using the suggested IV approach is that the averages will be less sensitive to renovation projects on the individual school in the period 2005-2009. This will also reduce the potential measurement problems caused by the time-gap between the collection of data on school building conditions and the national testing.

Note that in some of the municipalities there is only one school. In these municipalities we will have that the instrument is exactly identical to the endogenous explanatory variable. This should not be a problem for the instrument validity, since municipalities with only one school will not have any potential for sorting between schools within the municipality in the first place.

The suggested instrument should ensure that endogeneity issues related to any form of within municipality sorting are resolved. However, one potential worry arises from that the average school building conditions may be correlated with other resource factors in the municipality which are also important for student achievements. Note that if there are any municipality specific factors that are related to both average school building conditions in the municipality and student achievements that I am unable to control for, this will invalidate the instrument. I will thus have to return to the discussion regarding the instrument validity in the proceeding section, where the empirical results are discussed.

4. Results

Table 5 About here

Table 5 presents results from the OLS regressions where each of the three tests has been analyzed separately. In the regressions in the upper part, I have included dummies for each of the three least favorable categories, leaving the best buildings as reference. In the lower parts of the table I use the poor buildings dummy as the key explanatory variable. Columns (A)-(C) give results from simple regressions where the building condition is the only explanatory variable included, while control variables are gradually added in the remaining columns.

From the three-dummy formulation we observe that the signs, with three exceptions, are negative, as expected. The positive estimates are all far from being significant at any conventional level of significance, and are thus to be considered as estimated zeroes. There are no significantly negative effects from the category 1 dummy, and all positive estimates are for this category. This is also expected, since buildings in this category are considered to be in good working condition. Notably, category 2 has consistently stronger negative estimated effects than the poorer category 3 even though the difference is not statistical significant. The slightly stronger observed effect from category 2 buildings may to some extent come from the relatively few schools in category 3 compared to category 2.

The one-dummy specification with a separation between schools in good (category 0 and category 1) and poor (category 2 and category 3), is a simplification of the model which involves two restrictions. Firstly, I restrict the coefficient for the category one dummy to be equal to zero. Secondly, I restrict the coefficients for the categories 2 and 3 to be identical. Tests of the joint hypothesis indicate that this is a reasonable simplification of the model.[8] The

[8] This is found by using a simple F-test. The formula for the F-test can be written as $F = \frac{\left(R_{ur}^2 - R_r^2\right)/q}{\left(1-R_{ur}^2\right)/\left(n-k-1\right)}$.

R_{ur}^2 and R_r^2 are the R-squared of the unrestricted and restricted specifications respectively, q is the number of restrictions imposed (2), and $\left(n-k-1\right)$ is the degrees of freedom in the unrestricted specification. The two R-remainder of the study will focus on this specification because of its intuitively appealing interpretation.

In the simple regressions I find a significantly negative coefficient on test scores in both mathematics and English from the poor buildings dummy. A coefficient value of -0.653 for mathematics indicate that students in poor school buildings are expected to score roughly 7 percent of a standard deviation lower than those in good buildings. The estimated effect from the poor school buildings dummy on the English test scores is -0.701 which indicates that students in poor school buildings score roughly 9 percent of a test score standard deviation lower than students in good school buildings on the English reading test.

In the columns (D)-(L) I gradually extend the model by including relevant explanatory variables. Firstly, I include characteristics about the student and his family in columns (E)-(F). These are the student's gender and the parents' income and educational level. In columns (G)-(I) I extend the model with school specific controls. The teacher/student ratio is important since it is a measure of the general resource use in the school and may very well be correlated with resources spent on maintaining the building infrastructure. It is calculated as the number of teacher man years in the school divided by the number of students. Further I include the number of students, the share of teachers with a license to teach and a dummy indicating whether the school is a pure primary school (1.-7. grade) or a combined school (1.-10. grade). The dummy equals one if the school is a combined school.

The variables describing the municipality are included in columns (J)-(L). These include the average gross income and the general educational level of the population which are given from the test score data bank provided by Statistics Norway. In addition to these I include a set of control variables that I have connected to the dataset myself. These are the local governments' revenues and funds, population growth in the municipality, the share of socialists in the local council and a variable describing the level of political fragmentation in the local council. The additional municipality controls are similar to the variables used in Borge and Hopland's (2011) investigation of determinants of building conditions in

---

squares are identical in most of the specifications and in these cases we simply obtain an F-value of 0. We can thus not reject the joint hypothesis that the coefficient for category 1 dummy is zero and that the coefficients for the categories 2 and 3 dummies are identical.

Norwegian local governments. As part of their study, they analyzed the same school building conditions as I use in the present paper.

Interestingly the coefficients for the poor buildings dummy do not change dramatically when including the large set of control variables. However, when using the more general specifications we only observe significant effects from poor school buildings on the test scores in English. A coefficient value of -0.499 indicates a negative treatment effect of roughly 6 percent of a test score standard deviation in the most general specification. As discussed in Section 3, it will be useful to check whether the municipality specific controls used in the OLS analysis capture all relevant municipality specific effects. In Table 6 I therefore repeat the analysis, but now include municipality fixed effects in order to take into account all variation on the municipality level.

Table 6 About here

We observe that including municipality fixed effects in the regressions do not change the coefficients much, but that the significance is reduced so that none of the coefficients are significant at any conventional level of significance. However, the observation that the coefficients are stable is important, since it indicates that there does not seem to be any serious problems related to unobservable characteristics on the municipality level. This is consistent with the observation from Appendix Table A3 which reports estimations of the building conditions (a proxy of the first-stage regressions). From that we observe that the coefficient for the average building condition is not sensitive to inclusion of municipality specific controls when estimating the actual building condition. Even though these results cannot be considered as proof of the exogeneity of the instrument, they are certainly not inconsistent with it.

