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School performance and retrospective voting: Evidence from local elections in Denmark☆

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ABSTRACT

In this paper, we investigate whether voters hold local politicians accountable for the performance of local schools. We examine this effect for the 2013 and 2017 Danish local elections using register data and polling station-level voting records. We find robust evidence of retrospective voting from pooled and fixed effects estimations. Exploiting the micro-level character of our data, we present evidence that higher-income citizens are more sensitive to changes in school performance, while other demographic and political characteristics do not appear to have mattered.

1. Introduction

A large part of the literature investigating the retrospective voting hypothesis[1] has focused on the relationship between the electoral prospects of national or state level politicians and broad economic outcomes measured by objective performance indicators such as the unemployment rate or the growth rate (e.g., Page and Shapiro 1992; Duch and Stevenson 2008). More recent studies have considered outcomes that are more directly under politicians' control such as the occurrence of irregularities in the use of public funds (e.g., Ferraz and Finan 2008) or the handling of natural disasters (e.g., Bechtel and Hainmueller 2011).[2]

Yet, in the study of the local political level, questions about accountability have received relatively little attention.[3] This is surprising given that local politicians face a more limited range of outcomes compared to the national level and are responsible for services that are particularly close and easy for citizens to observe. These characteristics make local outcomes arguably better suited to test the retrospective voting hypothesis.

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[1] Reviews can be found in Nannestad and Paldam (1994), Lewis-Beck and Paldam (2000), Lewis-Beck and Stegmaier (2000), and Healy and Malhotra (2013).

[2] Voters have also been found to react to events that are beyond the control of politicians. For example, Healy et al. (2010) show that a recent win of local college sports teams often implies a greater vote share in favor of the incumbent in Senate, gubernatorial, and presidential elections; Miller (2013) finds a similar effect for mayoral elections.

[3] Exceptions include Burnett and Kogan (2016) and Hopkins and Pettingill (2018) that study retrospective voting in mayoral elections in San Diego and in a large sample of big U.S. cities, respectively. Burnett and Kogan (2016) report effects of neighborhood road quality on incumbent support in local elections. Hopkins and Pettingill (2018) find that the local unemployment rate relative to the national level influences incumbent mayors' vote shares, while the local crime rate and property values do not. They explicitly leave the question of school performance to future research.

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Our paper examines the connection between the performance of local schools and voters' evaluation of incumbent politicians in municipal elections in Denmark. Specifically, we analyze vote returns at the level of electoral precincts from the municipal elections in 2009, 2013, and 2017, which we combine with information about grade point averages (GPAs) in the final year of compulsory education at schools attended by students who reside in the polling station district.

Two facts make municipal elections in Denmark a useful case to study. First, as we explain in greater detail below, Danish municipal councils have substantial influence on local schools and citizens regularly name local school policy as an important criterion for the municipal elections. This suggests that voters are also aware that schools are the responsibility of municipalities.[4] Second, the grade point averages of individual schools for each year are publicly available information that can be accessed via a web tool of the Ministry of Children and Education.[5] When the relevant law was introduced in 2002, the argument put forward – in the spirit of the New Public Management wave (see, e.g., Stecher et al. 2010) – was that disclosure would provide citizens with crucial information for evaluating and choosing schools. For the U.S., Chingos et al. (2012) find that citizens' perceptions of school quality actually reflect publicly available information about student achievement levels in the schools.

Our empirical results are consistent with retrospective voting. In particular, we find that the vote share of the incumbent mayor's party moved in line with school performance, as measured by grade point average in the last year of compulsory education. The strength of the correlation varied slightly across the elections considered, which is not surprising but is a normal finding in studies of retrospective elections (see also Section 1.1). Paldam (1991) called this common feature of the literature "the instability dilemma".

Anderson (2007) argues that retrospective voting is conditioned by numerous factors such as voters' informational and cognitive limitations, party leanings, and media coverage. Of these factors, media coverage may have been critical in our Danish context, as the national government introduced significant reforms to public schools in 2013. Therefore, there was probably more reporting on the schools in 2013 than in 2017, causing voters to pay more attention to the topic. Because the reforms came from a left-leaning government, we suspect that left-leaning and right-leaning voters might respond differently to changes in school performance. With this in mind, we use our precinct-level data to study how various socioeconomic and political characteristics moderate the electoral reaction to changes in school performance. We find that the response is more pronounced in polling-station districts with higher income levels, but see no difference between areas with high and low shares of left-wing support in the previous election.

The remainder of this paper is organized as follows. The next subsection briefly summarizes the relevant literature. Section 2 explains the institutional background of municipal elections and schools in Denmark. We describe our data and empirical models in Section 3. We present and discuss our empirical results in Section 4. Section 5 concludes.

1.1. Related literature

Empirical studies on the relationship between school performance and voter behavior have focused on elections to school boards in the U.S., where they play a central role in the governance of public schools. Berry and Howell (2007) find evidence of a positive relationship between test scores and vote share for incumbent school boards in only one of the three South Carolina election cycles studied — the first one after the state's accountability system took effect. The authors attribute the lack of results in the other two later election cycles to a shift in media attention to other issues, which is similar to the conclusions of the present study.

Using a regression discontinuity design on Florida's accountability system, Barrows (2014) reports that school performance information influenced incumbent support only at one threshold, namely when the points score translated into an A rather than a B grade, and not in all election cycles considered. He attributes these differences in the effect of performance information to changes in citizens' trust in the source of information and in the higher cost of obtaining performance information. In our study, the cost of obtaining information was arguably lower in 2017 compared to 2013; nonetheless, this information had less effect than in 2013.

Scherer (2014, Ch. 1) compares incumbent re-election rates before and after the implementation of California's Public Schools Accountability Act. He finds that voters use publicly reported academic performance measures to hold incumbent school boards accountable in high-turnout "on-cycle" elections, i.e., when school board elections are held together with state and national elections, but not in low-turnout "off-cycle" elections.

Some studies have looked at aspects of elections and school performance measures other than support for incumbents. For example, turnout in school board elections (Holbein, 2016) and for the state's chief education officer (Manna and Cooper, 2014) negatively correlates with test scores. Kogan et al. (2016) show that poor performance of a local school according to the "adequate yearly progress" metric, instituted in the *No Child Left Behind Act* in 2001, substantially reduces support for school tax levies in local referenda in Ohio.

School board elections or school tax referenda in the U.S. seem to be an advantageous environment for testing retroactive voting, as the allocation of responsibility is clearer when incumbents have only one area, the school, to oversee. However, there are also disadvantages as these elections are very special; turnout is often in the range of 5 to 10 percent, and information about the candidates can be hard to find. Our study, on the other hand, is novel in that it considers local elections where turnout is high (73% on average) and involves mayors and councilors who have a much broader range of responsibilities, of which schools and local education policy are only one, albeit an important one (see Section 2). A related study is Lay and Tyburski (2017) who find a positive correlation between school performance and incumbent support in mayoral elections using survey data in the run-up to mayoral elections in 16 U.S. cities. Unlike their study, we look at actual voting behavior rather than survey data.

