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The impact of upper-secondary voucher school attendance on student achievement.

Swedish evidence using external and internal evaluations

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The impact of upper-secondary voucher school attendance on student achievement. Swedish evidence using external and internal evaluations[a]

by

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Abstract

Sweden has a school voucher system with universal coverage and full acceptance of corporate providers. Using a value added approach, we find that students at upper-secondary voucher schools on average score 0.06 standard deviations lower on externally graded standardized tests in first year core courses. The negative impact is larger among lower achieving students (but not among immigrant students), the same students who are most prone to attend voucher schools. For high achieving students, the voucher school impact is around zero. Comparing internal and external evaluations of the same standardized tests, we find that voucher schools are 0.14 standard deviations more generous than municipal schools in their internal test grading. The greater leniency in test grading is relatively uniform across different groups, but more pronounced among students at academic than vocational programs. The findings are consistent with voucher schools responding more to differences in educational preferences than municipal schools.

Keywords: Voucher schools, student achievement, grading standards
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1 Introduction

The analysis of potential costs and benefits of the private provision of publicly funded services in general and of education in particular has a long tradition in economics. Friedman (1962) famously argued in favor of a voucher school system fully open to private providers. On theoretical grounds Shleifer (1998) labelled the case for near-monopoly government provision of elementary and secondary education indefensible, and Hoxby (2003) has argued for voucher financing of private school providers. If families are well informed and there is no discrepancy between the private and public perceptions of school quality, the case for private provision is arguably strong. If these preconditions are not fulfilled, however, a provider can potentially offer a low-quality education either by exploiting the informational disadvantage of families or by catering to private preferences despite this not being in the public interest.[1]

The concerns regarding informational problems and a misalignment between public and private interests are likely to be important in education. First, separating a school's quality from the quality of its students is a non-trivial task even for skilled econometricians (Angrist et al, 2015). Second, peer concerns seem to be an important determinant of educational choice (Hastings et al., 2009; Burgess et al., 2015) despite being a questionable component of educational achievement (Angrist, 2014). Third, families seem to place widely different weights on various school characteristics, such as academic quality and school facilities (Jacob and Lefgren, 2007). There may therefore very well be demand for schools with low educational value added that instead offer families other perceived benefits.[2] Since the objectives of public and private providers are likely to differ, they are also likely to respond differently to the incentives given by the demand conditions.

In this paper, we provide an analysis of Swedish upper-secondary voucher schools (a.ka. *free schools*) using external and internal evaluations of the same standardized

[1] There is a large literature discussing these issues. Despite his support for the private provision of education, several of the concerns regarding contracting difficulties raised by Shleifer (1998) apply to publicly funded education. The public and private goods aspect of education is one of several themes in Levin (2001).

[2] Evidence suggesting that student composition is a more central concern to families choosing schools than school value added is provided by Rothstein (2006) and Mizala and Urquiola (2013). A large literature find positive causal effects of school outcomes on housing values, but such studies generally do not discriminate between school value added and student composition (Black and Machin, 2011). Cellini et al (2010) find that house prices respond positive to investments in school facilities despite having a small impact on test scores. Epple and Romano (2012) model voucher systems incorporating cream skimming and peer effects. Barseghyan et al. (2014) model the welfare implications of school choice taking peer preferences as given while MacLeod and Urquiola (2015) present a model of school choice where peer preferences arise endogenously because of signaling concerns.

tests.[3] Sweden is an interesting case to study since it in 1992 introduced school vouchers covering all students. In the Swedish system, there are few restrictions on who is allowed to own and manage voucher schools; corporate providers are for example fully accepted and providers are not required to have any prior experience in education. Entry is relatively free and approximately 25 percent of all Swedish upper-secondary students now attend voucher schools. Approximately 85 percent of these students study at for-profit schools, a majority of which are part of larger school corporations.

Using a value added approach, augmented with detailed socio-economic and demographic student characteristics, we find that students at municipal upper-secondary schools outperform students at privately run voucher schools by approximately 0.06 standard deviations in first year core courses. The negative impact of voucher school attendance is stronger among students who are academically relatively weak, also the group of students most prone to attend voucher schools. By comparing internal and external evaluations of the exact same standardized tests, we further find that voucher schools on average are 0.14 standard deviations more lenient in test grading.[4] This greater leniency in test grading is relatively uniform across different groups of students, but more pronounced among students at academic than vocational programs.

These asymmetries are consistent with voucher schools responding relatively strongly to differences in demand across groups. Prior evidence quite clearly suggests that academically strong students and high socio-economic families have a relatively strong preference for higher achieving schools, while other considerations are relatively more important for other groups (Hastings et al., 2009; Burgess et al., 2015). Our findings are also in line with recent evidence from Louisiana finding negative effects of school vouchers enabling disadvantaged students at low-performing public schools to attend private schools (Abdulkardioglu et al., 2015). On the other hand, our findings are in contrast to results on charter schools school attendance that tend to find positive effects on achievement among less advantaged students, but negative among the more advantaged (e.g. Clark et al., 2015). More generally, the bulk of the evidence suggests

[3] Neither the term *voucher school* nor *free school* is entirely correct. All schools are funded by voucher-type arrangements where funding follows the student, hence also public municipal schools could be called *voucher schools*. *Free school* is on the other hand a term originating from the less strict regulation applying to these schools. However, the current regulation does not substantially differ between private and public schools, hence making the term *free schools* obsolete. We therefore chose to refer to these entities as *voucher schools*.

[4] In Sweden, standardized tests are graded locally and used to help teachers align their grade setting. We have access to both external and internal evaluations of standardized tests regraded by the Swedish School Inspectorate.

that the performance difference between private and public providers of education is small on average (Neal, 2009; Rouse and Barrow, 2009; MacLeod and Urquiola, 2012; Epple et al., 2015), although some private providers certainly appear to produce large and consistent achievement gains (Abdulkadrioglu et al., 2011). In the UK, the first wave of academies – operating in relatively deprived areas where public schools appear to underperform – have had a non-trivial positive impact on student achievement (Eyles and Machin, 2015). However, it is an open question if further expansions of academies will be able to replicate these gains (Eyles et al., 2015).

Previous research on the Swedish voucher reform has mainly analyzed the compulsory level of education, where the share of voucher school students is substantially lower than at the upper-secondary level (13 percent compared to 25 percent in 2012). The main focus has further been on the aggregate impact of voucher school penetration at the municipal level rather than differences between providers (Böhlmark and Lindahl, 2015). Analyzing differences between providers at the compulsory level is challenging since it is not possible control for selection using prior achievement and since it is necessary to rely on teacher set grades or internally graded standardized tests. These caveats in mind, Böhlmark and Lindahl (2007) use a sibling fixed-effects approach to control for selection and find that the compulsory level vouchers schools outperform municipal schools by about 0.05 standard deviations. Sahlgren (2011) relies on basic socio-economic controls and find slightly larger differences. It can also be noted that OECD (2011) reports no difference in achievement between Swedish municipal and voucher schools at the compulsory level on the externally graded PISA test after controlling for crude socio-economic indicators. For reasons discussed in the concluding section, we caution against generalizing our findings to the compulsory level.

We start this paper by describing some important institutional features of the Swedish school system, with special attention paid to the voucher system. The empirical model and its limitations are discussed in Section 3 and details on the data are provided in Section 4. The results are presented in Section 5 and we summarize and discuss the results in Section 6.

