Do school building conditions matter in a rich country? A look to Norway

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Abstract

This paper studies the link between school building conditions and student achievement in Norwegian primary schools based on results from national tests. I combine three empirical strategies. (*i*) The benchmark is to include the condition of each school and control for observable characteristics. (*ii*) To take into account possible sorting between schools within a local government, I use the average building condition in the local government. (*iii*) I extend (*i*) to include local government fixed effects (LFE). A study of the correlation between school building conditions and determinants for student achievement, indicate that the LFE estimates are the most credible.

Keywords: School facilities

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1 Introduction

As in many other countries, the condition of school buildings has been heavily discussed in Norway. Building conditions may affect student achievement through several mechanisms,[1] but the topic is not widely studied empirically. This paper is inspired by the public debate and aims to investigate the link between school building conditions and student achievement in Norwegian primary schools.

Three recent papers are closely related to this. First, Cellini et al. (2010) study effects of investments in school facilities in California, and find only limited effects on achievement. Second, Neilson and Zimmerman (2011) study a school construction project in Connecticut, and identify a large and significant effect on achievement from investment in school facilities. Third, Hopland (2013) studies the link between school facilities and student achievement in eight rich countries using the TIMSS database. He finds that although there might be a relationship between school facilities and student achievement in some countries, the link is mostly insignificant. The diverging conclusions may be due to that Neilson and Zimmerman focus specifically on poor school districts. It is plausible that the effect from investment in school facilities is stronger in poorer districts, because of poorer initial condition on the facilities.

The contribution of this paper is three-fold. First, it studies building conditions directly using a unique survey data, rather than investment in school facilities such as Cellini et al. and Neilson and Zimmerman. The survey data includes building conditions for 464 Norwegian primary schools in 107 local governments. Second, it studies effects in a broad sample of the population in a very wealthy country, rather than districts at margin of a bond passage (Cellini et al.) or a single poor district (Neilson and Zimmerman). Third, the data for building conditions are administrative, and should thus be more reliable than the survey data used by Hopland.

The identification in this study, on the other hand, is admittedly weaker than in Cellini et al. and Neilson and Zimmerman.[2] Indeed, the cross-sectional nature of the data calls for a great deal of caution when interpreting the results in this paper. Sorting within local governments is

[1] E.g. by reducing distractions and missed school days (Earthman (2002) and Mendell and Heath (2005)). Better buildings may also have a positive effect on morale (Buckley et al., 2005).
[2] I am, however, able to perform more refined tests that Hopland (2013), who can only do cross-sectional OLS due to data shortages.

addressed by using the average school building condition in the local government, instead of each school's condition, while sorting across local governments is addressed by including local government fixed effects (LFE). Hence, I investigate how sensitive the baseline results are to sorting between and within local governments separately. An investigation of the relationship between school building conditions and observable determinants of student achievement indicates that the LFE estimates are most credible.

The coefficients are quite stable across different specifications. On face value, the coefficients indicate that students in 'poor' school buildings perform up to 5-8% of a test score standard deviation (SD) worse than those in 'good' buildings. In most cases, however, the coefficients are weak in terms of statistical significance.

The paper proceeds as follows: Section 2 presents the data. The empirical strategies are discussed in Section 3, before the results are presented in Section 4. Some concluding remarks are offered in Section 5.

2 The data

The key explanatory variable is from a survey conducted by The Auditor General of Norway (Riksrevisjonen, 2004-2005). A questionnaire was mailed to the department responsible for public school buildings in 129 (of 435) local governments, including all with population size above 20,000 and a stratified random sample of the remaining. Each local government was instructed to report up to ten school buildings built prior to 1985.[3] In order to secure a representative sample, local governments with more than ten schools were instructed to pick schools in alphabetical order. The response rate was as high as 85% and in total I have building condition data for 464 primary schools in 107 local governments.

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. I apply two formulations of the scale. (*i*) Dummies for each of the categories, using the best buildings as reference category. (*ii*) A poor buildings dummy equal

[3] New schools were excluded from the survey because the aim was to study whether maintenance was sufficient over time.