[4] It cannot be taken for granted that citizens can correctly assign policy areas and responsibilities to the various layers of government (see, e.g., Arceneaux 2006).

[5] Various media and the think tank Cepos also report the figures and publish ranked lists.

Our study also contributes to the literature by using micro-level data to analyze how the strength of the electoral response varies with characteristics such as income, educational background, ethnic heterogeneity, age, and political leanings. One study that has done something on voters' background is Arnold and Carnes (2012); using survey data, they show that black and white New Yorkers are very similar in how local economic conditions and crime rates affect their assessment of the city's mayor. Holbein (2016) shows that bad signals about school performance lead citizens to vote with their feet by leaving failing schools, but that the exit option is primarily used by citizens who are white, wealthy, and more likely to have voted in previous school board elections. In a similar vein, our data suggest that high-income voters are more responsive to school performance. In contrast to studies that found voters' partisan leanings to impact how the state of the economy is perceived, e.g., Evans and Andersen (2006) and Kayser and Wlezien 2011, we do not observe that political leanings matter in the electoral response to school performance.

2. Institutional background

2.1. Municipal elections in Denmark

Every four years in November, municipal elections are held in Denmark's 98 municipalities, resulting in a council headed by a mayor. The allocation of mayoral posts is not directly linked to the election results but depends on negotiation skills in the coalition formation process after the votes are counted (see, e.g., Elklit et al. 2017). In practice, the mayor often belongs to the party that has received the most votes in the municipality.

Mayors have a prominent role in local politics (see, e.g., Berg and Kjær 2007), which is why we focus on the vote share of the mayor's party in our analysis. In line with other research on Danish local politics, we do not consider the combined vote share of the coalition supporting a mayor. This is motivated by the observation that most voters can identify the mayoral party (Pedersen et al., 2022, p. 42f.), while they seem unlikely, except for insiders, to be able to name the coalition partners in their community. In addition, there are practical challenges that prevent us from looking at the coalitions: The first one is that coalitions can be defined in several ways – the core parties of the coalition agreement, all parties signing a coalition agreement, or the parties voting for the mayor at the inaugurative meeting of the municipal council. A second reason is that often there is only an oral coalition agreement. As we explain below (Section 3), we still try to control for the strength and visibility of the mayor and the mayor's party by including an indicator variable which equals one if the incumbent mayor belongs to the party that won the most votes in the previous election.

In international comparison, municipalities in Denmark have a very large area of responsibility, including schools, transfer payments and care centers for the elderly. To fulfill their functions, municipalities are largely dependent on central government funding and municipal finances are subject to government control. Yet, within the principles laid down by the central government, municipal self-government means that municipalities decide for themselves how to organize their work and prioritize their resources. Folke-schools are biggest spending item of the municipalities, consuming on average 16% of the budget. Municipal elections are therefore an opportunity to hold local politicians, and especially the mayor's party, accountable for the way they have managed municipal tasks.

Local education policy is widely covered by the local press, especially where it concerns the local schools. Surveys confirm that the folkeskole ranks high in terms of electoral salience, considered the most important or one of the most important issues by the voters at all recent municipal elections (DR/Danmarks Radio 2012, December 3rd; Altinget 2017, June 1st).[6]

2.2. School performance

Most compulsory education in Denmark takes place at *folkeskole*, a comprehensive form of school that addresses children from the age of six to sixteen and encompasses pre-school, primary and lower secondary education. Roughly four fifths of all children attend the compulsory grades 0–9 at the municipal folkeskole, while the remainder attends private and free schools, or, to a minor extent, a voluntary tenth grade.

Parents everywhere usually have a strong interest in the quality of the school their children attend.[7] Various studies confirm that school grades are significant predictors of parent satisfaction (e.g., Charbonneau and Ryzin 2012; Jacobsen and Saultz 2013). Parents monitor their children's performance, but in many countries, they lack information to assess school performance in general. In Denmark, a law was passed in 2002 that obliges educational institutions to publish the average marks of the leaving examination (taken in the 9th grade), in addition to the institution's pedagogical principles. The average is calculated from seven compulsory tests, which must include written and oral Danish, maths, oral English, and a collective examination in natural sciences and geography. The Danish Agency for Education and Quality provides nationally standardized assignments for written exams. Grading is done by appointed censors who also participate in the oral exams and we see no signs of a trend, e.g., grade inflation, over the period of our study. Crucially, the Ministry for Education (*Børne- og Undervisningsministeriet*) publishes GPAs in the school leaving exam for each school every year. Additionally, the number is also available from individual schools as part of the yearly quality report, which

[6] *DR*, formerly *Danmarks Radio*, is a public service broadcaster in Denmark. *Altinget* is a non partisan online newspaper on Danish politics that has existed since 2000.

[7] The quality of local schools is also of interest to members of society who do not have school-age children themselves, through their influence on housing prices (e.g., Black and Machin 2010; Mathur 2017). Estate agents in Denmark occasionally emphasize the proximity to a "good school" in advertisements for houses for sale.

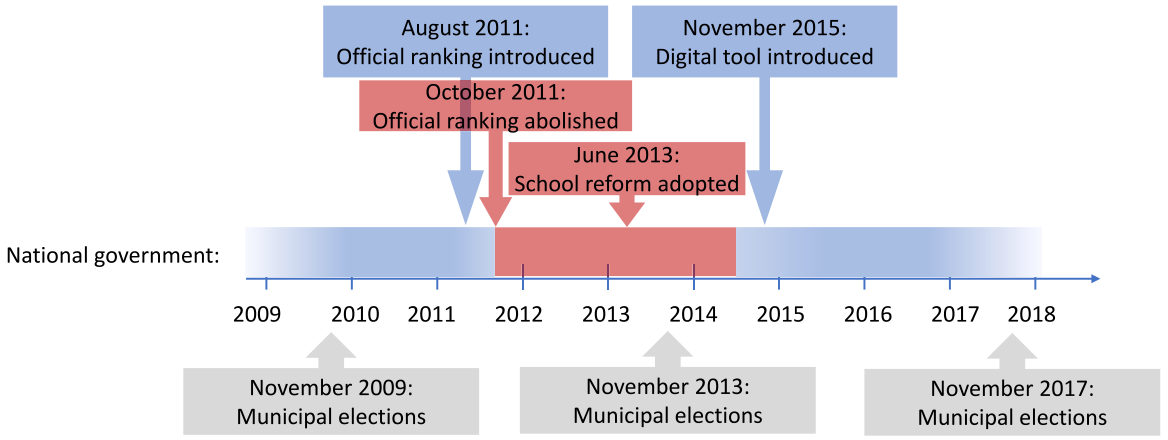

Fig. 1. Relevant policy events regarding schools and access to information about school performance. The colors refer to the ideological orientation of the national government (blue: right-of-center, red: left-of-center). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

schools usually publish on their websites. The tests used to calculate school grades are administered during the spring of each year, and school grades are published between June and early August. In election years, results from the same year are thus available before the municipal elections take place in November.