2 The institutional setting

Upper-secondary education in Sweden follows nine years of compulsory education. While being voluntary, 99 percent of the Swedish youth enroll in some type of upper-secondary program. Approximately 15 percent of all students enter various preparatory programs that aim at preparing non-eligible students for the 18 different three-year vocational or academic programs that the remaining 85 percent enroll in. The students in the preparatory programs do not take standardized test and are not part of this study. In the remainder of this section, we provide an overview of upper-secondary schooling in Sweden, with a special focus on the voucher system that funds independent schools. We also discuss admission and choice to upper-secondary schools, and finally we present the system of standardized tests and its role in the Swedish system.

2.1 The voucher system

Subject to national regulation, Swedish local governments (municipalities) are in charge of providing and maintaining the quality of both compulsory and upper-secondary education. Schools are financed by the municipalities and could either be run by the municipality itself or by an independent private provider, what we here call a voucher school. Both voucher schools and municipal schools funded in relation to its number of students. By law, municipalities are required to compensate voucher schools in the same way as they fund municipal schools. At the upper-secondary level, the size of the voucher is supposed to correspond to the municipal costs for each respective program. In several municipalities the voucher – as well as the funding of municipal schools – is weighted by socio-economic criteria, but such systems differ substantially between municipalities.

The voucher system was introduced in Sweden in 1992 and coverage is universal at both the compulsory (grades 1-9) and the upper-secondary level (10-12). The national school inspectorate review voucher school applications based on the general educational plan, the premises to be used, the financial strength of the provider, and forecasts concerning the student population. There are few restrictions on who is allowed to own and manage a voucher school. For example, no prior experience in education is required and for-profit incorporated schools are fully accepted. Prior to approval, municipalities – the default providers of compulsory and upper-secondary education, are allowed to

voice concerns regarding the impact of additional school entry.[5] Over time, the demands placed on new applicants appear to have increased: In the years directly following the voucher reform 80-90 percent of all new applications was approved (Skolverket, 1996). In 2009 the approval rate was 40 percent and in 2013 it was down to 20 (Skolinspektionen, 2013a).

Despite the increased rejection rate, voucher school entry has been substantial and the share of upper-secondary students attending privately run schools has increased from less than 0.5 percent in 1992 to 25 percent in 2012 (SOU, 2013:56). In 2012, 88 percent of the voucher schools at the upper-secondary level were incorporated limited liability entities, often managed by larger school corporations that are partly or fully owned by private equity firms. Ownership changes are recurring events and at least one major bankruptcy has occurred.[6]

2.2 School and program choice

Regarding the basic institutional set-up, there are 18 different upper-secondary programs, 12 vocational and 6 academically oriented.[7] The academic programs differ in the set of courses being offered and these courses determine which tertiary programs that the student is eligible for. The most encompassing is the science program that leaves all educational doors open after upper-secondary school. There are no default schools at the upper-secondary level so every student makes active choices for school-program combinations. These choices have to be approved by the students' parents or legal guardians. When school-program combinations are oversubscribed, the most common selection criterion is the grade point average (GPA) from compulsory school, although some school-programs also use various other selection criteria for special programs.[8]

[5] In practice, the concerns raised by municipalities appear to have had a limited impact on the approval rate of new voucher schools: In 2012, 15 percent of the rejections at the upper-secondary level and only a few applications at the compulsory level were for this reason (Skolinspektionen, 2013b).

[6] The bankruptcy of JB Education in 2013 affected more than 10 000 students. Of all voucher school students, 88 percent at the upper-secondary level attend incorporated schools (SOU, 2013:56; Tabell Bilaga 6.10 and 6.11). Further, 77 percent of voucher school students at the upper-secondary level receive their education at schools that are part of larger school corporations (SOU, 2013:56; Tabell bilaga 6.21 and 6.22). As discussed in Skolverket (2011, chapter 5) the market segment that is growing consists of for-profit voucher schools that are part of larger school corporations. Björklund et al. (2005), Wiborg (2010), and Sahlgren (2011) provide overviews (in English) of the Swedish school voucher system.

[7] The program structure changed slightly during the period that we analyze.

[8] Special programs with other selection criteria often belong to the aesthetic fields, such as music or dance.

There is a vast literature on the determinants of upper-secondary educational choice and it is not possible to here review this body of research in its entirety. Much of this work has focused on which type of program that students select into, rather than the choice of school. A general finding is that students from a more advantaged socio-economic background are substantially more prone to chose academically oriented programs than those from a more disadvantaged social background (e.g. Erikson and Rudolphi, 2010). This is partly because of the higher academic achievement among students from a socially advantaged background (primary effects) but also because these students are more prone to opt for academic programs for a given level of achievement (secondary effects).[9] Secondary effects also appear to depend on foreign background: for a given level of achievement, Jonsson and Rudolphi (2011) find that children with an immigrant background are more prone to chose academically oriented programs. That choice patterns differ between immigrant and non-immigrant students is also found by Söderström and Uusitalo (2010). They analyze the move from residency based to merit (GPA) based admission at the upper-secondary level in Stockholm and find that school segregation between immigrant and Swedish students increased more than can be accounted for by differences in academic achievement. There are also gender differences in program choice. These differences are strongly related to differences in absolute and comparative (between subjects) achievement, but some gender differences remain after taking achievement into account (Jonsson, 1999).

The research focus on program rather that school choice most likely reflect the importance of upper-secondary program in the Swedish educational system.[10] In the wake of increased competition, voucher school expansion and changes in the admission system, research on the joint school-program decision has increased. This work describes three basic dimensions of school-program choice: gender, which is mainly important between vocational programs, social class, and the distinction between economic and cultural capital.[11] There is little indication that the identity of the provider

[9] Interestingly, Erikson and Rudolphi (2010) find that secondary effects are substantially smaller when the GPA rather than various cognitive test scores are used to measure achievement. They argue that this reflects that the GPA captures socio-economic differences to a higher degree than cognitive tests.

[10] Using a vignette approach, Thelin and Niedomsly (2015) find that program availability is indeed by far the most important determinant of school attractiveness, followed by school reputation, distance from home, and social ties to the school. These patterns are relatively stable across students of different gender, family background, and achievement levels.

[11] Forsberg (2015) summarizes and expands previous research by, most importantly, Broady and Börjesson (2008), Palme (2008), and Lidegran (2009).

is an important choice aspect *per se*, but Forsberg's (2015) analysis shows that commercial voucher schools tend to be centrally located along the three dimensionalities described. Non-profit voucher schools, on the other hand, tend to be geared towards the social elite where they compete with established, centrally located municipal schools. For all types of schools, central location in the proximity of transport nodes has become increasingly important since this expands the pool of potential applicants. Forsberg stresses that the basic social structure of educational choice at the upper-secondary level has been remarkably stable over time, but that competition and privatization has led to increased differentiation. Thus, the basic social patterns of school-program choice have become increasingly pronounced.

2.3 Testing and grading

The upper-secondary programs are course based and the teacher rewards grades at the end of each individual course. These grades are averaged into a final GPA which is the main selection mechanism to further studies in Sweden. Partly to aid teachers in their grade setting, standardized, but locally graded, tests are administered to all students in mathematics, Swedish, and English towards the end of the first year of study. Depending on program, tests in more advanced courses are also administered. The school-level results of these tests are available on government webpages and thus accessible for those interested. Although there is no formal alignment between the subject grades set by teachers and the test results, the National School Board report deviations between subject grades and the test scores. To the schools, the tests are thus formally low-stakes but are – just as any test – high stakes to the students. In practice, the tests are regarded as important to schools and a majority of students receive the same final grade as the grade on the test. The relation between test grades and final grades differs substantially between schools, however, suggesting that the degree to which schools consider the test results when setting final grades varies (Skolverket, 2009).

Since 2009, the School Inspectorate has re-graded a subset of locally graded tests. Comparisons between the locally graded and the externally re-graded tests reveal that there is also a substantial school-level variation test in grading practices (Skolinspektionen, 2011; 2012). These re-graded tests are the main object of analysis in this study, and more details are provided below.