Table 7 About here

Table 7 reports the results from the second stage of the instrumental variable approach where county dummies are included in order to capture any unobservable geographical characteristics. We observe that the first stage-F is far above the rule of thumb of 10 suggested by Staiger and Stock (1997), indicating that the instrument is sufficiently correlated with the endogenous explanatory variable. We still observe that all the estimated coefficients are negative, but that most of them are somewhat less precisely estimated than when using OLS. This is expected since introducing IV as an alternative to OLS means trading bias for precision.

The estimated coefficients are quite similar to the ones obtained when using OLS and MFE when estimating test scores in mathematics and Norwegian. However, when estimating the test scores in English we observe a rather large increase in the absolute value of the coefficient for the poor buildings dummy. Furthermore, the estimation of the English test score in the most general model also provides the only significant coefficient for the poor buildings dummy.

A coefficient value of -1.304 for the poor buildings dummy indicate that students in poor school buildings are expected to score roughly 16 percent of a standard deviation lower in English than those in good buildings. The somewhat stronger effect from poor school buildings on the test scores in English is also observed (though to a lesser extent) in the OLS and MFE estimations, and thus seems to be a robust finding. However, it is far from obvious why this is the case.

One final worry must be addressed before concluding the paper. As discussed earlier, it may be problematic that I cannot control for municipality fixed effects when using this instrument. It is not given that fixing the effects at the county level will solve problems related to geographical fixed effects, due to the rather high aggregation level.[9] In order to test if the results are sensitive to the inclusion of geographical fixed effects a test of robustness is provided in the Appendix. Appendix Table A8 reports results from IV regressions with two alternative levels of geographical controls. The upper part of the table controls for less than the one reported in the main text, and includes no geographical dummies. The lower part of the Table reports results where labor market region dummies are included. This is a level between the municipality and the county and thus captures more geographical fixed effects than the benchmark. The latter should be interpreted with some caution since I end up with only one municipality in many of the regions, and thus loose a lot of variation, due to the low number of municipalities in the sample. The low variation especially gives that the standard errors are not very precisely calculated.

[9] The 107 municipalities are spread over 18 counties.

We observe that the results are mostly not sensitive to which extent I choose to control for geographical fixed effects. All coefficients for the poor buildings dummy are quite similar to the benchmark estimation with county dummies when the regional dummies are used instead. This indicates that the county dummy specification captures the same unobserved geographical characteristics as the lower aggregation level. When estimating the model without any geographical dummies, we yet again observe that most of the results do not seem to be sensitive to fixed geographical effects. The only exception is the coefficient for the poor buildings dummy when estimating the English test scores in the most general model. This is reduced quite heavily when no geographical fixed effects are taken into account.

To sum up the results from the empirical approaches, we observe that the findings do not differ heavily between the three suggested approaches OLS, municipality fixed effects and IV. This indicates that the basic OLS estimates are not severely biased, since the fixed effects analysis indicates that little bias is generated from unobserved attributes of the municipalities and the IV-procedure suggests that sorting between schools within the municipality does not seem to bias the estimates heavily either. The exception is the effect on English test scores, where the absolute value of the coefficient for poor buildings increase quite a lot when using IV compared to OLS or MFE.

All in all, the results indicate that there may be some negative effects from poor school buildings on student achievements, but I can in most cases not conclude that the effects are significantly different from zero. Hence the results are similar to the results from the study by Hopland (2011) and Cellini et al. (2010). Hopland also found that there seems to be a negative relationship between poor school buildings and student achievements when studying data from the TIMSS. Similar to the present study, most of the coefficients in the TIMSS study are also insignificant. Cellini et al. unveiled a tendency that investments in school infrastructure lead to improvements in scholastic achievements in the long run, but similar to the results in this study, their results are not unambiguous. Thus it seems to be a consistent finding that there is a weak tendency towards that good school buildings give better student achievements in the countries that are studied in these papers.

The low significance of the results in this paper may come from that the difference between the schools in the different building condition categories is simply too small for it to matter for student achievements. In a wealthy country, such as Norway, one may have that minor issues concerning the building conditions are sufficient for a school to be reported as having poor buildings. Further, we have that a fairly low share of the students are enrolled in schools in one of the “extreme categories” (categories 0 and 3). This also points in the direction that the difference between school buildings reported to be in good or poor condition is not very large. Hence most students are enrolled in schools with buildings that are either, “quite good” (category 1) or “slightly poor” (category 2). It is possible that the differences between these are simply not severe enough to have any impact on the achievements.

5. Concluding remarks

This paper studies the effects from school building conditions on student achievements in Norwegian primary schools using data from national tests in mathematics, English and Norwegian, combined with survey data on school building conditions. The OLS estimates indicate some negative effects from poor school buildings on student achievements, but the estimates are mostly insignificant. Municipality fixed effects are used in order to control for unobservable characteristics on the municipality level. The estimates are similar to the OLS estimates, but the significance is somewhat lower. Finally, an instrumental variable approach is suggested in order to remove endogeneity due to sorting between schools within the municipality. The results from this approach are also mostly similar to the OLS estimates. The conclusion is that there seems to be some negative effects from poor school buildings on student achievements, but that the effects are mostly insignificant. This may be because the difference between the school buildings reported within the different building condition categories is simply not sufficiently large for them to affect student achievements in a rich country like Norway.