Over the time horizon of our study, the informational environment with regard to school performance changed twice. Fig. 1 illustrates these changes. In August 2011, the Danish Ministry of Education had issued for the first time a ranked list detailing the ninth grade GPA of all schools in the country, drawing huge interest from parents and other citizens (see, e.g., Berlinske 2011, August 22nd,[8] and considerable media coverage (e.g., DR/Danmarks Radio 2011, July 15th).[9] Along with the actual GPA, the ranking also showed whether a school's actual performance was better or worse than what would be expected, taking into account parents' socio-economic background. Yet, after the incumbent center-right coalition lost power to a center-left coalition led by the Socialdemocrats (*Socialdemokratiet*) as a result of the general election on September 15, 2011,[10] the ranked list was abolished on October 10. The grade information for each individual school continued to be retrievable though on the website of the Ministry of Children and Education, and it was still possible for media and individuals to compare several schools based on the figures available. Moreover, the ousted liberal center-right party *Venstre* posted a ranked list on its own website, following the new Minister of Education's removal of the list. In the general elections on June 18, 2015, *Venstre* reclaimed the position of Prime Minister and formed a minority government. On November 25, 2015, the *Venstre* government introduced a digital tool that made information on schools' GPA, teacher competence and measures of pupils' well-being easily accessible. The tool made it also easy again to compare a particular school to the average in the municipality or nationwide.

To what extent can local councilors influence school performance as measured by the GPA? While it is clear that pupil-level factors such as socio-economic status explain a significant proportion of differences in academic performance (e.g., Davidson et al. 2015), the Danish Center for Social Science Research concludes in an analysis that the municipal management of primary schools has a noticeable impact on pupils' grades (Bjørnholt et al., 2019).

An important element of local school policy is that the council, in cooperation with the school management, takes measures or provides resources to improve academic performance and other quality features of schools. Examples of such measures are dyslexia initiatives or the establishment of a tutor network. An evaluation report shows that goal setting and dialogue between council and school management have a positive impact on student outcomes (Bjørnholt and Krassel, 2016). At the same time, it has been shown that greater autonomy for school leaders also has a positive impact on academic school performance (Bjørnholt et al., 2019, p. 33). In principle, the municipality can impose sanctions on the school management if a school fails to achieve the set goals repeatedly.

Another channel of municipal influence arises from the fact that the staff of primary schools is employed by the municipality. While the formal responsibility for hiring and dismissing head teachers, teachers, and pedagogues thus lies with the municipal council, the hiring of teachers is in practice left to the head of the respective school. If a head teacher needs to be hired, this task usually falls to the director of children and education of the municipality, who in turn is selected and hired by the municipal council.

[8] *Berlingske* is a Danish national daily newspaper that has existed since 1749.

[9] The think tank Cepos has been publishing school rankings already since 2005.

[10] Besides the Socialdemocratic Party, the coalition included the Danish Social Liberal Party (*Radikale Venstre*) and the Socialist People's Party (*Socialistisk Folkeparti*) and relied on ad hoc support by the Red–Green Alliance (*Enhedslisten*).

3. Data and empirical models

3.1. Data

We examine the impact of the GPA change on the electoral outcomes of the incumbent mayor's party in the municipality, using polling station districts (precincts) as the basic unit of analysis. This is the appropriate level, in our view, as polling station areas correspond more closely to school catchment areas than municipalities. If voters vote retrospectively, their behavior reflects the quality of services they receive, which is not necessarily evident from the average municipality-wide results (see Burnett and Kogan 2016).

The election results of the 2009, 2013 and 2017 municipal elections are taken from the official statistics, the "Den Danske Valgdatabase". Although GPA data were also available at the time of the 2005 municipal elections, we could not utilize that election because a comprehensive reform of the Danish administrative structure (*Strukturreformen*) took effect on January 1, 2007, which included as a central elements a reduction in the number of municipalities, and thus mayors, from 271 to 98. We calculate how the vote share of the incumbent mayor's party in a polling station district has changed compared to the previous election. This difference is our main dependent variable.

Since citizens are assigned to polling stations based on their residence, we can identify the school-age children living in the polling station area and the schools they attend from the school register. Using these figures, we calculate a weighted average of the GPA in the last year of compulsory education in the schools attended by pupils in the precinct. For example, if 50 percent of the children in the precinct go to a school whose GPA is 8.0, and 50 percent go to a school whose GPA is 5.0, then the precinct-level GPA equals 6.5.[11] The difference $\Delta GPA_t = GPA_t - GPA_{t-4}$ in polling station-level GPA from one election year to the next is our first main independent variable.

We construct a second – relative – measure of local school performance by ranking all schools based on their GPA (in each election year separately) and assigning them their respective percentile ranks (PRs). This measure is aggregated to the precinct level by weighting schools' PRs by the population of their pupils in the precinct, e.g., if 50 percent of the children in the precinct go to a school whose GPA is in the 90th percentile, and 50 percent go to a school whose GPA is in the 50th percentile, then the precinct-level PR equals 0.7. The difference $\Delta GPAPR = GPAPR_t - GPAPR_{t-4}$ in these weighted PRs between the election year compared to the previous one is an alternative main independent variable.

Because students in a polling station area attend different schools, the GPA scores and percentile ranks are weighted averages for those schools, resulting in distributions that approximate normal distributions (see Fig. A.1 in the Appendix). Table 1 presents the summary statistics for the full set of variables included in our analysis.

3.2. Empirical models

Our basic model specification is the following pooled ordinary least-squares (OLS) model

$$\Delta SMP_{i,t} = \alpha_0 + \alpha_1 \Delta P_{i,t} + \boldsymbol{\alpha}_2 \mathbf{X}_{i,t} + \boldsymbol{\alpha}_3 \mathbf{Z}_{k,t} + \kappa_k + \lambda_t + \epsilon_{i,t} \tag{1}$$

where i, k and t represent the precinct, municipality and election year index, respectively. $\Delta SMP_{,it}$ is the difference in the vote share of the incumbent mayor's party in a polling station i between the current election year t and the municipal election before. $\Delta P_{i,t}$ is the change in our school performance measure (i.e., *GPA* or *GPAPR*) between these two periods, and Z_i and T_t are precinct and election year fixed effects. The **X**-vector and the **Z**-vector in Eq. (1) include a number of precinct-level and municipality-level controls, respectively.

As a next step, we exploit the panel structure of our data by introducing precinct fixed-effects. Specifically, we formulate

$$\Delta SMP_{i,t} = \beta_0 + \beta_1 \Delta P_{i,t} + \boldsymbol{\beta}_2 \mathbf{X}_{i,t} + \boldsymbol{\beta}_3 \mathbf{Z}_{k,t} + \gamma_i + \lambda_t + \epsilon_{i,t} \tag{2}$$

where γ_i denotes precinct fixed effects. Thus, Eq. (2) uses of within-precinct variation only, eliminating between-precinct differences that may stem from underlying precinct-specific particularities.