3 Empirical considerations

In order to obtain causal estimates of the impact of upper-secondary voucher school attendance on student achievement, we would ideally like to randomly allocate students between voucher schools and municipal schools. Since this is not possible in the current setting, we instead rely on a value added-type analysis (VA) that controls for student achievement at the compulsory level. In other words, we estimate regressions of the following type: $A_{it} = \beta_0 + \beta_1 Voucher_i + \beta_2 A_{it-1} + X_i'\gamma + \varepsilon_{it}$, where A_{it} is the achievement of student i, A_{it-1} is past achievement, and $Voucher_i$ is an indicator variable. X_i' is a vector of other observed student characteristics. The identifying assumption needed for β_1 to yield causal estimates is that the ability, motivation, parental support and similar factors affecting student achievement are not correlated with voucher school attendance, conditional on lagged achievement and other controls.

As discussed by Todd and Wolpin (2003), the identifying assumptions underlying the VA model are quite stringent. As long as student ability (broadly defined) is not fully captured by lagged measures of achievement and other controls, VA models run the risk of yielding biased estimates.[12] Despite these concerns, VA models are widely used and have been evaluated against experimental evidence in various settings. For example, when comparing VA and experimental evidence on the impact of smaller class size, Kreuger (1999) finds that VA estimates are downward biased as they cannot account for the initial achievement gains induced by being assigned to a smaller class. In our analysis, we control for achievement at the compulsory level and no such initial effects at the upper-secondary level cancel out. Lindahl (2005) also finds biases in VA estimates of class size and the likely reason behind this is non-random assignment to smaller classes within schools. Similar concerns regarding non-random assignment are central to the large literature on teacher value added (e.g. Kane and Staiger, 2008; Rothstein, 2010; Chetty et al., 2014). It should be noted that non-random assignment is more likely to be an issue when schools and teachers have soft information that is not captured by test scores or similar indicators of student achievement.

On the one hand, when estimating VA models at the school level, non-random assignment based on soft information only available within the school is less of an issue. On the other, students self-select to schools and the preference for attending a

[12] Classical measurement error in lagged achievement also results in biased estimates of the treatment variable in question.

particular school may be correlated with unobserved student ability. A number of school level studies have found that VA models perform well compared to experimental models based on lottery assignment of students to schools (Abdulkadiroğlu et al., 2011; Angrist et al., 2013; Deming, 2014). Dobbie and Fryer (2013), however, find that VA estimates of charter school attendance are downward biased compared to lottery based estimates. In a recent study, Angrist et al. (2015) find that there are indeed biases in VA estimates of school effectiveness but these biases are relatively small.[13]

Some aspects of the current setting mitigate concerns regarding identification based on our VA approach. First of all, voucher schools are an integrated part of the Swedish school system and all students make active choices at the upper-secondary level. Choosing a voucher school therefore does not mean opting out of the regular public school system. Indeed, the qualitative evidence referred to in the previous section does not cite schools' voucher status as being an important issue when making upper-secondary school choices. This suggests that students opting for voucher schools are not systematically different compared to students opting for municipal schools.[14] This said, voucher schools may still offer profiles, locate, or market themselves in ways that yield similar biases. Second, rather than relying on test scores as measures of prior achievement, we include compulsory school grade point average (GPA) among the controls. The GPA is not only the main selection instrument in the upper-secondary school system, it also has substantially higher predictive power of future academic success than standardized tests such as the SAT (Cliffordson, 2008).[15] Finally, we have register data containing detailed information on student and parental characteristics at our disposal. US studies, on the other hand, typically only control for gender, race, subsidised lunch eligibility, special education status, and limited English proficiency.

Ultimately, the identifying assumptions allowing a casual interpretation of our estimates cannot be tested. However, we can still gauge the credibility of our design by comparing VA estimates with and without controls for student and family

[13] When comparing lottery and VA estimates, Angrist et al. (2015) find forecast coefficients that should be one (1) in case of no bias to be 0.86 (0.08) or 0.95 (0.55), depending on the VA model that is used (p-values of the null hypothesis that the coefficient is equal to one in parentheses).

[14] One possibility is that students opting for voucher schools systematically exert more (less) effort to attain their preferred school than students opting for municipal schools. Such behavior would imply that the VA estimates of voucher school impact are downward (upward) biased.

[15] The GPA is based on many different types of evaluations – both teacher designed and standardized – in several (16) different subjects. Measurement error is thus likely to be less severe for GPA than for test scores. Further, the GPA not only captures cognitive abilities but also non-cognitive traits that are predictive of academic success (Grönqvist et al., 2010).

characteristics, i.e. the vector X_i'. If there is a correlation between student ability and voucher school choice, conditional on prior achievement, this should at least partly be captured when applying our extensive set of controls. Our baseline approach is to estimate the following regression using OLS:

$$y_{iusmcrpt} = \beta_0 + \beta_1 Voucher_u + \beta_2 GPA_{it-1} + \sum_s \beta_{3,s} Grade_{ist-1} + X_i'\beta_4 + \mu_m + \mu_{ct-1} + \mu_r + \mu_p + \varepsilon_{iusmcrpt}.$$

Here, $y_{iusmcrpt}$ is the outcome of student *i*, at upper-secondary school *u*, , in subject *s*, in municipality *m*, at time *t*, who attended compulsory school *c* in period *t*-1, who is enrolled in program *p*, and who had his/her test regraded by re-grader *r*. We also include indicators of upper-secondary program, *p*. Outcomes are standardized by test and year. $Voucher_u$ is an indicator variable, taking the value one (1) if the student attends an upper-secondary voucher school and zero (0) otherwise. GPA_{it-1} is a flexible function of student's the grade point average from compulsory school and $Grade_{ist-1}$ is the compulsory school grade in subject *s*. The coefficients of these subject grades are flexible across subjects. As mentioned in the previous section, grading standards may differ between schools which is one reason to include compulsory school fixed effects (by year), μ_{ct-1}. These fixed effects potentially also capture some unobserved heterogeneity among students, for example compulsory school peer-effects in ambition or school preference not captured prior achievement.[16] Because of the strong connection between place of residence and compulsory school location (Böhlmark et al., 2015), these fixed effects further serve as relatively detailed indicators of student location. This might be important since student location constrains the choice set of students (Burgess et al., 2015).[17] We include municipality fixed effects, μ_m, thereby effectively comparing outcomes between schools within municipalities where there is at least one municipal and one voucher school in our sample. Controlling for municipality is important, not the least since municipalities decide on the level and structure of funding. Local labor market conditions can also affect the type of schools or programs that students apply to,

[16] Peer-effects include rank concerns that have been shown to be important determinants of educational choices (Elsner and Isphording, 2015; Murphy and Weinhardt, 2016). Ruijs and Oostereek (2014) find evidence consistent with students preferring schools where they have peers from prior educational levels.