References

Akerhielm, K., 1995. “Does Class Size Matter?”, *Economics of Education Review*, 14, 229-241

Angrist, J. D., Lavy V. (1999): “Using Maimonides’ rule to estimate the effect of class size on scholastic achievement” *Quarterly Journal of Economics*, 114, 533-75

Bonerønning, H., Falch, T., Strøm, B., 2005. “Teacher sorting, teacher quality and student composition” *European Economic Review* 49 457-483

Borge, L.-E., Hopland, A.O., 2011. “Maintenance and building conditions in Norwegian local governments: Economic and political determinants” Unpublished draft.

Buckley, J., Schneider, M., Shang, Y. 2005. “Fix It and They Might Stay: School Facility Quality and Teacher Retention in Washington D.C”. *The Teachers College Record*. 107, 1107-1123

Card, D., Krueger, A.,B., 1996. “School Resources and Student Outcomes: An Overview of the Literature and New Evidence from North and South Carolina”. *Journal of Economic Perspectives*, 10, 31-50

Cellini, S.R, Ferreira, F., Rothstein, J., (2010). “The Value of School Facility Investments: Evidence from a Dynamic Regression Discontinuity Design” *Quarterly Journal of Economics*, 125, 215-261

Earthman, G.I., 2002. “School Facility Conditions and Student Academic Achievement”. UCLA’s Institute for Democracy, Education and Access (IDEA) Paper no. wws-rr008-1002

Falch, T., Strøm, B., (2005). “Teacher turnover and non-pecuniary factors” *Economics of Education Review*, 24 611-631

Hanushek, E.A., 1996. “School Resources and Student Performance”, in *Does Money Matter? The Effect of School Resources on Student Achievement and Adult Success*, Gary Burtless, ed-Washingtion D.C: Brookings Institution

Hopland, A.O., 2011. “School facilities and student achievements: Evidence from the TIMSS” Unpublished draft

Krueger, A. (1999): ”Experimental estimates of education production functions” *Quarterly Journal of Economics* 114, 497 – 532

Leuven, E., Oosterbeek, H., Rønning, M. (2008): Quasi-experimental Estimates of the Effect of Class Size on Achievement in Norway” *Scandinavian Journal of Economics* 110(4), 663 – 693

Mendell, M. J. and Heath, G. A. (2005). Do indoor pollutants and thermal conditions in schools influence student performance? A critical review of the literature. *Indoor Air*, 15: 27-52

Riksrevisjonen, 2004-2005. *Dokument nr. 3:13 (2004-2005) Riksrevisjonens undersøkelse av kommunenes ansvar for skolebygninger*

Staiger, D., Stock, J., 1997. Instrumental variables regressions when the instruments are weak. *Econometrica*, 557-586

Wößmann, L., West, M. (2006): “Class-size effects in school systems around the world: Evidence from between-grade variation in TIMSS” *European Economic Review* 50, 695-736

Table 1. The Building condition Index

Category	Interpretation	Frequency (%)
0	Flawless building	16 %
1	Building in good working condition. Normal maintenance sufficient	31 %
2	Building which needs some improvement exceeding normal maintenance	42 %
3	Building in deteriorated condition. Critical improvements needed	11 %

	Poor buildings dummy
Average	0.53
(St.dev)	(0.50)
Obs	13,874

Table 2. Descriptive statistics. Test results

	Mathematics	Norwegian	English
Average score	26.10	19.86	22.56
(St.dev)	(9.13)	(6.66)	(8.16)
Max/min	0/48	0/32	1/40
Observations	13,474	13,162	13,457

Table 3. Test of the link between non-reported schools in participating municipalities and student achievements. Municipality fixed effects.

VARIABLES	(1) Math	(2) Nor	(3) Eng
School is not reported	-0.357	-0.00219	0.0724
	(0.230)	(0.152)	(0.257)
Father's education	0.861***	0.568***	0.594***
	(0.0470)	(0.0359)	(0.0380)
Mother's education	0.852***	0.605***	0.518***
	(0.0466)	(0.0322)	(0.0479)
Father's income	8.57e-07***	4.21e-07***	5.51e-07***
	(2.21e-07)	(1.18e-07)	(1.47e-07)
Mother's income	3.06e-06***	1.23e-06***	1.52e-06***
	(3.45e-07)	(2.43e-07)	(3.38e-07)
First generation immigrant	-5.390***	-4.834***	-1.617***
	(0.433)	(0.367)	(0.399)
Second generation immigrant	-2.638***	-2.739***	0.770*
	(0.366)	(0.257)	(0.411)
Number of students in school	-0.00140	-0.00111*	-0.00207**
	(0.00137)	(0.000605)	(0.000971)
Share of teachers with license	-2.926**	0.589	0.818
	(1.458)	(0.881)	(1.387)
Teacher/student ratio	-0.0496	-0.0131	-0.0341
	(0.0461)	(0.0333)	(0.0451)
Observations	22,100	21,651	22,058
Number of knr	68	68	68

Robust standard errors in parentheses
Constant term (not reported) included
*** p<0.01, ** p<0.05, * p<0.1

Table 4. Summary statistics for the instrument, average school building condition in the municipality.