The vector **X** in Eqs. (1) and (2) also contains the *Population size* of the precinct. This makes sense because, in smaller precincts, pupils are more likely to go to the same school, and thus there might be a closer relationship between school performance measures and electoral incentives compared to larger precincts. It should be noted, however, that all precincts are relatively small. Further, school performance is likely to be of most interest to parents who actually have children in school. We therefore use the Danish national registers to average various sociodemographic characteristics over these voters in each polling station district to obtain our control variables. Specifically, we compute the mean *Income*,[12] average *Age*, and the share of citizens with a *University degree*.

In some specifications, we additionally control for political factors such as *Turnout* in the current election and the vote share for left-of-center parties (*Left support*) in the previous election at the polling station. The major political parties in Denmark can be placed on a traditional left–right political spectrum. This division also follows the two "red and blue" blocks of Danish politics that traditionally form and support governments in Denmark. We use this left–right distinction to create an indicator variable *LoC mayor*

[11] Denmark uses a 7-point grading scale, with grade 12 corresponding to grade "A" and grade −3 corresponding to grade "F" on the ECTS scale.

[12] The income measure includes taxable and non-taxable salary after deductions for pension but before labor market contributions and special pension contributions, income from stock options, and possible illness and maternity pay.

Table 1
Descriptive statistics at the polling-station level.

	Obs	Mean	Standard deviation	Min	Max
Population	2662	3286.562	2903.670	32	23746
Turnout	2662	0.726	0.062	0.39	0.91
Share of valid votes	2662	0.984	0.006	0.95	1.00
Share of the mayor's party (SMP)	2570	0.355	0.128	0.01	0.82
ΔSMP	2662	0.001	0.084	−0.44	0.48
Mayor-from-largest	2662	0.821	0.383	0.00	1.00
Left-of-center (LoC) mayor[a]	2662	0.467	0.499	0.00	1.00
Left support[b]	2662	0.416	0.133	0.06	0.86
Congruence	2662	0.395	0.096	0.19	0.82
GPA	2662	6.528	0.707	3.64	9.84
GPAPR	2662	0.527	0.118	0.18	0.91
ΔGPA	2662	0.310	0.580	−3.47	4.03
ΔGPAPR	2662	0.009	0.077	−0.34	0.49
Age	2662	47.463	1.157	*	*
Mean income (in 1000 DKK)	2661	337.136	94.264	*	*
University degree	2649	0.327	0.120	*	*
Share of native Danes	2662	0.906	0.118	*	*

Notes. *Age, Median income, University degree*, and *Share of native Danes* are observed in our population defined by all children in primary school and their parents between 2008 and 2019. This includes approx. 2.4 Mill. individuals, or ca. 40% of the whole population. Data about school children and their grades, their parents and location as well as income, age, parental education and immigration status are taken from the Danish national registers. Population refers to all citizens. Left support, Valid votes and Turnout are taken from valgdatabase.dk.

[a]*LoC mayor* is coded = 1 when the mayor is from the Socialdemocrats or the Socialist People's Party, and = 0 when the mayor belongs to the right-of-center parties Venstre or The Conservative People's Party.

[b]*Left support* is the combined vote share for the left-of-center parties Socialdemocrats, Socialistisk Folkeparti, Enhedslisten and Alternativet.

*Min and Max cannot be included for these variables due to the regulations of our data provider (Statistics Danmark).

which equals one if the incumbent mayor's party is left-of-center (Socialdemocrats and the Socialist People's Party), and zero if it is right-of-center (Venstre and The Conservative People's Party). Another municipality-level control is the indicator variable *Mayor-from-largest* which equals one if the incumbent mayor's party won the most votes in the previous election, and zero otherwise. This variable is intended to capture how visible a mayor's party affiliation is to the voters, making it easier for them to ascribe responsibility. The popularity of local politicians at the ballot box might also reflect the current standing of their respective parties at the national level. To account for this, we further include an indicator *Congruence* that equals one if the incumbent mayor's party is also in charge at the national level at the time of the local elections, and zero otherwise.

4. Results

4.1. Basic results

Fig. 2 illustrates the relationship between our main variables of interest using binned scatterplots. We observe a positive correlation between the change in GPA between the current and the previous election year and the change in the vote share of the incumbent mayor in the aggregate data. Fig. A.2 in the Appendix shows that the positive correlation in 2013 and 2017 persisted when examined separately.

The impression gained from Fig. 2 is supported by the econometric analysis sketched in Eq. (1), whether one considers ΔGPA or the change in school percentile ranking, denoted as ΔGPAPR, as the main independent variable. Table 2 documents corresponding results from pooled cross-sectional regressions; these are consistent with retrospective voting based on school performance also when demographic and political factors are controlled for (columns 2–3 and 5–6). The estimates suggest that a one-unit increase in a precinct's average GPA increases the mayor party's vote share by ca. 0.7 percentage point (about 1/11 of standard deviation). Among the control variables, *Age* is positively related to ΔSMP in all specifications, whereas coefficients for *Left support*, *LoC mayor*, and *Congruence* have a negative sign and are highly significant.

When slopes are allowed to differ by election year (see Table A.1), the 2013 association looks stronger, but Wald tests show that the difference between 2013 and 2017 is not statistically significant in any of our specifications.

We next present fixed effects results based on regression equation (2) in Table 3. As with the cross-sectional regressions, the point estimates on ΔGPA (in columns 1–3) are positive and statistically significant, with slightly larger effect sizes. They imply that a one-unit increase in a precinct's average GPA is associated with increase in the vote share of the mayor's party by about 0.9 percentage points. In columns (4)-(6), we estimate a corresponding set of models with ΔGPAPR as the main independent variable; the results are consistent with those for ΔGPA.

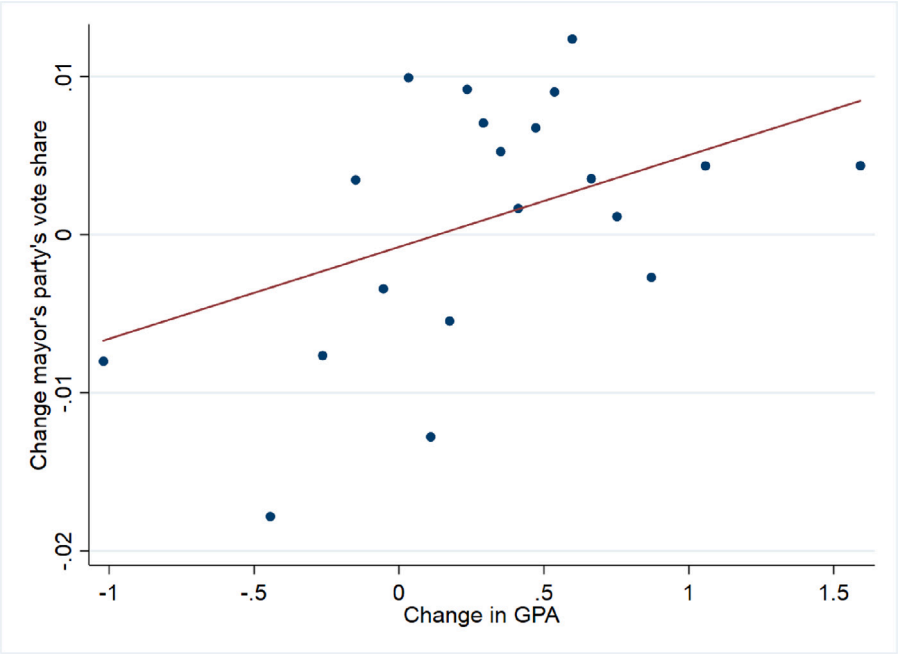

Fig. 2. School performance and election results. Averaged data for 2013 and 2017.