[17] Geographical constraints are less binding at the upper-secondary than at the compulsory level, but they are not non-existent.

and how important upper-secondary studies are perceived among students. To the extent that voucher schools systematically tend to locate in municipalities where the public schools achieve higher (or lower) test scores, this will be captured by these fixed effects.[18] X_i' is a vector containing a rich set of individual and parental control variables, $\mu_p$is a vector of program fixed effects, μ_r is a vector of re-grader fixed effects, and $\varepsilon_{iusmcrpt}$ is an error term. Standard errors are clustered at the upper-secondary school level.[19]

Since the number of tests administered in mathematics, English, and Swedish differs and we want to give equal weights to all subjects, the baseline regressions are weighted by the ratio between the total number of observations in each year and the number of observations in each subject in that year. I.e., $weight_1 = \frac{Total\ obs_t}{Total\ obs_{st}}$, thus giving equal weight to all three subjects. Using these weights, the regressions are effectively weighted by the number of students per school in the sample. When checking the robustness of the main results, we apply two alternative weighting schemes. First, we assign weights that amount to treating all schools in our sample as being equally sized. We do this by dividing $weight_1$ with the number of students observed at each school, i.e. $weight_2 = weight_1 / number\ of\ observed\ students_{ut}$. Second, we assign weights that correspond to the number eligible students to take the test at the school, i.e. $weight_3 = weight_2 \times Eligible\ number\ of\ students_{ut}$.[20]

When using OLS to analyse the causal impact of voucher school attendance, one concern is the potential imbalance in covariates between attendees of voucher and municipal schools. In addition to OLS, we therefore apply coarsened exact matching (CEM) where we restrict the analysis to a sample that is balanced along a set of characteristics. As discussed by Iacus et al. (2011), CEM can improve inference compared to other types of approximate matching estimators such as propensity score matching. In our CEM analysis, we construct strata based on test subject, student gender, foreign background, GPA quintile, and county of residence (21 counties). Strata

[18] As shown in Appendix Table A2, voucher schools are more prevalent in relatively rich and densely populated municipalities where the population has higher educational attainment. It is likely that the general bureaucratic capacity to manage schools is better in such regions.
[19] We have attempted to add clustering at the municipal level. Since this only marginally affects standard errors, we stick to clustering at the level of treatment, i.e. at the school level.
[20] Information on the number of eligible students per school is from the School Inspectorate's analysis of regraded tests.

that do not contain observations from both voucher and municipal schools are dropped from the analysis. The choice of strata is to some extent arbitrary, but it is reasonable to make comparisons within subject. As discussed in the previous section, upper-secondary choices are further influenced by gender and compulsory school achievement (which also proxies for social background), and there is a strong geographical component to the voucher school expansion that motivates strata based on county of residence. Finally, students with foreign background may face particular constraints in education both due to language barriers and residential location.[21] Previous research also finds that upper-secondary choices differ between students with immigrant background compared to native students with the level of compulsory school achievement (Jonsson and Rudolphi, 2011).

4 Data

In order to study achievement effects and differences in grading standards between voucher schools and municipal schools, we merge data on test scores from the School Inspectorate's re-grading of standardized national tests with register data on student and parental background.

4.1 Re-graded tests

Standardized national tests are locally graded in Sweden, usually by the teacher responsible for teaching the students. At some schools tests are graded in teams but cooperation in grading between schools is rare. In an effort to map potential differences in grading standards between schools, the Swedish School Inspectorate has regraded a large sample of upper-secondary tests collected in several waves. We have access to both the original score and the regraded test results from three such waves, 2010, 2011 and 2012. In each wave, a random sample of schools, stratified by school size, was selected. At each sampled school, a random sample of 100 students was drawn and if the number of students was less than 100, all students were sampled.

The sampling scheme has varied substantially and there are inconsistencies over the years but the stratification variable has always been number of eligible students to take the test. Since there is no straightforward solution to account for the variability of the

[21] As discussed in Holmlund et al. (2014), residential sorting (within municipalities) with respect to immigration status has increased substantially in Sweden.

scheme, we are agnostic with respect to sample weights to be used. Thus, we use three different weights as described in section 3. Moreover, since there is attrition that cannot be controlled for (e.g. we do not observe which students that were absent on the test day) we rely on comparison between our sample at hand with the full population for some key variables such as GPA.

After requesting copies of the original tests and test scores, the tests where digitally cleaned from the student identity and teachers notes. This was done either by a professional computer software and if not sufficient, manually by using white color. The tests were then re-graded blindly by teachers hired through a teachers' employment agency. The external graders were required to be certified teachers with prior experience in grading national tests in the relevant subject. The external graders were provided the official written guidelines stating the prerequisites for each grade and topic in the same manner as teachers originally grading the tests.

In each wave, there is one test re-graded in mathematics, one in Swedish, and two in English.[22] As previously mentioned, test scores are standardized by subtracting the mean and dividing by the standard deviation for each test-year. Attrition is a potential concern since not all schools submitted tests of all students to the School Inspectorate. We do not have information on which schools and students that were originally sampled and cannot perform a formal analysis of this attrition. What is possible, however, is to compare the test taking population to the general student population. As can be seen in Table 1, there is a slight under-representation of voucher students in the sample, but the compulsory school grade point average (GPA) of both voucher students and municipal students match well to the overall population. Among the voucher school students in our sample 86 percent attend corporate schools, which is just short of the share in the total population. From this, we draw the conclusion that the sample seems representative of the overall upper-secondary student population.

[22] In 2012 the mathematics test is divided into four sub-tests.

Table 1. Sample/population comparisons

	(1) **Sample**	(2) **Population**
Share voucher students	.22	.25[a)]
Share voucher students at corporate schools	.86	.88[a)]
Compulsory school GPA (municipal)	219	218[b)]
Compulsory school GPA (voucher)	212	212[b)]

The total number of observations in the sample is 48,073 and there are 27,422 individual students. Sources for population data are [a)] SOU (2013:56) and [b)] Skolverket (2013a).

4.2 Other data

The test data are merged with register information from different sources from Statistics Sweden. From the *Compulsory school register* we match students' grade point average (GPA9) and subject grades from compulsory school. Student gender, quarter of birth and foreign background are taken from the *Louise* register. We code immigrant background using indicators of student being born abroad, having at least one parent born abroad, and having both parents born abroad. Based on the results in Böhlmark (2008), we use four indicators to control for age of immigration: below 7, between 7 and 10, between 11 and 13, and above 14).

Links to parental identity are created using the *Multi-generation register*. Again from *Louise*, we gather data on educational attainment, income, occupation, civil status, family size, age, employment status, and information on various social benefits. For all parental characteristics, we retain observations with missing data and include indicators for variables being missing. In order to allow for a flexible relation between parental income and student achievement, we create decile indicators of wage income separately for mothers and fathers. Educational attainment is converted into eight educational levels using the SUN2000 classification (one for missing). Employment status is classified into employed, not employed, and self-employed. Binary indicators of the following social benefit claims are constructed: early retirement, welfare, unemployment, housing, sick leave (at least one two-week spell during the year), student benefits, and participating in active labor market programs. Parental age at child birth is classified into seven groups for fathers (below 21, 21 to 25, 26 to 30, 31 to 35, 36 to 40, 41 to 45, above 45) and six for women (below 20, 20 to 24, 25 to 29, 30 to 34, 35 to 39, above 39). Marital status is classified into married, unmarried, divorced, and other (unknown or widowed). Family size is grouped into less than three children, 3 to 4 children, and 5 or more children.

In some specifications make use of more detailed indicators of parental education by interacting educational level with the 1-digit level field of study, resulting in 60 educational groups. We also have information on 2-digit occupational codes (28 groups). In order to account for even more details on parental background, we use data from Håkanson et al. (2015) on cognitive and non-cognitive test scores from the military enlistment.[23] Since these data are not available for women (or for all men), we use the average score at the most detailed educational groups available (3-digit level and 3-digit field of study) which results in close to 1,200 individual values in both skill dimensions.[24]

Data on schools are from the *School register* which contains information on the organization form of the private voucher schools. At the upper-secondary level, a large majority all voucher schools are run as limited liability corporations (aktiebolag). We also have indicators for the compulsory school which each student attended prior to upper-secondary school. From this register, we also collect measures of teacher density and the share of teachers with teaching credentials.