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

to one for schools in category 2 or 3. Though restrictive, (*ii*) has an intuitive interpretation: Do students in 'poor' school buildings have lower test scores than those in 'good' school buildings?

The test scores are from a national test of 5th grade students in 2009 and is provided by the Norwegian Directorate for Education and Training. The school building conditions in the survey thus illustrates the building condition around the time the students started school (in 2005). Register data and school building conditions were connected to the test score data by Statistics Norway. Since I can identify the local governments (but not the students and schools), I have also added more local government specific control variables. Descriptive statistics for the control variables are given in Appendix Table A1 and they will be more closely discussed in Section 3.

Table 1 presents descriptive statistics and a first look at the relationship between school building conditions and student achievement. By far most buildings are in categories 2 (42%) and 1 (31%). These categories define an important cut-off since whereas category 1 buildings are in satisfying condition, category 2 buildings are in unsatisfying condition. Only a low share of the students attend schools with flawless (category 0) or very poor (category 3) buildings. Hence, much of the distinction between 'good' and 'poor' school buildings will be based on the mid-categories. 53% of the students attend schools in category two or three, giving the poor buildings dummy an average value of 0.53.

The test scores are transformed into a z-score with zero mean and a SD of unity.[5] Interestingly, the test scores are higher in schools with 'good' buildings. This is most easily seen in the bottom row. The differences in means between students in 'poor' and 'good' buildings are strongly significant and indicate that students in 'poor' buildings perform 5-8% of a SD worse than students in 'good' buildings. Even though this observation is interesting, it is far from certain that it indicates a causal effect. Before any conclusions can be made, I have to conduct a more formal econometric analysis.

[5] I have also estimated the models using a pooled score average, which may increase precision. The results are similar.

Table 1: Building conditions

Category	Interpretation	Frequency (%)	Math (SD)	Norwegian (SD)	English (SD)
0	Flawless building.	16%	0.06	0.08	0.09
			(0.99)	(0.97)	(1.00)
			N=2097	N=1990	N=2054
1	Building in good working condition.	31%	0.03	0.00	0.02
	Normal maintenance sufficient.		(1.00)	(1.00)	(1.01)
			N=4198	N=4105	N=4215
2	Building which needs some improvement	42%	-0.03	-0.03	-0.05
	exceeding normal maintenance.		(1.00)	(1.00)	(0.99)
			N=5688	N=5598	N=5695
3	Building in deteriorated condition.	11%	-0.02	0.01	-0.02
	Critical improvements needed.		(1.03)	(1.00)	(1.01)
			N=1491	N=1469	N=1493
	All students		0	0	0
			(1.00)	(1.00)	(1.00)
			N=13,474	N=13,162	N=13,457
	Poor buildings dummy (N=13,874)				
Avg. (SD)	0.53 (0.50)				
	Poor buildings dummy=1	53%	-0.03	-0.02	-0.04
			(1.00)	(1.00)	(0.99)
	Poor buildings dummy =0	47%	0.04	0.03	0.04
			(1.00)	(0.99)	(1.00)
	Difference in means		-0.07***	-0.05***	-0.08***

The figures are on the student level. N is the number of students. ***p<0.01

School renovation projects between 2004 and 2009 is a possible concern with the data. If buildings were renovated early in this period, making the reported conditions irrelevant for a large proportion of the students four finished school years, my key explanatory variable will suffer from measurement errors. To address this, I have contacted the local governments and asked whether any of the reported schools were subject to major upgrading between the survey and the tests. The responses from the local governments indicate that even though some schools was renovated in this period, it should not have a critical impact on my results.

Sample selection is a second concern since I for most local governments (68) only have a sample of the schools in the local government rather than all. These 68 local governments are mostly large. This is illustrated by the observation that out of the roughly 13,500 students in the full sample, more than 11,000 are from these 68 local governments.