Table 2
Cross-sectional analysis: Changes in school performance and in the vote share of the incumbent mayor's party.

	(1)	(2)	(3)	(4)	(5)	(6)
ΔGPA	0.0075*	0.0069*	0.0066+			
	(0.0035)	(0.0035)	(0.0035)			
ΔGPAPR				0.0698**	0.0702**	0.0735**
				(0.0228)	(0.0228)	(0.0225)
Demographic controls	No	Yes	Yes	No	Yes	Yes
Political controls	No	No	Yes	No	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
N	2662	2662	2662	2662	2662	2662
R^2	0.3411	0.3453	0.3656	0.3421	0.3467	0.3676

Notes. Dependent variable ΔSMP. Pooled OLS. Demographic control variables include Population, University degree and Age. Political control variables include Turnout, Left support, LoC mayor, Congruence, and Mayor-from-largest. Robust standard errors clustered at the precinct level are reported in parentheses. $^{+}p \leq 0.10$. $^{*}p \leq 0.05$. $^{**}p \leq 0.01$.

Again, we relegate results allowing for different estimates in 2013 and 2017 to the Appendix (see Table A.2). Wald tests reported at the bottom of the table show that the difference between the coefficients on the interaction terms is weakly statistically significant in the ΔGPA models with demographic and political controls (columns 4 and 5), but not in other models.

As a robustness check, we consider whether voters react to the recent development in school performance when casting their votes. To this end, we compute the *Relative recent school performance* (RRSP) which measures the deviation of the GPA in the election year, i.e., the results published ca. four months before the elections, from the average GPA in the electoral period, i.e., $\text{RRSP} \stackrel{\text{def}}{=} \text{GPA}_t - \frac{1}{4}\sum_{s=(t-4)}^{(t-1)} \text{GPA}_s$. As shown in Table A.3 in the Appendix, the results from using this alternative main independent variable are qualitatively very similar to the previous ones, with somewhat larger effects.

4.2. Extensions

Previous research has shown that evaluations of the national economy in the United States can vary systematically with information, media exposure, political attitudes, personal experiences, and demographic traits (see Duch et al. 2000). As our first extension, we aim to find out whether similar effects are present in local elections in Denmark and estimate several models to examine how the strength of retrospective voting varies with different characteristics of the local, i.e., polling-station level, electorate.

Table 3
Fixed effects models: Changes in school performance and in the vote share of the incumbent mayor's party.

	(1)	(2)	(3)	(4)	(5)	(6)
ΔGPA	0.0088*	0.0094*	0.0082*			
	(0.0039)	(0.0040)	(0.0040)			
ΔGPAPR				0.0905**	0.0905**	0.0977**
				(0.0277)	(0.0277)	(0.0266)
Demographic controls	No	Yes	Yes	No	Yes	Yes
Political controls	No	No	Yes	No	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Precinct FE	Yes	Yes	Yes	Yes	Yes	Yes
N	2662	2662	2662	2662	2662	2662
R^2	0.0150	0.0183	0.0813	0.0184	0.0212	0.0870

Notes. Dependent variable: ΔSMP. Panel analysis. Demographic control variables include Population, University degree and Age. Political control variables include Turnout, Left support, LoC mayor, Congruence, and Mayor-from-largest. Standard errors are in parentheses and clustered at the polling station level: $^{+}p \leq 0.10$. $^{*}p \leq 0.05$. $^{**}p \leq 0.01$.

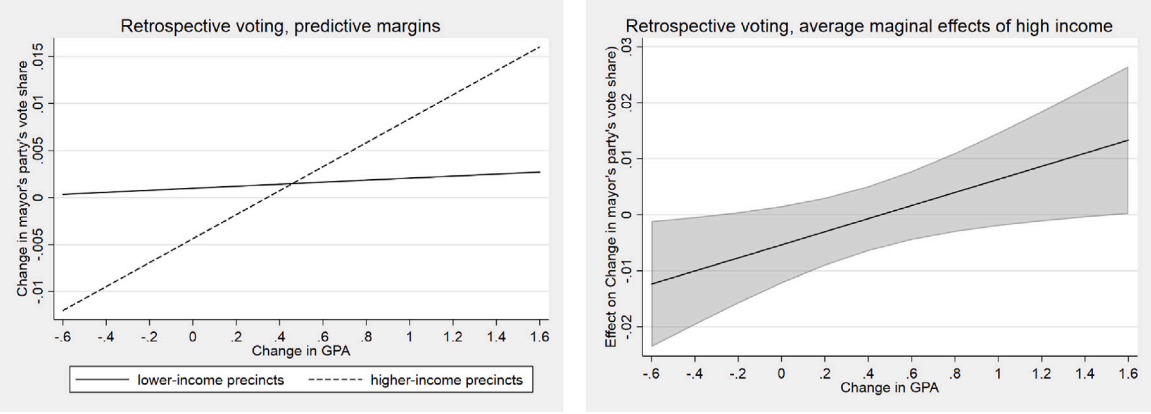

Fig. 3. Retrospective voting differs with respect to income. Left panel: Change in vote share of the mayor's party as a function of the change in GPA by precincts' income status. Right panel: Contrasts. The shaded area represents 90% confidence intervals. Robust standard errors clustered at the polling-station.

For our analysis, we create categorical variables by classifying precincts as above or below the median precinct concerning the characteristic in question. We then interact the resulting indicator variables with ΔGPA. The polling-district characteristics we study are the income level, the share of individuals who hold a university degree, the ethnic homogeneity, the average age of the population and the share of support for left-of-center parties in the previous election (see Section 3.1). As a measure of ethnic homogeneity, we use the share of native Danes, i.e., individuals who are born in Denmark and are not descendants of immigrants.

We present OLS results in Table 4. In model (1), including the interaction of school performance and income, the point estimate on the interaction term is positive and statistically significant. This indicates that a change in the GPA level led to a stronger electoral response in the same direction in districts with above-median income than in those below the median. The estimates imply that a unit-change in ΔGPA has no significant effect in areas with below-median income, but is associated with a change in the incumbent party's vote share of 1.28 percentage points in richer areas. This is also illustrated in the left-hand panel of Fig. 3 which depicts the precinct-level change in the mayor party's vote share as a function of the change in GPA. The contrasts between above-median vs. below-median precincts shown in the right-hand panel reveal that richer and poorer precincts only differ significantly from each other at more extreme changes in school performance.