4.3 Sample decriptives

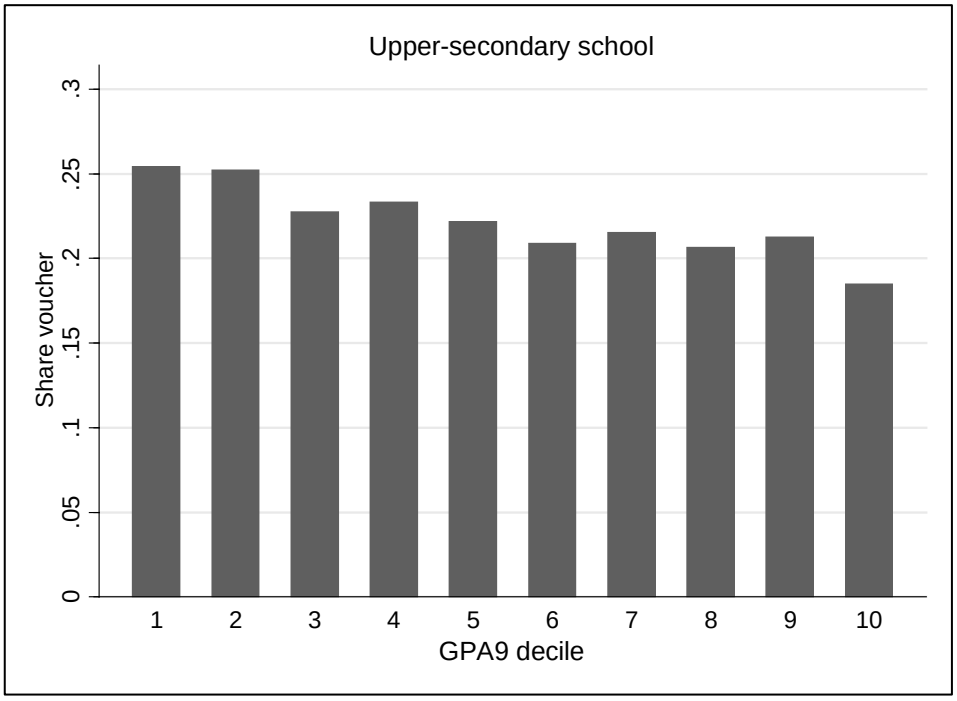
In total, there are 48,073 observations and 27,422 individuals in our sample and summary statistics are given in Appendix Table A1. In the upper panel, we see that the variation in test scores is larger among voucher schools than among municipal ones, regardless if we consider externally or internally graded tests. Further, the difference between internally and externally graded scores is larger among voucher schools, suggesting that voucher schools on average grade the national tests more leniently. Such differences can, however, arise for other reasons than differences in leniency. For example, the share of tests in each subject is not exactly the same between municipal and voucher schools, even though the differences are small.

As can be seen in the lower panel of Table A1, there are also more or less pronounced differences in various student level characteristics between the different types of schools. Not the least, students at municipal upper-secondary schools on average have 7 points higher compulsory school grade point average (GPA9) than voucher school students. This amounts to a non-trivial difference of 0.13 standard

[23] See Lindqvist and Vestman (2011) for details on these enlistment measures.
[24] With a large enough sample size we could have added 1,200 level-by-field dummies for each parent. Considering the sample size at hand, however, many cells would have been empty.

deviations. That students in voucher schools are negatively selected with respect to GPA9 is further highlighted in Figure 1 which shows the share of voucher students in each GPA9 decile.

Figure 1. Voucher school share by GPA9 decile



Note: This graph shows the share of voucher school students in each GPA decile (compulsory school GPA).

It is worth keeping in mind that the share of voucher school students varies substantially across municipalities. As seen in Table A2, the share is higher in population dense municipalities with high income and high educational attainment. Students in such regions on average have higher GPA9 so the differences between students in voucher and municipal schools are even more pronounced when taking regional differences into account. That upper-secondary voucher school students are negatively selected is strikingly different from the selection to voucher schools at the compulsory level. As has been shown in several studies and reports, voucher students at the compulsory level are positively selected with respect to expected achievement (e.g. Holmlund et al., 2014). We can here only speculate on the reasons behind these differences in selection patterns, but some aspects can be noted. First of all, all students make an active choice when entering upper-secondary school, while there is a municipal default school at the compulsory level. Second, students are approximately 15 years old when choosing upper-secondary school, thus presumably having a greater say on this choice than at

younger ages. Third, GPA9 is the main selection mechanism to upper-secondary schools, while student aptitude is not used to screen students at the compulsory level. For this reason, and because of program choice, the degree of ability segregation is substantially more pronounced at the upper-secondary level. Finally, schools have more discretion regarding the program content at the upper-secondary than at the compulsory level. It is possible that students with relatively low GPA are more interested in less traditional programs and that voucher schools are relatively keen to offer various special programs catering to these demands.

In the Appendix, we further show regressions with externally and internally graded test results as the dependent variable. The regressions are shown both at the observational level (Table A3a) and collapsed to the school level (A3b). In columns (1a/b), we see that the correlation between externally and internally graded tests is high. The coefficient at the individual level is 0.72 with an R-squared of 0.51 and at the school level, the coefficient is 0.8 (R-squared 0.71). A strong relation between these measures is of course expected and it is worth highlighting the less than perfect fit of these regressions. In columns (2a/b) and (3a/b), we relate external and internal test scores to the compulsory school GPA. Again, the relation is strong, and the difference in the relation between the GPA and external or internal test scores is small. However, it is worth pointing that at the individual level, the correlation is somewhat stronger between GPA and internally graded test scores, while the opposite is the case at the school level. In columns (4a/b) to (11a/b), we run regressions of test score outcomes on different parental characteristics: maternal years of education, paternal income, and derived measures of parental cognitive and non-cognitive abilities.[25] As expected, there is a strong relation between the socio-economic characteristics of the parents and both individual and school level test scores. At the school level, the explanatory power of the parental characteristics is generally higher when considering externally graded tests, which may reflect heterogeneity in grading standards across schools.

Voucher and municipal schools differ in resource availability. We characterize these differences in Table A4 by running individual level regressions using the teacher-student ratio and the percent of teachers with a degree in education as dependent variables. The sample is also split according to which type of program the student we

[25] As described in the previous section, these derived measures are based on average cognitive and non-cognitive abilities of adult men in approximately 1200 educational categories.

observe attend (vocational or academic).[26] In order to highlight within-municipality differences, municipality fixed effects are included, and year fixed effects are included to account for time trends. The first three columns show that the teacher density is approximately 11 percent lower at voucher schools and this difference is of the same magnitude at vocational and academic programs. The share of teachers with a degree in education is 24 percentage points (30 percent) lower in voucher schools. At vocational programs, the difference is 28 percentage points (38 percent) and at academic programs it is 22 percentage points (28 percent).

5 Results

We begin by presenting the basic results and discuss their robustness with respect to changes in the control group, the set of conditioning variables, and estimation method. Thereafter, we analyze if voucher attendance has different effects over the achievement distribution and some other types of heterogeneity. Finally, we undertake a brief analysis of the impact of voucher school competition at the municipal level. We save most of the interpretation of these results to the concluding section of the paper.

5.1 Main results

The main results are presented in Table 2. The raw difference presented in column (1) shows that voucher school students on average have 0.064 standard deviations lower test scores than students in public municipal schools (not statistically significant). In the next column, re-grader fixed effects are added and as expected this only marginally affects the coefficient. In column (3), we add municipal fixed effects and find that within municipalities that have both municipal and voucher schools, students at voucher schools have substantially lower test scores than students at municipal schools (-0.22 standard deviations). This reflects the strong tendency for voucher schools to be located in high-income municipalities where students have more well-educated parents (see Table A2). The large negative coefficient also reflects the negative selection to voucher schools in relation to prior achievement. This is clearly reflected in column (4) where we flexibly control for the GPA and subject grades from compulsory school. The voucher school coefficient in this value added-type specification is -0.056 meaning that

[26] Since schools may offer both vocational and academic programs, it is somewhat misleading to split the sample by which program the observed student attends. Since resources are reported at the school and not at the school-program level, no alternative is possible however.

students at voucher schools on average achieve just short of 0.06 standard deviations lower test scores than students at municipal schools.