	Average school building condition
Average	1.51
(St.dev)	(0.60)
Observations	13,874
Correlation with poor buildings dummy (n=13874)	0.54

Table 5. Estimation of test results. OLS

VARIABLES	(A) Math	(B) Nor	(C) Eng	(D) Math	(E) Nor	(F) Eng	(G) Math	(H) Nor	(I) Eng	(J) Math	(K) Nor	(L) Eng
Cat 1 (good working condition)	-0.274	-0.494	-0.632	0.0342	-0.387	-0.439	0.203	-0.336	-0.343	0.208	-0.311	-0.312
	(0.583)	(0.327)	(0.465)	(0.516)	(0.265)	(0.408)	(0.500)	(0.269)	(0.399)	(0.427)	(0.231)	(0.339)
Cat 2 (some improvement required)	-0.856	-0.742**	-1.178***	-0.411	-0.526**	-0.877**	-0.289	-0.493**	-0.796**	-0.209	-0.376*	-0.746**
	(0.567)	(0.307)	(0.434)	(0.498)	(0.246)	(0.378)	(0.482)	(0.249)	(0.364)	(0.480)	(0.209)	(0.291)
Cat 3 (critical improvements needed)	-0.761	-0.406	-0.929	-0.392	-0.204	-0.678	-0.270	-0.197	-0.551	-0.0504	-0.209	-0.562
	(0.747)	(0.434)	(0.641)	(0.640)	(0.342)	(0.582)	(0.638)	(0.343)	(0.559)	(0.636)	(0.250)	(0.473)
R-squared	0.001	0.001	0.003	0.114	0.100	0.054	0.118	0.102	0.059	0.122	0.104	0.063
Poor buildings dummy	-0.653*	-0.340	-0.701**	-0.430	-0.198	-0.539*	-0.421	-0.209	-0.518*	-0.318	-0.133	-0.499*
(= 1 if building is in Cat 2 or Cat 3)	(0.391)	(0.216)	(0.306)	(0.362)	(0.185)	(0.281)	(0.355)	(0.182)	(0.268)	(0.374)	(0.165)	(0.260)
R-squared	0.001	0.001	0.002	0.114	0.100	0.054	0.118	0.101	0.059	0.122	0.103	0.063
Individual and family characteristics				+	+	+	+	+	+	+	+	+
School characteristics							+	+	+	+	+	+
Municipality characteristics										+	+	+
Observations	13,474	13,162	13,457	12,934	12,659	12,919	12,934	12,659	12,919	12,764	12,490	12,752

Robust standard errors ((A)-(I): clustered on school level. (J)-(L): clustered on municipality level) in parentheses
Constant term (not reported) included
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 6. Estimation of test results. Municipality Fixed Effects included

VARIABLES	(A) Math	(B) Nor	(C) Eng	(D) Math	(E) Nor	(F) Eng	(G) Math	(H) Nor	(I) Eng
Poor buildings dummy	-0.479	-0.240	-0.553	-0.362	-0.167	-0.467	-0.385	-0.179	-0.485
(= 1 if building is in Cat 2 or Cat 3)	(0.469)	(0.256)	(0.365)	(0.431)	(0.234)	(0.341)	(0.425)	(0.230)	(0.335)
Individual and family characteristics				+	+	+	+	+	+
School characteristics							+	+	+
Observations	13,474	13,162	13,457	12,934	12,659	12,919	12,934	12,659	12,919
Number of municipalities	107	107	107	107	107	107	107	107	107

Robust standard errors in parentheses
Constant term (not reported) included
*** p<0.01, ** p<0.05, * p<0.1

Table 7. IV regressions

VARIABLES	(A) Math	(B) Nor	(C) Eng	(D) Math	(E) Nor	(F) Eng	(G) Math	(H) Nor	(I) Eng	(J) Math	(K) Nor	(L) Eng
Poor buildings dummy	-0.729	-0.553	-1.090	-0.365	-0.336	-0.779	-0.184	-0.378	-0.700	-0.233	-0.496	-1.304***
(= 1 if building is in Cat 2 or Cat 3)	(0.856)	(0.567)	(0.707)	(0.662)	(0.363)	(0.531)	(0.682)	(0.353)	(0.502)	(0.795)	(0.399)	(0.464)
Individual and family characteristics				+	+	+	+	+	+	+	+	+
School characteristics							+	+	+	+	+	+
Municipality characteristics										+	+	+
Observations	13,474	13,162	13,457	12,934	12,659	12,919	12,934	12,659	12,919	12,764	12,490	12,752
First stage-F	210	203	213	218	210	223	202	194	206	164	154	161

Robust standard errors (clustered on municipality level) in parentheses
County dummies and a constant term (not reported) included
*** p<0.01, ** p<0.05, * p<0.1

Appendix. Appendix tables

Table A1. Descriptive statistics, control variables.

Variable	Obs	Mean	Std. Dev.
Teacher/student ratio	13,874	10.42	2.47
Number of students in school	13,874	326	147
Share of teachers with license	13,874	0.83	0.09
Combined school dummy	13,874	0.19	0.40
Boy	13,874	0.50	0.50
Father's education	13,874	4.59	1.77
Mother's education	13,874	4.68	1.72
Father's income	13,351	473646	362740
Mother's income	13,649	256402	184242
First generation immigrant	13,874	0.03	0.18
Second generation immigrant	13,874	0.03	0.18
Percentage of pop with univ. education	13,874	26	6.91
Avg. gross income	13,874	343883	38526
Effective number of parties in the local council	13,735	4.44	0.81
Population growth (88-03, %)	13,742	11.53	10.21
Local government revenue	13,742	96.70	10.01
Funds	13,700	3.18	3.78
Share of socialists in the local council	13,735	0.39	0.11

A2. Estimating the probability that the school was not reported. Linear probability model with municipality fixed effects.

VARIABLES	Scool is not reported
Father's education	-0.000182
	(0.00302)
Mother's education	-0.00589**
	(0.00236)
Father's income	7.68e-09
	(6.49e-09)
Mother's income	-1.04e-08
	(1.63e-08)
First generation immigrant	0.0244
	(0.0279)
Second generation immigrant	0.0497
	(0.0444)
Number of students in school	-0.000370**
	(0.000168)
Share of teachers with license	0.0757
	(0.161)
Teacher/student ratio	0.00670
	(0.00630)
Observations	22,702
Number of knr	68

Robust standard errors in parentheses
Constant term (not reported) included
*** p<0.01, ** p<0.05, * p<0.1

Table A3. Estimations of school building condition dummy. OLS.