The selection process ensures that the local governments do not perform strategic reporting. However, reported schools may still differ from the other schools in the local government, since only schools built prior to 1985 was reported. Hence, I in Table 2 investigate the link between test scores and whether or not the school was reported. The LFE 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. A positive (negative) estimate for the dummy variable would imply that my sample has an overweight of poorer (better) performing students. The results from Table 2 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 local governments (conditioned on observables), and thus that the analysis will not suffer from problems related to sample selection.[6]

[6] I have also tried to place the dummy indicating that the school has not been reported on the left hand side and estimate a linear probability model including LFE. The idea is then to test whether the probability that the school was not reported depends on observable characteristics. The conclusion is the same as in the reported test.

Table 2: Test of the link between non-reported schools in participating local governments and student achievement. LFE.

VARIABLES	(A) Math	(B) Nor	(C) 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 local governments	68	68	68

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

3 Empirical strategies

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

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

y_{ijm} is the test score for student *i* in school *j* located in local government *m*. $\boldsymbol{\alpha}$ captures the effect from the measure(s) of building condition, Condition_{jm}. $\boldsymbol{x}_{ijm}$ is a vector of individual and family characteristics. These are the student's gender and the parents' income and educational level.

θ_{jm} is a vector of school specific controls. Included are the teacher/student ratio,[7] 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 (1st-7th grade) or a combined school (1st-10th grade).

δ_m is a vector of variables describing the local governments. I include the average gross income and the general educational level of the population in the local government to capture peer effects. Further, I include a set of controls that are similar to the variables used in Borge and Hopland's (2012) investigation of determinants of building conditions in Norwegian local governments. As part of their study, they analyzed the same school building conditions as I use in the present paper. These are the local governments' revenues and funds, population growth in the local government, the share of socialists in the local council and a variable describing the level of political fragmentation in the local council.

OLS may be biased even when controlling for the full set of observable characteristics, and the bias can go in either direction. Bias can for example be caused by sorting of good teachers and resourceful parents into schools with 'good' buildings. Both of these mechanisms suggest that OLS will overestimate the link between building conditions and achievement. On the other hand, policies aimed to compensate students in schools with 'poor' buildings will tend to bias OLS in the opposite direction.

Unobservables may cause problems both between schools within local governments and between local governments. I am not aware of any instrument that solves sorting both within and between local governments. Instead I propose a strategy where I attempt to handle unobservable characteristics between and within local governments separately.

Studies by Bonesrønning et al. (2005) and Falch and Strøm (2005) indicate that teacher turnover mainly takes place within local governments. Using the average school building condition in each local government rather than the individual school building condition is helpful here.[8] To check robustness, I fix the effect at various geographical levels. Specifically, I estimate the model including labor market region dummies, county dummies and no

[7] Calculated as the number of teacher man years in the school divided by the number of students.
[8] The correlation between average and individual school building condition is 0.54.

geographical dummies.[9] Sorting between local governments may be handled by including LFE. All variables in the vector $\boldsymbol{\delta}_m$ are then placed in a local government specific constant term, giving us

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

ϕ_m captures the LFE and should to a large extent solve problems related to omitted local government specific variables.

Clearly, none of the strategies handle sorting both between and within local governments. To get an impression of how serious the problem is for each strategy, I have estimated regressions with building conditions on the left hand side and sorting variables on the right hand side. This will indicate how strongly correlated building conditions are to observable sorting variables. This may again give an indication as to how correlated building conditions are to unobservable features of the sorting variables.[10] The results are reported in Table 3 and unveil an interesting pattern.

In Column (A) I estimate the poor buildings dummy using OLS, including the full set of explanatory variables. The poor buildings dummy is not significantly correlated with observable characteristics that determine sorting within local governments. It does, however, seem to be determined by local government characteristics, which is not surprising since local governments are in charge of these buildings. The results for the average school building condition, reported in Column (B) are quite similar to the results in Column (A). When rather including LFE in Column (C), we observe that none of the sorting variables come out as significant determinants for school building condition.