Our estimates in columns (2)-(5) of Table 4 show that no statistically significant differences in the retrospective voting effect exist with respect to any of the other characteristics. In particular, we did not find differential effects according to the ideological orientation of the electorate, which we had suspected due to the prominence of the left-wing government's school reforms. These findings do not change when examining the 2013 and 2017 elections separately for heterogeneous effects. Regressions corresponding to those in Table 4, but with fixed effect estimators, yield similar results and are reported in Table A.4 in Appendix.

Second, we study whether retrospective voting was conditional on the political characteristics of the incumbent. We hypothesize that school performance could have different standing in the agenda and priorities of mayors from different parties. We thus distinguish between incumbents on the left and right of center. Given the association of the 2013 school reform with a left-of-center

Table 4
Cross-sectional analysis: Interactions with socioeconomic and political characteristics.

	(1)	(2)	(3)	(4)	(5)
Δ GPA	0.0011	0.0073	0.0080^{+}	0.0066	0.0070
	(0.0042)	(0.0050)	(0.0046)	(0.0042)	(0.0044)
ΔGPA× :					
Income - Above median	0.0117*				
	(0.0059)				
University degree - Above median		0.0025			
		(0.0066)			
Native population - Above median			−0.0026		
			(0.0057)		
Age - Above median				−0.0006	
				(0.0059)	
Left support - Above median					−0.0011
					(0.0059)
Income - Above median	−0.0054				
	(0.0042)				
University degree - Above median		−0.0030			
		(0.0039)			
Native population - Above median			−0.0026		
			(0.0057)		
Age - Above median				−0.0003	
				(0.0049)	
Left support - Above median					0.0014
					(0.0051)
Demographic controls	Yes	Yes	Yes	Yes	Yes
Political controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes
N	2662	2662	2662	2662	2662
R^2	0.3732	0.3678	0.3663	0.3662	0.3507

Notes. OLS estimates. Dependent variable ΔSMP. *Above median* refers to indicators for a polling-station district having above-median *Income* (model (1)), *Share of university graduates* (model (2)), *Share of natives* (model (3)), *Age* (model (4)), and *Left support* (model (5)). Robust standard errors clustered at the polling-station level are reported in parentheses. $^{+}p \leq 0.10$. $^{*}p \leq 0.05$. $^{**}p \leq 0.01$.

national government,[13] public attention may have been drawn to school performance as an indicator of the competence of these parties. In this case, we should find larger retrospective voting effects for left-of-center mayors.

Table 5 shows our estimates for models with an interaction between GPA change and a binary variable indicating a LoC incumbent mayor. Our point estimates in the panel regression with full controls (column 6) suggest that a one-unit change in ΔGPA resulted in a 1.48 percentage point change in the same direction when the incumbent mayor was from a right-of-center party. By contrast, the effect of such a change for left-of-center mayors is −0.23 percentage points. This should, however, be interpreted cautiously, as a statistically significant effect only occurs in one of our models.

The result still suggests that citizens may treat mayors of different political leanings differently when it comes to the role school performance plays in the evaluation of political leaders, but not in the way we had previously hypothesized. One possible explanation for the larger effects among right-of-center mayors is that they are more likely to hold office in municipalities with more conservative constituents, among whom the willingness to vote retroactively based on school performance may be more pronounced than among left-leaning voters.

Our final extension is to investigate whether retrospective voting is asymmetric concerning improvements and deteriorations of school performance. Therefore, we split the data set into two sub-samples based on the sign of the GPA change. Identifying the retrospective voting effect in the sub-sample with worsening performance (marked by ↘) indicates an electoral punishment. In the sample where grade point averages have improved, marked by ↗, it would suggest a reward for incumbents.

Table 6 shows OLS (columns 1–3) and fixed effects (columns 4–6) estimates from the ↗ and ↘ sub-samples. The average effects suggest that voters treated improvements and deteriorations in school performance symmetrically. When we allow effects to differ by election year, a different tendency emerges. The positive and significant estimates on the interaction term for 2013 (models (4) and (8)) indicate that voters were more inclined to punish the incumbent for worsening in school performance in that election compared to 2017. Wald tests show that the coefficients differ significantly ($p = 0.018$ and $p = 0.026$ in columns (4) and (8), respectively). We can only speculate about what causes this finding. One possible explanation could be that in the 2013 elections, school performance might have served as an indicator of the left-leaning national government's competence among more conservative voters.

[13] Between 3 October 2011 and 3 February 2014, the government was a coalition of the Socialdemocrats, the Socialist People's Party, and the Danish Social Liberal Party (*Radikale Venstre*)

Table 5
Changes in GPA and in the vote share of the municipal incumbent party, conditional on mayor's left–right position.

	(1) OLS	(2) OLS	(3) OLS	(4) FE	(5) FE	(6) FE
ΔGPA × LoC-mayor	−0.0037	−0.0045	−0.0048	−0.0111	−0.0114	−0.0171*
	(0.0059)	(0.0059)	(0.0059)	(0.0090)	(0.0087)	(0.0084)
ΔGPA	0.0088+	0.0081+	0.0084+	0.0132*	0.0130*	0.0148*
	(0.0048)	(0.0048)	(0.0048)	(0.0059)	(0.0059)	(0.0061)
LoC-mayor	−0.0263**	−0.0261**	−0.0214**	−0.0242**	−0.0240**	−0.0053
	(0.0074)	(0.0074)	(0.0070)	(0.0077)	(0.0076)	(0.0078)
Demographic controls	No	Yes	Yes	No	Yes	Yes
Political controls	No	No	Yes	No	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	No	No	No
Precinct FE	No	No	No	Yes	Yes	Yes
N	2662	2662	2662	2662	2662	2662
R^2	0.3476	0.3530	0.3565	0.0297	0.0346	0.0645

Notes. Dependent variable ΔSMP. In columns 1–3, OLS estimates are reported. In columns 4–6, the fixed effects estimator is applied. Demographic control variables include Population, University degree and Age. Political control variables include Turnout, Left support, Congruence and Mayor from largest party. Standard errors are in parentheses and clustered at the polling station level: $^{+}p \leq 0.10$. $^{*}p \leq 0.05$. $^{**}p \leq 0.01$.

Table 6
Positive vs. negative changes in GPA and in the vote share of the municipal incumbent party.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sub-sample:	OLS ↗	OLS ↘	OLS ↗	OLS ↘	FE ↗	FE ↘	FE ↗	FE ↘
ΔGPA	0.0053	0.0038			0.0090	0.0483		
	(0.0050)	(0.0107)			(0.0080)	(0.0455)		
ΔGPA × 2013			−0.0016	0.0273*			0.0108	0.0780+
			(0.0065)	(0.0125)			(0.0135)	(0.0399)
ΔGPA × 2017			0.0113	−0.0127			0.0071	−0.0371
			(0.0072)	(0.0122)			(0.0154)	(0.0561)
2017	0.0099*	0.0128+	0.0027	−0.0012	−0.0032	−0.0051	−0.0049	−0.0306
	(0.0039)	(0.0073)	(0.0062)	(0.0093)	(0.0081)	(0.0186)	(0.0132)	(0.0235)
Demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Political controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	No	No	No	No
Precinct FE	No	No	No	No	Yes	Yes	Yes	Yes
N	1982	680	1982	680	1982	680	1982	680
R^2	0.3899	0.4059	0.3899	0.4130	0.0942	0.5583	0.0943	0.5957

Notes. Dependent variable ΔSMP. In columns 1–4, OLS estimates are reported. In columns 5–8, the fixed effects estimator is applied. Columns (1), (3), (5), and (7) show estimates based on the sub-sample where ΔGPA > 0. Columns (2), (3), (6), and (7) show estimates based on the sub-sample where ΔGPA < 0. Demographic control variables include *Population*, *University degree* and *Age*. Political control variables include *Turnout*, *Left support*, *Congruence* and *Mayor-from-largest* party. Standard errors are in parentheses and clustered at the polling station level: $^{+}p \leq 0.10$. $^{*}p \leq 0.05$. $^{**}p \leq 0.01$.