VARIABLES	(A) Building condition dummy	(C) Building condition dummy	(D) Building condition dummy
Average school building	0.465***	0.468***	0.433***
Condition	(0.0317)	(0.0324)	(0.0337)
Teacher/student ratio		-0.000168	0.00457
		(0.0121)	(0.0126)
Stud in school		-5.08e-05	-4.36e-05
		(0.000271)	(0.000294)
Teachers with		-0.352	-0.322
license (share)		(0.308)	(0.303)
Combined		0.0440	0.0374
(1.-10. grade)		(0.0594)	(0.0629)
Boy		0.00823	0.00784
		(0.00707)	(0.00712)
Father’s ed.		-0.00590**	-0.00449*
		(0.00277)	(0.00246)
Mother’s ed.		-0.00314	-0.00179
		(0.00242)	(0.00228)
Fathers inc.		-3.10e-09	6.63e-09
		(1.21e-08)	(1.09e-08)
Mother’s inc.		5.86e-09	1.69e-08
		(1.67e-08)	(1.63e-08)
First generation		0.0320	0.0289
immigrant		(0.0273)	(0.0275)
Second generation		0.0509	0.0506
immigrant		(0.0396)	(0.0361)
Percentage with university			0.000497
education in the municipality			(0.00586)
Avg. gross inc.			-3.26e-07
			(1.27e-06)
Effective number of parties			0.0819**
			(0.0393)
Population growth (88-03, %)			-0.00241
			(0.00357)
Local government revenue			-0.00484
			(0.00304)
Funds (% of revenues)			0.0141**
			(0.00619)
Share of socialists in the			0.471*
local council			(0.280)
Observations	13,874	13,289	13,116
R-squared	0.319	0.327	0.344

Robust standard errors (clustered on municipality level) in parentheses
County dummies and a constant term (not reported) included
*** p<0.01, ** p<0.05, * p<0.1

Table A4. Estimation of test scores. Full regressions corresponding to upper part of Table 5 in main text.

VARIABLES	(A) Math	(B) Nor	(C) Eng	(D) Math	(E) Nor	(F) Eng	(G) Math	(H) Nor	(I) Eng	(J) Math	(K) Nor	(L) Eng
Category 1 (best buildings)	-0.274	-0.494	-0.632	0.0342	-0.387	-0.439	0.203	-0.336	-0.343	0.208	-0.311	-0.312
	(0.583)	(0.327)	(0.465)	(0.516)	(0.265)	(0.408)	(0.500)	(0.269)	(0.399)	(0.427)	(0.231)	(0.339)
Category 2	-0.856	-0.742**	-1.178***	-0.411	-0.526**	-0.877**	-0.289	-0.493**	-0.796**	-0.209	-0.376*	-0.746**
	(0.567)	(0.307)	(0.434)	(0.498)	(0.246)	(0.378)	(0.482)	(0.249)	(0.364)	(0.480)	(0.209)	(0.291)
Category 3 (worst buildings)	-0.761	-0.406	-0.929	-0.392	-0.204	-0.678	-0.270	-0.197	-0.551	-0.0504	-0.209	-0.562
	(0.747)	(0.434)	(0.641)	(0.640)	(0.342)	(0.582)	(0.638)	(0.343)	(0.559)	(0.636)	(0.250)	(0.473)
Boy				1.878***	-1.197***	0.101	1.871***	-1.199***	0.0938	1.889***	-1.192***	0.0974
				(0.186)	(0.122)	(0.166)	(0.185)	(0.122)	(0.165)	(0.233)	(0.123)	(0.184)
Father's ed.				0.888***	0.611***	0.615***	0.867***	0.605***	0.595***	0.868***	0.590***	0.579***
				(0.0556)	(0.0398)	(0.0514)	(0.0548)	(0.0399)	(0.0510)	(0.0616)	(0.0437)	(0.0536)
Mother's ed.				0.870***	0.617***	0.508***	0.868***	0.618***	0.504***	0.883***	0.610***	0.509***
				(0.0613)	(0.0414)	(0.0526)	(0.0618)	(0.0413)	(0.0524)	(0.0585)	(0.0345)	(0.0484)
Fathers inc.				1.32e-06***	5.64e-07***	1.03e-06***	1.26e-06***	5.60e-07***	9.93e-07***	1.06e-06***	4.94e-07***	7.98e-07***
				(2.50e-07)	(1.47e-07)	(1.93e-07)	(2.46e-07)	(1.45e-07)	(1.87e-07)	(1.94e-07)	(1.48e-07)	(1.73e-07)
Mother's inc.				2.97e-06***	1.26e-06***	1.94e-06***	2.77e-06***	1.22e-06***	1.85e-06***	2.55e-06***	1.06e-06***	1.64e-06***
				(4.57e-07)	(3.31e-07)	(3.96e-07)	(4.52e-07)	(3.22e-07)	(3.83e-07)	(3.75e-07)	(2.75e-07)	(3.75e-07)
First gen.				-4.369***	-4.297***	-1.589***	-4.457***	-4.328***	-1.626***	-4.695***	-4.381***	-1.755***
immigrant				(0.573)	(0.436)	(0.544)	(0.584)	(0.437)	(0.545)	(0.646)	(0.431)	(0.584)
Second generation				-2.196***	-2.436***	1.106**	-2.479***	-2.498***	0.915**	-2.649***	-2.589***	0.785*
immigrant				(0.517)	(0.353)	(0.454)	(0.540)	(0.367)	(0.460)	(0.545)	(0.365)	(0.407)
Teacher/student ratio							-0.00589	-0.0276	-0.0205	0.0538	-0.0125	0.0137
							(0.0705)	(0.0371)	(0.0501)	(0.0720)	(0.0377)	(0.0603)
Stud in school							0.000828	-0.000579	-0.000222	-6.97e-05	-0.00136*	-0.000392
							(0.00141)	(0.000674)	(0.00102)	(0.00152)	(0.000721)	(0.000979)
Teachers with							-4.183**	-1.415	-1.925	-1.982	-0.775	-1.559
license (share)							(2.006)	(0.975)	(1.325)	(2.038)	(1.075)	(1.389)
Combined							-0.812*	-0.400	-1.261***	-0.608	-0.296	-1.264***
(1.-10. grade)							(0.488)	(0.279)	(0.395)	(0.539)	(0.285)	(0.402)
Percentage with university										-0.0402	0.0296	-0.0163
education in the municipality										(0.0288)	(0.0196)	(0.0260)
Avg. gross inc.										1.73e-05**	4.57e-06	1.97e-05***
										(6.64e-06)	(4.07e-06)	(6.40e-06)
Effective number of parties										-0.520*	-0.255*	0.301
										(0.275)	(0.153)	(0.262)
Population growth (88-03, %)										0.00891	-0.00711	-0.0404**
										(0.0246)	(0.0123)	(0.0194)
Local government revenue										-0.0422**	-0.0184*	-0.0290**
										(0.0185)	(0.00971)	(0.0132)
Funds (% of revenues)										0.0405	0.00975	0.0748**
										(0.0553)	(0.0192)	(0.0293)
Share of socialists in the local council										-0.787	0.281	1.553
										(2.258)	(1.078)	(1.573)
Observations	13,474	13,162	13,457	12,934	12,659	12,919	12,934	12,659	12,919	12,764	12,490	12,752
R-squared	0.001	0.001	0.003	0.114	0.100	0.054	0.118	0.102	0.059	0.122	0.104	0.063