It thus seems that the LFE estimates will be the most credible in this analysis. The indication of relatively little within local government sorting is not necessarily surprising, given the

[9] Statistics Norway has classified 90 labor market areas consisting on average of 4.8 local governments. The regions are widely used for research purposes, see e.g. Falch et al. (2009). The local governments in this study are spread over 60 of these regions and over all 18 counties (excluding Oslo which is both a local government and a county.

[10] This informal test is based on the logic from Altonji et al. (2005).

rigidity of the Norwegian school system. Children are assigned to public primary schools using a neighborhood rule, and private schools are rare (in practice religious alternatives). The parents' possibility to affect enrollment is thus quite limited.

Table 3: Test of link between building conditions and observables

VARIABLES	(A) Poor buildings dummy	(B) Avg. school building condition in the local government	(C) Poor buildings dummy
Father's education	-0.00262	0.00682*	-0.00282
	(0.00324)	(0.00357)	(0.00231)
Mother's education	0.000181	0.00563	-0.00107
	(0.00295)	(0.00414)	(0.00232)
Father's income	-4.02e-10	-1.72e-08	-1.47e-09
	(1.37e-08)	(1.37e-08)	(1.10e-08)
Mother's income	5.84e-09	-2.62e-08	1.44e-08
	(2.52e-08)	(4.02e-08)	(1.68e-08)
First generation immigrant	0.00893	-0.0457	0.0182
	(0.0351)	(0.0368)	(0.0252)
Second generation	0.0236	-0.0640	0.0289
Immigrant	(0.0316)	(0.0513)	(0.0296)
Number of students in	-0.000156	-0.000325	-7.54e-05
School	(0.000291)	(0.000299)	(0.000364)
Share of teachers with	-0.296	0.0982	-0.428
License	(0.283)	(0.343)	(0.336)
Teacher/student ratio	-0.00586	-0.0137	0.00462
	(0.0147)	(0.0191)	(0.0150)
% of pop with	-3.34e-05	0.00873	
univ. education	(0.00706)	(0.0131)	
Avg. gross income	-1.76e-07	-2.18e-06	
	(1.62e-06)	(3.63e-06)	
Effective number of parties	0.116**	0.153	
in the local council	(0.0501)	(0.105)	
Population growth	-0.00595	-0.0148	
(1988-2003, %)	(0.00542)	(0.0101)	
Local government revenue	-0.00973**	-0.0144**	
	(0.00397)	(0.00598)	
Disposable funds	0.0244***	0.0255**	
	(0.00817)	(0.0116)	
Share of socialists in the	0.822**	0.950	
local council	(0.392)	(0.700)	
Method	OLS	OLS	LFE
Observations	13,116	13,116	13,289
R-squared	0.073	0.166	0.009
Number of local governments			107

Robust standard errors (clustered on the local government level) in parentheses. A constant term (not reported) included.
*** p<0.01, ** p<0.05, * p<0.1

4 Results

Table 4 presents results from the OLS regressions where I use building condition data for each school. 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. There are no significantly negative effects of the category 1 dummy, and all positive estimates are for this category. This is not surprising, since buildings in this category are considered to be in good working condition and do not necessarily differ much from those in category 0. Interestingly, 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' and 'poor' condition, is a simplification of the model which involves two restrictions. First, I restrict the coefficient for the category one dummy to be equal to zero. Second, 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. The 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. The results indicate that students in 'poor' school buildings are expected to score roughly 7% of a SD lower in mathematics than those in 'good' buildings. The estimated effect from the poor school buildings dummy on the English test scores indicates that students in 'poor' school buildings score about 9% of a test score SD lower than students in 'good' school buildings on the English reading test.