As discussed extensively in section 3, value added estimates run the risk of being biased. There is no definite way of determining the level and direction of such biases and we attempt to judge this by adding different sets of controls. A first concern is that compulsory schools differ in the grading standards and that this is related to voucher school choice. To deal with this, we add compulsory school fixed effects (5) to the value added specification. Those fixed effects not only capture differences in grading standards between compulsory schools, but they also proxy for student location as well as potential peer effects in ambition and upper-secondary school choice. The voucher school coefficient hardly moves when including these school fixed effects, however.

Biases in the value added specification can also arise if students who chose voucher schools are on different trajectories compared to students opting for municipal schools. Since both differences in trajectories and the choice of upper-secondary schools and programs may be systematically related student and family characteristics, we in column (6) add a large set of control variables. These include student gender, immigration background, parental educational attainment, income, proxies for cognitive and non-cognitive abilities, civil status, family composition, indicators of employment status, and various indicators of welfare dependence. Again, the voucher school coefficient is stable (-0.053). In column (7), we add upper-secondary program fixed effects but the result is essentially the same, indicating that voucher school students achieve 0.056 standard deviations lower test scores than students at municipal schools.

An interesting aspect of our data is that we have access to both externally and internally graded test scores of the exact same test. In column (8), we therefore run the same specification as in column (7) but using the internal test scores as the dependent variable. The difference is quite striking: when using internally rather than externally graded tests, voucher school students appear to perform 0.078 standard deviations better than comparable students at municipal schools. Since the voucher coefficient changes from -0.056 to 0.078 when moving from externally to internally graded tests, voucher schools on average give their students 0.133 standard deviations higher test scores relative to the external evaluators. Column (9) highlights this by running the difference between internally and externally graded tests on the full set of controls. The coefficient

is highly statistically significant and shows that the internal grading at voucher schools is on average 0.133 standard deviations more generous than at municipal schools.

Table 2. Main results

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				External test scores				Internal	Diff
voucher	-0.064	-0.068	-0.222***	-0.056**	-0.057**	-0.053**	-0.056**	0.078***	0.133***
	(0.055)	(0.061)	(0.053)	(0.026)	(0.025)	(0.025)	(0.024)	(0.028)	(0.022)
Observations	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073
R-squared	0.001	0.036	0.084	0.390	0.429	0.434	0.437	0.444	0.138
Regrader FE	no	yes	yes	yes	yes	yes	yes	yes	yes
Mun FE	no	no	yes	yes	yes	yes	yes	yes	yes
Lagged Grades	no	no	no	yes	yes	yes	yes	yes	yes
Comp school FE	no	no	no	no	yes	yes	yes	yes	yes
Controls	no	no	no	no	no	yes	yes	yes	yes
Program FE	no	no	no	no	no	no	yes	yes	yes

Dependent variables are externally graded standardized test scores (1)-(7), internally graded standardized test scores (8) and the difference between internally and externally graded test scores (9). "Lagged grades" include a cubic function of compulsory school grade point average (GPA9), quintile indicators of GPA9, and indicators of compulsory school grades in Swedish, English, and mathematics (interacted with subject indicators). Student controls are male student, quarter of birth, immigrant status, age of immigration (5 categories). Parental controls are indicators of educational attainment (8 groups), (log of) parental income, decile income indicators (by gender), age of parent (8 categories), civil status (5 categories), employment or self-employment indicators, indicators of social benefits (early retirement, welfare, housing, student, unemployment, active labor market program). Parental cognitive and non-cognitive abilities are imputed based on years and field of study. Indicators of missing parental characteristics are included. Regrader, municipality of school, compulsory school, and 18 program fixed effects are included where indicated. Regressions are weighted by the ratio of the total number of annual observations to the number of observations in each subject-year ($weight_1$ in text). Standard errors are clustered by school. *** p<0.01, ** p<0.05, * p<0.1

5.2 Robustness

Although we control for lagged achievement and a rich set of covariates, there might still be a concern that the main results are sensitive to the exact model specifications. In Table 3, we therefore consider different extensions to the main set of control variables, different weighting, and estimation methods. The reference points to the results presented in Table 3 are those in Table 2, columns (7) and (9).

Instead of using the standard controls for the level of parental educational level (8 groups), we in column (1) control for maternal and paternal level-by-field of educational indicators (60 groups). The voucher school coefficient is stable to this change. In (2), we replace educational groups with 28 occupational indicators for each parent, and again the voucher coefficient is stable. In column (3) we control for both level-by-field of education and occupation indicators and the estimated voucher school impact is -0.06, marginally different from the -0.056 estimate in the original specification. Finally in (4), we run the difference between internal and external test scores on these wider sets of controls and the voucher coefficient again hardly moves. While there may still be unobserved student characteristics that render the results biased, we from this exercise conclude that this is unlikely.

In the main specifications, the regressions are effectively weighted with the number of observed students at each school. In columns (5) and (6), we reweight the observations using $weight_2$ described in Section 3 such that all schools are given equal weight. Using these weights, the voucher school coefficient in column (5) is -0.051, a minor change from the baseline estimate of -0.056. When analyzing the difference between internal and external grading, the point estimate is 0.125 which should be compared to the baseline of 0.133. An alternative approach is to weigh schools according to the number of students that attend them. This is done in columns (7) and (8) where the regressions are weighted by the number of eligible students at each school using $weight_3$ described in Section 3. When applying these weights, the estimated coefficients are -0.053 and 0.156. Regardless of how we weight the regressions, the results are thus both qualitatively and quantitatively similar.

As the next step, we attempt to deal with the potential problems that may arise when estimating OLS on data for which there is no common support. As discussed in Section 3, we do this by using coarsened exact matching (CEM) and restrict our attention to observations that belong to strata that contain both voucher and municipal schools. The

choice of strata is discussed in Section 3, and we require there to be overlap in student gender, foreign background, GPA9 quintile, subject of test, and county of residence. Out of 1124 possible strata, 599 are matched and out of a total of 9282 voucher school observations, we lose 165 using this procedure. As can be seen in columns (9) and (10) of Table 3, this leads to a marginal increase in the absolute value of the point estimates.

Since we include municipal fixed effects, we identify the voucher school effect only on schools in municipalities that have both voucher and municipal schools. In Appendix Table A5, we present results where we first replace municipal fixed effects with local labor market fixed effects and a set of municipal controls. Local labor markets are larger than municipalities and defined by Statistics Sweden based on actual commuting patterns. The point estimates are somewhat reduced (in absolute values) compared to the baseline estimates but the difference is small and far from statistically significant (-0.045 compared -0.056 in levels, and 0.126 compared to 0.133 when estimating the difference between internal and external test scores). Next, we restrict our attention to the municipalities where our sample contains both voucher and municipal schools. Hardly surprising, the results are essentially identical to the baseline estimates. Finally, we use this restricted sample and replace municipal fixed effects with local labor market fixed effects and municipal controls. Again, the estimates are close to the baseline.