Robust standard errors (clustered on school or municipality level) in parentheses. Constant term (not reported) included *** p<0.01, ** p<0.05, * p<0.1

Table A5. Estimation of test scores. Full regressions corresponding to lower part of Table 5 in main text.

VARIABLES	(A) Math	(B) Nor	(C) Eng	(D) Math	(E) Nor	(F) Eng	(G) Math	(H) Nor	(I) Eng	(J) Math	(K) Nor	(L) Eng
Poor buildings dummy	-0.653*	-0.340	-0.701**	-0.430	-0.198	-0.539*	-0.421	-0.209	-0.518*	-0.318	-0.133	-0.499*
(= 1 if building is in Cat 2 or Cat 3)	(0.391)	(0.216)	(0.306)	(0.362)	(0.185)	(0.281)	(0.355)	(0.182)	(0.268)	(0.374)	(0.165)	(0.260)
Boy				1.877***	-1.192***	0.105	1.869***	-1.195***	0.0976	1.888***	-1.188***	0.100
				(0.186)	(0.122)	(0.166)	(0.185)	(0.122)	(0.165)	(0.232)	(0.123)	(0.184)
Father’s ed.				0.888***	0.613***	0.616***	0.867***	0.606***	0.595***	0.868***	0.590***	0.578***
				(0.0555)	(0.0399)	(0.0515)	(0.0548)	(0.0400)	(0.0511)	(0.0615)	(0.0438)	(0.0536)
Mother’s ed.				0.870***	0.618***	0.508***	0.868***	0.618***	0.505***	0.883***	0.610***	0.509***
				(0.0614)	(0.0416)	(0.0528)	(0.0620)	(0.0415)	(0.0527)	(0.0584)	(0.0344)	(0.0483)
Fathers inc.				1.32e-06***	5.70e-07***	1.04e-06***	1.26e-06***	5.64e-07***	9.98e-07***	1.06e-06***	4.95e-07***	7.99e-07***
				(2.51e-07)	(1.50e-07)	(1.96e-07)	(2.46e-07)	(1.47e-07)	(1.90e-07)	(1.94e-07)	(1.47e-07)	(1.72e-07)
Mother’s inc.				2.96e-06***	1.28e-06***	1.97e-06***	2.76e-06***	1.23e-06***	1.86e-06***	2.54e-06***	1.07e-06***	1.64e-06***
				(4.57e-07)	(3.30e-07)	(3.99e-07)	(4.51e-07)	(3.22e-07)	(3.85e-07)	(3.73e-07)	(2.75e-07)	(3.77e-07)
First generation				-4.370***	-4.302***	-1.585***	-4.459***	-4.338***	-1.631***	-4.700***	-4.387***	-1.757***
immigrant				(0.572)	(0.435)	(0.543)	(0.583)	(0.436)	(0.544)	(0.645)	(0.430)	(0.577)
Second generation				-2.198***	-2.414***	1.130**	-2.487***	-2.486***	0.926**	-2.653***	-2.584***	0.788*
immigrant				(0.516)	(0.353)	(0.456)	(0.538)	(0.368)	(0.462)	(0.543)	(0.371)	(0.414)
Teacher/student ratio							-0.00341	-0.0357	-0.0281	0.0546	-0.0185	0.00724
							(0.0702)	(0.0366)	(0.0488)	(0.0731)	(0.0373)	(0.0571)
Stud in school							0.000808	-0.000636	-0.000274	-0.000106	-0.00144*	-0.000494
							(0.00141)	(0.000673)	(0.00102)	(0.00156)	(0.000731)	(0.000966)
Teachers with							-4.134**	-1.598*	-2.081	-1.973	-0.916	-1.700
license (share)							(2.011)	(0.953)	(1.303)	(2.043)	(1.030)	(1.371)
Combined							-0.809*	-0.377	-1.242***	-0.602	-0.269	-1.236***
(1.-10. grade)							(0.485)	(0.279)	(0.393)	(0.547)	(0.287)	(0.402)
Percentage with university										-0.0390	0.0320*	-0.0139
education in the municipality										(0.0286)	(0.0191)	(0.0259)
Avg. gross inc.										1.72e-05***	4.60e-06	1.98e-05***
										(6.54e-06)	(4.09e-06)	(6.36e-06)
Effective number of parties										-0.523*	-0.253	0.306
										(0.275)	(0.155)	(0.263)
Population growth (88-03, %)										0.00744	-0.00639	-0.0396**
										(0.0246)	(0.0124)	(0.0194)
Local government revenue										-0.0430**	-0.0180*	-0.0283**
										(0.0186)	(0.0101)	(0.0136)
Funds (% of revenues)										0.0404	0.00894	0.0736**
										(0.0556)	(0.0192)	(0.0295)
Share of socialists in the local council										-0.831	0.357	1.650
										(2.268)	(1.076)	(1.561)
Observations	13,474	13,162	13,457	12,934	12,659	12,919	12,934	12,659	12,919	12,764	12,490	12,752
R-squared	0.001	0.001	0.002	0.114	0.100	0.054	0.118	0.101	0.059	0.122	0.103	0.063