5. Conclusion

In this paper, we studied whether Danish voters base their electoral support for the incumbent mayor and their party on changes in the performance of local primary schools, a key area of responsibility for local politicians. We focused on the grade point average in the last year of compulsory education because this value is publicly available for all schools, is widely discussed in the Danish media each year, and its movements are likely to be relevant for parents and other voters. We found a retrospective election effect related to school performance which is robust across specifications. A second notable finding is that voters in above-average income areas showed a somewhat greater willingness to address school performance in the voting process than voters in poorer precincts.

Information on school standing was arguably more readily available in 2017 compared to 2013, making it perhaps surprising that the association between school performance an voting behavior tended to be stronger in 2013.[14] One factor that is difficult to control for is voters' perception of outcomes which, usually, will differ from actual outcomes. This perception is, among other things, moderated by the media (see, e.g., Hetherington 1996; Berry and Howell 2007; Sanders and Gavin 2004; Hopkins and Pettingill 2018). In terms of media attention, it seems that school policy in general, and the GPA measure in particular, were much more in the

[14] The temporal variability of the outcome-vote relation that we document here is, after all, very common (see Nannestad and Paldam 2000, p. 124.).

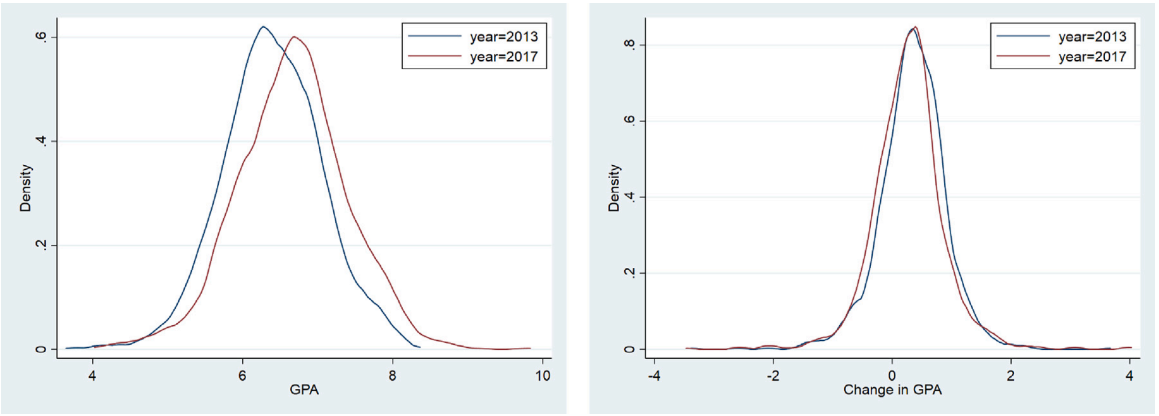

Fig. A.1. Kernel densities. Panel (a) shows average GPA levels at the precinct level; panel (b) shows the change in average GPA levels at the precinct level.

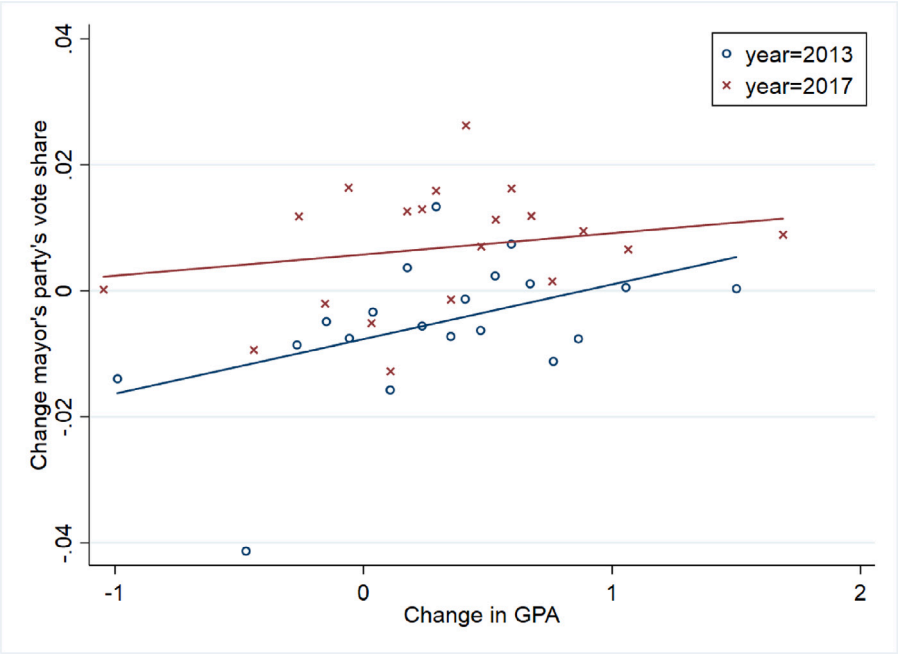

Fig. A.2. School performance and election results, by election year.

spotlight in 2013 than in 2017, due to the major school reform discussed since 2012 and passed by the national parliament in June 2013. Moreover, the official ranking's removal in 2011 led to outrage and defiance from the right-of-center opposition, which may still have been reflected in a particular focus on school quality in the 2013 elections. It would be a worthwhile question for future research to analyze whether changes in broader measures of school quality, including "soft" measures such as pupils' well-being, which is also measured in a nationally unified way in Denmark, are similarly reflected in the electoral response.

In interpreting our results, one should remember that mayors and councils in Denmark have other functions besides the local schools and can therefore be held accountable for changes in outcomes such as, for example, crime rates, the level of services for the elderly, or the condition of the roads. It would therefore be desirable to observe changes in these measures as well. Again, looking at micro-level data, as we have done in this paper, rather than looking at city, state, or national-level results, seems to be the most appropriate way to advance our understanding of which issues matter in retrospective voting and when.

Table A.1
Changes in school performance and in the vote share of the incumbent mayor's party, interaction with year.