Based on these tests, we conclude that are results are robust and are likely to reflect causal estimates of voucher school attendance. This said, it is impossible to rule out that some omitted variables are biasing the estimates. One such hard-to-observe factor is student motivation for attending popular schools with high admissions thresholds. Students aiming for such schools are likely to work harder in compulsory school and hence graduate with a higher GPA. All else equal, such students would then be on a lower achievement trajectory and estimates of the value added of the schools they attend would be downward biased. Since higher achieving students on average are more likely to attend municipal schools, such a bias would imply that we are underestimating the negative impact of voucher school attendance.

Table 3. Robustness

VARIABLES	(1) External	(2) External	(3) External	(4) Diff	(5) External	(6) Diff	(7) External	(8) Diff	(9) External	(10) Diff
voucher	-0.058**	-0.057**	-0.060**	0.134***	-0.051**	0.125***	-0.053**	0.156***	-0.060**	0.141***
	(0.023)	(0.024)	(0.024)	(0.022)	(0.023)	(0.024)	(0.023)	(0.023)	(0.025)	(0.024)
Observations	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073	39,519	39,519
R-squared	0.439	0.438	0.440	0.142	0.485	0.235	0.445	0.162	0.467	0.196
Ed group	yes	no	yes	yes	no	no	no	No	no	no
Occupation	no	yes	yes	yes	no	no	no	No	no	no
Weight	$weight_1$	$weight_1$	$weight_1$	$weight_1$	$weight_2$	$weight_2$	$weight_3$	$weight_3$	$weight_1$	$weight_1$
Method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS	CEM	CEM

Dependent variables are externally graded standardized test scores or the difference between internally and externally graded test scores. Ed group corresponds to 60 educational categories and Occupation to 28 occupational groups (by parent). Other controls are as in Table 2, column (7). Observations are weighted by the ratio between the annual number of observations and the number of observations in each subject-year ($weight_1$ in text). In (5) and (6), weight1 is divided by the total number of school-year observations ($weight_2$ in text). In (7) and (8), $weight_2$ is multiplied by the total number of eligible students per school-year ($weight_3$ in text). CEM refers to course exact matching where strata are defined using subject, county of residence, GPA quintile, gender, and immigrant background. Out of 1124 CEM strata, 599 are matched. Out of 9282 voucher school observations, 165 are unmatched using CEM. Standard errors are clustered by school. *** p<0.01, ** p<0.05, * p<0.1

5.3 Heterogeneity among students

The results so far show that voucher school students on average achieve between 0.05 and 0.06 standard deviations lower test scores than students at municipal schools when using externally graded tests. Voucher schools are, however, on average about 0.14 standard deviations more generous when grading these tests. An important and potentially informative question is if these effects are homogenous across different types of students or if they are concentrated among some groups. In particular, we are interested in whether students at different achievement levels are differently affected by attending voucher schools. Based on the literature on school preferences, it is quite clear that lower achieving or students whose parents have less educated/lower income parents tend to put lower emphasis on school's academic quality (Hastings et al., 2009; Burgess et al., 2015).[30]

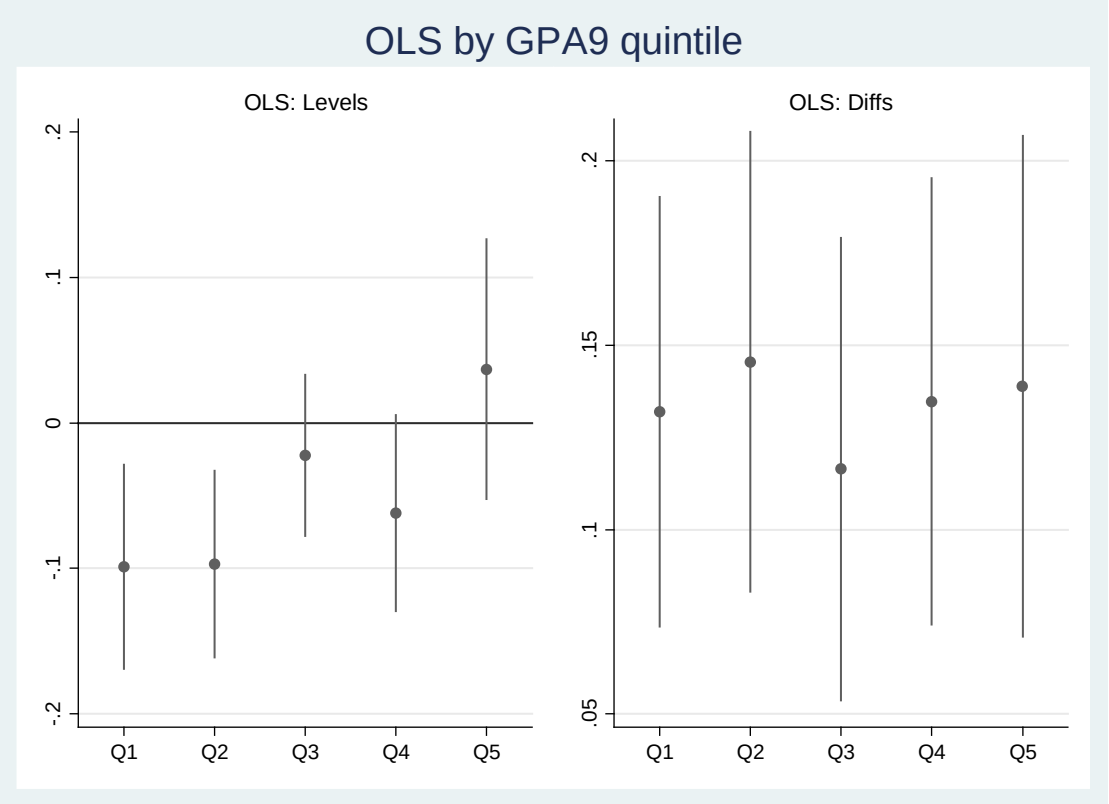
To address this question, we allow the voucher school coefficients to vary by compulsory school GPA quintile. The results are shown in Figure 2 and the corresponding graphs using coarsened exact matching are presented in Appendix, Figure A1. As can be seen, voucher school attendance is not associated with statistically significant achievement gains anywhere along the achievement distribution, but the voucher school impact appears to be heterogeneous. In the bottom two quintiles, the voucher impact is approximately -0.1 standard deviations using either OLS or CEM as the estimation technique. In the third quintile, the estimate is around -0.02 and not statistically significant while it in the fourth is -0.06 and only significant at the 10 percent level. In the highest quintile, the estimate is positive – around 0.03 – and not statistically significant. Thus, the highest performing students seem to avoid voucher schools with lower value added than municipal schools while this is not the case among lower performing students.

More generous test grading among voucher schools appears to take place throughout the student achievement distribution. Using OLS, the estimated voucher schools impact on difference between internal and external test scores is relatively homogenous around 0.13-0.14 standard deviations for all groups of students. Using CEM, however, there is

[30] Somewhat contradictory, Jacob and Lefgren (2007) find that parents at high poverty schools place a higher relative emphasis on teacher value added than parents at low poverty schools. As discussed in their study, these estimates are within schools and may hence reflect a shortage in the supply of high value added teachers among high poverty schools. I.e., even if the marginal valuation of teacher value added is higher within high poverty schools, the average valuation of value added may very well be lower among poor families.

a tendency towards more generous test grading in the highest quintile (0.18 standard deviations, compared to 0.11 in the lowest quintile). Students in the highest achieving group attending voucher schools therefore on average achieve substantially higher internal test scores than students at municipal schools, even though there is no statistically significant difference in achievement when using externally graded tests.

Figure 2. Voucher school impact on external test scores and the difference between internally and externally graded tests, by GPA9 quintile



Note: The same specifications as in Table 2, columns 7 and 9 are used. Regressions are weighted by the ratio of the total number of observations to the number of observations in each subject (by year). Standard errors are clustered by school and 95% confidence intervals are indicated.