Robust standard errors (clustered on school level) in parentheses
Constant term (not reported) included
*** p<0.01, ** p<0.05, * p<0.1

Table A6. Estimation of test results. Municipality Fixed Effects included. Full regressions, corresponding with Table 6 in main text.

VARIABLES	(A) Math	(B) Nor	(C) Eng	(D) Math	(E) Nor	(F) Eng	(G) Math	(H) Nor	(I) Eng
Poor buildings dummy	-0.479	-0.240	-0.553	-0.362	-0.167	-0.467	-0.385	-0.179	-0.485
(= 1 if building is in Cat 2 or Cat 3)	(0.469)	(0.256)	(0.365)	(0.431)	(0.234)	(0.341)	(0.425)	(0.230)	(0.335)
Boy				1.928***	-1.192***	0.120	1.925***	-1.194***	0.115
				(0.233)	(0.121)	(0.186)	(0.232)	(0.121)	(0.185)
Father's ed.				0.891***	0.609***	0.612***	0.890***	0.606***	0.602***
				(0.0612)	(0.0443)	(0.0528)	(0.0620)	(0.0442)	(0.0527)
Mother's ed.				0.866***	0.605***	0.499***	0.866***	0.605***	0.497***
				(0.0571)	(0.0341)	(0.0483)	(0.0577)	(0.0345)	(0.0484)
Fathers inc.				1.03e-06***	4.53e-07***	7.67e-07***	1.04e-06***	4.55e-07***	7.65e-07***
				(1.86e-07)	(1.44e-07)	(1.73e-07)	(1.85e-07)	(1.43e-07)	(1.68e-07)
Mother's inc.				2.44e-06***	9.34e-07***	1.52e-06***	2.45e-06***	9.37e-07***	1.54e-06***
				(3.85e-07)	(2.73e-07)	(3.81e-07)	(3.84e-07)	(2.72e-07)	(3.78e-07)
First generation				-4.766***	-4.252***	-1.781***	-4.769***	-4.253***	-1.777***
immigrant				(0.638)	(0.422)	(0.573)	(0.639)	(0.424)	(0.571)
Second gen.				-2.779***	-2.558***	0.843*	-2.787***	-2.570***	0.809*
immigrant				(0.516)	(0.343)	(0.453)	(0.519)	(0.343)	(0.440)
Teacher/student ratio							0.0429	-0.00441	0.0121
							(0.0801)	(0.0415)	(0.0593)
Stud in school							-3.80e-05	-2.51e-05	0.000502
							(0.00170)	(0.000858)	(0.00108)
Teachers with							-0.705	-0.479	0.271
license (share)							(2.441)	(1.200)	(1.834)
Combined							-0.157	-0.279	-1.178**
(1.-10. grade)							(0.519)	(0.326)	(0.460)
Observations	13,474	13,162	13,457	12,934	12,659	12,919	12,934	12,659	12,919
R-squared	0.000	0.000	0.001	0.107	0.091	0.045	0.107	0.091	0.047
Number of knr	107	107	107	107	107	107	107	107	107

Robust standard errors in parentheses
Constant term (not reported) included
*** p<0.01, ** p<0.05, * p<0.1

Table A7. IV regressions. Full regressions corresponding with Table 7 in main text.