Table 4: 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)	-0.0300	-0.0740	-0.0775	0.00374	-0.0580	-0.0538	0.0222	-0.0503	-0.0420	0.0227	-0.0466	-0.0382
	(0.0638)	(0.0491)	(0.0570)	(0.0565)	(0.0397)	(0.0500)	(0.0548)	(0.0404)	(0.0489)	(0.0468)	(0.0347)	(0.0416)
Cat 2 (some improvement required)	-0.0937	-0.111**	-0.144***	-0.0450	-0.0788**	-0.107**	-0.0317	-0.0739**	-0.0975**	-0.0229	-0.0564*	-0.0914**
	(0.0621)	(0.0461)	(0.0532)	(0.0545)	(0.0370)	(0.0464)	(0.0528)	(0.0373)	(0.0446)	(0.0526)	(0.0313)	(0.0357)
Cat 3 (critical improvements needed)	-0.0833	-0.0609	-0.114	-0.0429	-0.0306	-0.0831	-0.0296	-0.0295	-0.0676	-0.00552	-0.0313	-0.0689
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	-0.0716*	-0.0509	-0.0860**	-0.0471	-0.0296	-0.0661*	-0.0461	-0.0313	-0.0635*	-0.0348	-0.0199	-0.0612*
(= 1 if building is in Cat 2 or Cat 3)	(0.0428)	(0.0325)	(0.0375)	(0.0396)	(0.0278)	(0.0344)	(0.0389)	(0.0272)	(0.0328)	(0.0409)	(0.0248)	(0.0318)
R-squared	0.001	0.001	0.001	0.114	0.100	0.054	0.118	0.101	0.059	0.122	0.103	0.063
Individual and family characteristics				+	+	+	+	+	+	+	+	+
School characteristics							+	+	+	+	+	+
Local government 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 the local government level) in parentheses
Constant term (not reported) included
*** p<0.01, ** p<0.05, * p<0.1

In Columns (D)-(L) I gradually extend the model by including control variables.[11] First, I include characteristics about the student and his family ($\boldsymbol{x}_{ijm}$) in Columns (D)-(F). Second, in Columns (G)-(I) I extend the model with school specific controls ($\boldsymbol{\theta}_{jm}$). Finally, the variables describing the local government ($\boldsymbol{\delta}_m$) are included in Columns (J)-(L). 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 of 'poor' school buildings on the test scores in English. The results indicate a negative treatment effect of roughly 6% of a test score SD in the most general specification.

Table 5 reports the results from the estimations where I use the average school building condition in the local government rather than that of each school. In the upper part of the table I have included the labor market region dummies. We observe that the estimates do not differ heavily from those in the benchmark OLS estimations. The coefficient for the poor buildings dummy is, however, only significant in the most general specification, and only when estimating the test score in English.

Since the average is continuous, rather than a dummy, the interpretation of the coefficients is slightly different. An increase in the average by a full point (e.g. from 1 to 2) is associated by a drop in student achievement by roughly 5% of a SD lower in English. The results remain fairly stable when using country dummies or no geographical dummies instead of labor market region dummies even though the significance level changes a bit.

[11] The control variables are omitted from the reported tables. Full results are available upon request.

Table 5: Regressions with average school building condition in the local government.

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
Labor market region dummies												
School building condition	-0.0475	-0.0239	-0.0620	-0.0404	-0.0218	-0.0548	-0.0292	-0.0193	-0.0455	-0.00982	-0.0119	-0.0620**
(local government average)	(0.0466)	(0.0372)	(0.0392)	(0.0438)	(0.0345)	(0.0389)	(0.0445)	(0.0348)	(0.0384)	(0.0411)	(0.0396)	(0.0302)
Individual and family characteristics				+	+	+	+	+	+	+	+	+
School characteristics							+	+	+	+	+	+
Local government characteristics										+	+	+
Observations	13,343	13,031	13,329	12,808	12,533	12,796	12,808	12,533	12,796	12,764	12,490	12,752
R-squared	0.034	0.024	0.033	0.140	0.116	0.077	0.140	0.116	0.078	0.141	0.118	0.079
County dummies												
School building condition	-0.0371	-0.0382	-0.0621*	-0.0186	-0.0233	-0.0447	-0.00944	-0.0263	-0.0401	-0.0111	-0.0318	-0.0692***
(local government average)	(0.0399)	(0.0302)	(0.0339)	(0.0372)	(0.0259)	(0.0318)	(0.0381)	(0.0257)	(0.0309)	(0.0381)	(0.0253)	(0.0247)
Individual and family characteristics				+	+	+	+	+	+	+	+	+
School characteristics							+	+	+	+	+	+
Local government 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
R-squared	0.018	0.007	0.015	0.127	0.105	0.063	0.129	0.105	0.066	0.130	0.107	0.070
No geographical dummies												
School building condition	-0.0318	-0.0259	-0.0635*	-0.0196	-0.0194	-0.0504	-0.00725	-0.0174	-0.0410	0.0177	-0.0101	-0.0356
(local government average)	(0.0396)	(0.0275)	(0.0336)	(0.0365)	(0.0233)	(0.0308)	(0.0375)	(0.0230)	(0.0289)	(0.0438)	(0.0209)	(0.0241)
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	0.000	0.000	0.001	0.113	0.099	0.054	0.117	0.101	0.058	0.122	0.103	0.062