	(1)	(2)	(3)	(4)	(5)	(6)
ΔGPA × 2013	0.0099*	0.0093*	0.0095*			
	(0.0042)	(0.0042)	(0.0043)			
ΔGPA × 2017	0.0055	0.0049	0.0041			
	(0.0045)	(0.0044)	(0.0044)			
ΔGPAPR × 2013				0.0765**	0.0794**	0.0849**
				(0.0287)	(0.0285)	(0.0279)
ΔGPAPR × 2017				0.0613+	0.0585	0.0592
				(0.0362)	(0.0361)	(0.0362)
Year 2017	0.0133**	0.0105**	0.0064	0.0127**	0.0101*	0.0057
	(0.0037)	(0.0038)	(0.0042)	(0.0033)	(0.0034)	(0.0038)
Demographic controls	No	Yes	Yes	No	Yes	Yes
Political controls	No	No	Yes	No	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes
ΔGPA × 2013 = ΔGPA × 2017	$p = 0.414$	$p = 0.406$	$p = 0.318$			
ΔGPAPR × 2013 = ΔGPAPR × 2017				$p = 0.740$	$p = 0.647$	$p = 0.573$
R^2	0.3413	0.3455	0.3659	0.3421	0.3468	0.3677
N	2662	2662	2662	2662	2662	2662

Notes. Dependent variable ΔSMP. Pooled OLS. Demographic control variables include Population, University degree and Age. Political control variables include Turnout, Left support, LoC mayor, Congruence, and Mayor-from-largest. Robust standard errors clustered at the precinct level are reported in parentheses. $^{+}p \leq 0.10$. $^{*}p \leq 0.05$. $^{**}p \leq 0.01$.

Table A.2
Fixed effects models: Changes in school performance and in the vote share of the incumbent mayor's party, interaction with year.

	(1)	(2)	(3)	(4)	(5)	(6)
ΔGPA × 2013	0.0198**	0.0206**	0.0177*			
	(0.0072)	(0.0071)	(0.0072)			
ΔGPA × 2017	−0.0011	−0.0011	−0.0006			
	(0.0069)	(0.0071)	(0.0074)			
ΔGPAPR × 2013				0.1217**	0.1233**	0.1262**
				(0.0448)	(0.0445)	(0.0441)
ΔGPAPR × 2017				0.0513	0.0490	0.0620
				(0.0524)	(0.0522)	(0.0520)
Year 2017	0.0185**	0.0175**	0.0001	0.0135**	0.0119**	−0.0051
	(0.0051)	(0.0055)	(0.0070)	(0.0033)	(0.0041)	(0.0055)
Demographic controls	No	Yes	Yes	No	Yes	Yes
Political controls	No	No	Yes	No	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Precinct FE	Yes	Yes	Yes	Yes	Yes	Yes
N	2662	2662	2662	2662	2662	2662
R^2	0.0150	0.0183	0.0813	0.0184	0.0212	0.0870
Δ GPA × 2013 = Δ GPA × 2017	$p = 0.076$	$p = 0.069$	$p = 0.135$	$p = 0.377$	$p = 0.348$	$p = 0.423$

Notes. Dependent variable: ΔSMP. Panel analysis. Demographic control variables include Population, University degree and Age. Political control variables include Turnout, Left support, LoC mayor, Congruence, and Mayor-from-largest. Standard errors are in parentheses and clustered at the polling station level: $^{+}p \leq 0.10$. $^{*}p \leq 0.05$. $^{**}p \leq 0.01$.

Declaration of competing interest

The authors certify that they have no conflicts of interest regarding the subject matter or materials discussed in this manuscript.

Data availability

The authors do not have permission to share data.

Appendix. Additional figures and tables

See Figs. A.1 , A.2 and Tables A.1–A.4

Table A.3
Fixed effects models: Relative recent school performance and change in the vote share of the incumbent mayor's party.

	(1)	(2)	(3)	(4)	(5)	(6)
RRSP	0.0114*	0.0124*	0.0105*			
	(0.0052)	(0.0053)	(0.0053)			
RRSP × 2013				0.0188*	0.0199*	0.0155^{+}
				(0.0088)	(0.0087)	(0.0084)
RRSP × 2017				0.0053	0.0060	0.0062
				(0.0076)	(0.0077)	(0.0077)
Year 2017	0.0121**	0.0114**	−0.0061	0.0133**	0.0105**	0.0064
	(0.0032)	(0.0041)	(0.0054)	(0.0037)	(0.0038)	(0.0042)
Demographic controls	No	Yes	Yes	No	Yes	Yes
Political controls	No	No	Yes	No	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Precinct FE	Yes	Yes	Yes	Yes	Yes	Yes
N	2662	2662	2662	2662	2662	2662
R^2	0.0145	0.0180	0.0808	0.0156	0.0191	0.0813
RRSP × 2013 = RRSP × 2017				$p = 0.287$	$p = 0.266$	$p = 0.443$

Notes. Panel regressions. Dependent variable ΔSMP. The main independent variable is RRSP $\stackrel{\text{def}}{=}$ $\text{GPA}_t - \frac{1}{4}\sum_{s=(t-4)}^{(t-1)} \text{GPA}_s$. Demographic control variables include *Population*, *University degree* and *Age*. Political control variables include *Turnout*, *Left support*, *LoC mayor* incumbent, *Congruence* and *Mayor-from-largest* party. The last row presents results from Wald tests. Robust standard errors clustered at the precinct level are reported in parentheses. $^{+}p \leq 0.10$. $^{*}p \leq 0.05$. $^{**}p \leq 0.01$.

Table A.4
Fixed effects models: Interactions with socioeconomic and political characteristics.

	(1)	(2)	(3)	(4)	(5)
Δ GPA	0.0023	0.007^{+}	0.0061	0.0120*	0.0071^{+}
	(0.0040)	(0.0045)	(0.0056)	(0.0049)	(0.0043)
ΔGPA× :					
Income - Above median	0.0129^{+}				
	(0.0070)				
University degree - Above median		0.0032			
		(0.0070)			
Native population - Above median			0.0033		
			(0.0074)		
Age - Above median				−0.0076	
				(0.0072)	
Left support - Above median					−0.0001
					(0.0072)
Income - Above median	−0.0083				
	(0.0073)				
University degree - Above median		0.0032			
		(0.0070)			
Native population - Above median			0.0042		
			(0.0066)		
Age - Above median				0.0035	
				(0.0059)	
Left support - Above median					−0.0354**
					(0.0083)
Demographic controls	Yes	Yes	Yes	Yes	Yes
Political controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Precinct FE	Yes	Yes	Yes	Yes	Yes
N	2662	2662	2662	2662	2662
R^2	0.0837	0.0736	0.0786	0.0784	0.0537

Notes. Fixed effects estimates. Dependent variable ΔSMP. *Above median* refers to indicators for a polling-station district having above-median *Income* (model (1)), *Share of university graduates* (model (2)), *Share of natives* (model (3)), *Age* (model (4)), and *Left support* (model (5)). The dependent variable is the difference in the vote share of the incumbent party in 2013 compared to 2009 in polling-station i. We include control variables (see Section 3.2). Robust standard errors clustered at the polling-station level are reported in parentheses. $^{+}p \leq 0.10$. $^{*}p \leq 0.05$. $^{**}p \leq 0.01$.

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