VARIABLES	(A) Math	(B) Nor	(C) Eng	(D) Math	(E) Nor	(F) Eng	(G) Math	(H) Nor	(I) Eng	(J) Math	(K) Nor	(L) Eng
Poor buildings dummy	-0.729	-0.553	-1.090	-0.365	-0.336	-0.779	-0.184	-0.378	-0.700	-0.233	-0.496	-1.304***
(= 1 if building is in Cat 2 or Cat 3)	(0.856)	(0.567)	(0.707)	(0.662)	(0.363)	(0.531)	(0.682)	(0.353)	(0.502)	(0.795)	(0.399)	(0.464)
Boy				1.905***	-1.187***	0.119	1.897***	-1.186***	0.114	1.923***	-1.175***	0.129
				(0.233)	(0.122)	(0.185)	(0.231)	(0.122)	(0.184)	(0.233)	(0.122)	(0.184)
Father's ed.				0.871***	0.609***	0.600***	0.865***	0.609***	0.592***	0.865***	0.594***	0.582***
				(0.0592)	(0.0404)	(0.0510)	(0.0592)	(0.0405)	(0.0508)	(0.0614)	(0.0437)	(0.0519)
Mother's ed.				0.882***	0.619***	0.518***	0.880***	0.620***	0.515***	0.883***	0.610***	0.511***
				(0.0566)	(0.0330)	(0.0481)	(0.0569)	(0.0336)	(0.0477)	(0.0572)	(0.0340)	(0.0481)
Fathers inc.				1.12e-06***	5.24e-07***	8.79e-07***	1.12e-06***	5.36e-07***	8.79e-07***	1.08e-06***	4.94e-07***	8.03e-07***
				(1.83e-07)	(1.53e-07)	(1.95e-07)	(1.81e-07)	(1.52e-07)	(1.89e-07)	(1.93e-07)	(1.44e-07)	(1.69e-07)
Mother's inc.				2.55e-06***	1.05e-06***	1.64e-06***	2.56e-06***	1.07e-06***	1.67e-06***	2.54e-06***	1.02e-06***	1.58e-06***
				(3.86e-07)	(2.82e-07)	(3.71e-07)	(3.79e-07)	(2.79e-07)	(3.69e-07)	(3.69e-07)	(2.71e-07)	(3.79e-07)
First generation				-4.798***	-4.435***	-1.809***	-4.791***	-4.435***	-1.794***	-4.917***	-4.422***	-1.825***
immigrant				(0.611)	(0.420)	(0.570)	(0.619)	(0.420)	(0.567)	(0.614)	(0.424)	(0.567)
Second generation				-2.628***	-2.609***	0.771*	-2.698***	-2.592***	0.722*	-2.681***	-2.599***	0.758*
immigrant				(0.514)	(0.366)	(0.430)	(0.541)	(0.373)	(0.432)	(0.535)	(0.369)	(0.435)
Teacher/student ratio							0.0889	-0.0179	0.0317	0.0975	0.00253	0.0437
							(0.0687)	(0.0327)	(0.0512)	(0.0712)	(0.0378)	(0.0524)
Stud in school							0.000648	-0.000886	-0.000450	0.000406	-0.00109	-0.000130
							(0.00126)	(0.000567)	(0.000881)	(0.00141)	(0.000775)	(0.000966)
Teachers with							-0.644	-0.104	0.332	-0.140	-0.264	-0.233
license (share)							(2.130)	(1.036)	(1.479)	(2.115)	(1.056)	(1.432)
Combined							-0.758*	-0.265	-1.113***	-0.656	-0.214	-1.164***
(1.-10. grade)							(0.444)	(0.277)	(0.402)	(0.474)	(0.291)	(0.417)
Percentage with university										-0.0593	0.0176	-0.0338
education										(0.0435)	(0.0233)	(0.0285)
Avg. gross inc.										1.77e-05	6.22e-06	1.97e-05**
										(1.12e-05)	(6.50e-06)	(9.23e-06)
Effective number of parties										0.185	0.195	0.989***
										(0.344)	(0.227)	(0.283)
Population growth (88-03, %)										0.00293	-0.0181	-0.0557***
										(0.0257)	(0.0138)	(0.0200)
Local government revenue										-0.0187	-0.0231*	-0.0333*
										(0.0232)	(0.0133)	(0.0172)
Funds (% of revenues)										0.0175	0.0253	0.0953***
										(0.0621)	(0.0256)	(0.0308)
Share of socialists in the local council										0.572	0.147	1.773
										(1.877)	(1.165)	(1.394)
Observations	13,474	13,162	13,457	12,934	12,659	12,919	12,934	12,659	12,919	12,764	12,490	12,752
First stage-F	210	203	213	218	210	223	202	194	206	164	154	161

Robust standard errors (clustered on municipality level) in parentheses. County dummies and a constant term (not reported) included

*** p<0.01, ** p<0.05, * p<0.1

Table A8. Robustness test. IV-regressions with no geographical dummies and regional dummies

VARIABLES	(A) Math	(B) Nor	(C) Eng	(D) Math	(E) Nor	(F) Eng	(G) Math	(H) Nor	(I) Eng	(J) Math	(K) Nor	(L) Eng
No geographical dummies												
Poor buildings dummy	-0.641	-0.381	-1.142	-0.392	-0.283	-0.897	-0.144	-0.251	-0.729	0.355	-0.148	-0.639
(= 1 if building is in Cat 2 or Cat 3)	(1.042)	(0.547)	(0.765)	(0.839)	(0.331)	(0.556)	(0.838)	(0.311)	(0.498)	(0.883)	(0.305)	(0.413)
Observations	13,474	13,162	13,457	12,934	12,659	12,919	12,934	12,659	12,919	12,764	12,490	12,752
First stage-F	177	182	178	184	191	187	167	175	166	201	201	195
Regional dummies												
Poor buildings dummy	-0.982	-0.359	-1.138*	-0.833	-0.328	-1.001**	-0.596	-0.287	-0.826	-0.223	-0.197	-1.256**
(= 1 if building is in Cat 2 or Cat 3)	(0.969)	(0.666)	(0.630)	(0.666)	(0.485)	(0.470)	(0.648)	(0.480)	(0.516)	(0.925)	(0.657)	(0.622)
Individual and family characteristics				+	+	+	+	+	+	+	+	+
School characteristics							+	+	+	+	+	+
Municipality characteristics										+	+	+
Observations	13343	13031	13329	12808	12533	12796	12,808	12,533	12,796	12,764	12,490	12,752
First stage-F	130	133	134	132	135	136	143	148	145	123	130	123

Robust standard errors (clustered on municipality level) in parentheses
Constant term (not reported) included
*** p<0.01, ** p<0.05, * p<0.1