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

Table 6: Estimation of test results. LFE.

VARIABLES	(A) Math	(B) Nor	(C) Eng	(D) Math	(E) Nor	(F) Eng	(G) Math	(H) Nor	(I) Eng
Poor buildings dummy	-0.0524	-0.0360	-0.0678	-0.0397	-0.0251	-0.0572	-0.0421	-0.0268	-0.0594
(= 1 if building is in Cat 2 or Cat 3)	(0.0513)	(0.0383)	(0.0447)	(0.0472)	(0.0351)	(0.0418)	(0.0466)	(0.0344)	(0.0411)
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 local governments	107	107	107	107	107	107	107	107	107

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

Table 6 reports the results from the LFE regressions. We observe that including LFE in the regressions do not change the coefficients much, but the significance is reduced so none of the coefficients are significant. This is an interesting result, given that the results in Table 3 indicated that school building conditions in fact is correlated with variables on the local government level. However, the results in Table 6 suggest that unobservable characteristics of the local governments do not necessarily generate a large bias in the OLS estimates.

To sum up, the coefficients do not differ heavily between the three suggested approaches. The different strategies also have in common that the coefficients are mostly weak in terms of statistical significance. The weak significance may be due to that the difference between 'poor' and 'good' schools is simply too small for it to matter for student achievement. In a wealthy country, such as Norway, one may have that minor issues concerning building conditions are sufficient for a school building to be reported as 'poor'. Moreover, we have that a low share of the students is enrolled in schools in one of the 'extreme categories' (categories 0 and 3). Hence most students are enrolled in schools with buildings that are either, 'quite good' (category 1) or 'slightly poor' (category 2). One should also keep in mind that the building condition measure is likely to have some level of measurement errors, giving an attenuation bias. Anyway, the results indicate that building conditions should not be the main priority for Norwegian politicians eager to boost student achievement.

5 Concluding remarks

This paper studies the effects of school building conditions on student achievements in Norwegian primary schools using data from national tests in mathematics, Norwegian, and English, combined with survey data on school building conditions. A raw comparison of means indicate that students in 'poor' school buildings perform roughly 5-8% of a SD poorer than students in 'good' school buildings. In the raw comparison, the difference is highly significant. A formal econometric approach using OLS and LFE provide some estimates in the same area as the raw comparison, in particular for the test score in English. The coefficients in the formal econometric procedure are, however, much weaker in terms of statistical significance. My interpretation of this is that the school buildings in very rich countries, such as Norway, are simply not 'poor enough to matter' for student achievement. The policy implication is thus that politicians in rich countries should likely look to other aspects of the school than the physical facilities when aiming to boost student achievement.

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Appendix

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
% of pop with univ. education in the local government	13,874	26	6.91
Avg. gross income in the local government	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. (Index with (weighted) avg. 100 in each year)	13,742	96.70	10.01
Disposable funds (in % of revenues)	13,700	3.18	3.78
Share of socialists in the local council	13,735	0.39	0.11

Note: Parental education is measured as an index (1-8). 1 indicates no more than compulsory schooling, 8 indicates a Phd.