Apart from differences in voucher school value added across the achievement distribution, there is a number of other types of heterogeneity that can be interesting to analyze. In Table 4, we therefore present results where we interact the voucher school indicator with student gender, immigrant background, and parental educational attainment.[31] Since male students on average have substantially lower GPA than female students, the first result is in line with what previous findings lead us to expect. The negative interaction term between the voucher indicator and the student being male

[31] Students are classified as having an immigrant background if they are born abroad or if both parents are born abroad. Students are classified as having highly educated parents if parental average educational attainment is in the top quartile in our sample.

indicates that males that attend voucher schools perform worse than girls attending these schools. As the interaction term is not statistically significant, not too much weight should be placed on this however. There is no indication that the generosity in test grading among voucher schools differs between males and females or for any other group.

The findings in column (3) indicate that the negative voucher school impact is concentrated among non-immigrant students (-0.07 standard deviations) while it is close to zero among students with immigrant background. Since the students with an immigrant background in our sample on average have a 0.25 standard deviations lower GPA than non-immigrant students, this is particularly interesting in the light of our previous findings. The general tendency for lower achieving students to enroll in lower-performing voucher schools thus does not appear to apply to students with an immigrant background. The mechanisms behind this result are not obvious, but it can be noted that Jonsson and Rudolphi (2011) find that students with an immigrant background tend to have higher educational aspirations and select more ambitious upper-secondary programs than non-immigrant students at the same achievement level (GPA). One possible interpretation of our result is therefore that higher educational aspirations lead this group of students to avoid less ambitious voucher schools.[32]

Next, we find that the negative impact of voucher school attendance is concentrated among students whose parents do not belong to the top of the educational attainment distribution. The voucher coefficient for this group is -0.08 standard deviations and the interaction term between the indicators of high parental education and voucher school attendance is 0.1. Students from the most highly educated families (top 25 percent of the educational attainment distribution) thus do not tend to attend voucher schools that have a negative value added compared to municipal schools. In the last columns of Table 4, we include triple interaction terms between voucher school attendance, foreign background, and high educational attainment. The triple interactions themselves are imprecisely estimated, but the voucher school coefficients in these specifications show that non-immigrant students whose parents are not in the top of the distribution of educational attainment achieve 0.1 standard deviations lower test scores when attending

[32] This is not due to a general avoidance of voucher schools among students with an immigrant background. In our sample, the voucher school attendance rates are essentially the same among students with and without immigrant background (see Table A1).

a voucher school rather than a municipal school. Since voucher schools on average grade the standardized tests more generously than municipal schools, this negative impact is not apparent when considering internally graded tests. If anything, there is a slight positive impact on internally graded test scores by attending a voucher school even for this group of students. Among students with foreign background or with highly educated parents, attending a voucher school has an approximate zero impact on achievement. Due to more generous test grading among voucher schools, however, these students come out close to 0.15 standard deviations ahead of their municipal school counterparts.

Table 4. Interactions with student characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Gender		**Immigrant**		**Education**		**Triple interaction**	
	External	**Diff**	**External**	**Diff**	**External**	**Diff**	**External**	**Diff**
voucher	-0.032	0.143***	-0.067***	0.133***	-0.079***	0.132***	-0.094***	0.134***
	(0.025)	(0.024)	(0.024)	(0.023)	(0.024)	(0.022)	(0.024)	(0.023)
× Male	-0.049	-0.018						
	(0.032)	(0.023)						
× Foreign			0.075**	0.005			0.091**	-0.012
			(0.034)	(0.031)			(0.036)	(0.033)
× High ed					0.097***	0.006	0.107***	-0.006
					(0.026)	(0.025)	(0.030)	(0.028)
× Foreign × High ed							-0.042	0.093
							(0.075)	(0.063)
Observations	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073
R-squared	0.437	0.138	0.437	0.138	0.437	0.138	0.438	0.138

Dependent variables are externally graded standardized test scores or the difference between internally and externally graded test scores. Same specifications as in Table 2, columns 7 and 9 are used. The voucher school indicator is interacted with student gender, immigrant background (born abroad or both parents born abroad), and high parental educational attainment (in the top quartile of the distribution of parental educational attainment). Columns (7) and (8) contain an unreported interaction term between Foreign and High ed. Observations are weighted by the ratio between the annual number of observations and the number of observations in each subject-year ($weight_1$ in text). Standard errors are clustered by school. *** p<0.01, ** p<0.05, * p<0.1

5.4 Other heterogeneity: provider, program and region

In this section we present evidence on other potential types of heterogeneity. In particular we study asymmetries between academic and vocational programs, corporate and non-corporate voucher school providers, and different types of municipalities.

Our main specification includes upper-secondary program fixed effects and it could be asked if the impact differs between different program types. In order to address this, we classify the 18 different programs into vocational, academic, and academic with a science specialization. There is a marked connection between these program categories and prior achievement: the GPA9 in the vocational group is 185 merit points (0.66 standard deviations below the mean), in the academic, non-science, group it is 233 merit points (0.22 standard deviations above the mean), and in the science specialization 267 merit points (0.87 standard deviations above the mean).[33]

Given the strong relation between prior achievement and program choice, the results reported in Table 5 are unsurprising: the negative impact by voucher school attendance on achievement is concentrated among vocational students. The interaction between the voucher indicator and an indicator for non-science academic programs is positive, albeit not statistically significantly different from estimate for vocational students. The point estimate for voucher attendance among students in science programs is on the other hand significantly larger than for vocational students. For students at science programs, the total voucher estimate is positive (0.04) but not statistically significant. Since these students have the highest compulsory school GPA, this result is consistent with the findings in Figure 2. More generous test grading again seems quite uniform between groups.

In columns (3) to (6), we analyze heterogeneity between student background and program orientation simultaneously. This is done by splitting the sample in vocational and academic programs and including an interaction between the voucher indicator and an indicator of high parental education. In column (3), we see that the negative voucher estimate is around 0.17 standard deviations for vocational students whose parents do not belong to the top of the educational attainment distribution. Among the few (10 percent) vocational students with highly educated parents, the negative impact is around 0.05 standard deviations. On average, voucher schools grade vocational students approxi-

[33] As shown in Table A1, 38 percent of the observations belong to the vocational group, 50 percent to the academic, non-science, group, and 12 percent to the science program.

mately 0.08 standard deviations more generously than municipal schools (column 4). The results in column (5) show that the negative voucher school impact among students at academic programs without highly educated parents is 0.04. The share of students with highly educated parents at the academic programs is 30 percent, and for this group the voucher impact is approximately zero. Voucher school students at academic programs are on average graded approximately 0.15 standard deviations more generously than students at municipal schools (column 6). Students at these programs therefore come out ahead of their municipal school counterparts, despite having the similar levels of achievement when the tests are externally evaluated.

Table 5. Differences between programs

	(1)	(2)	(3)	(4)	(5)	(6)
			Vocational		Academic	
	External	Diff	External	Diff	External	Diff
Voucher	-0.094**	0.137***	-0.167***	0.083**	-0.041*	0.145***
	(0.037)	(0.031)	(0.043)	(0.036)	(0.023)	(0.025)
× Other ac	0.049	-0.005				
	(0.039)	(0.033)				
× Science	0.137**	-0.011				
	(0.055)	(0.069)				
× High ed			0.117*	0.000	0.046*	0.028
			(0.062)	(0.057)	(0.026)	(0.027)
Observations	48,073	48,073	18,247	18,247	29,826	29,826
R-squared	0.437	0.138	0.436	0.218	0.442	0.173

The dependent variable is externally graded test scores or and the difference between internally and externally graded test scores. The same set of controls as in Table 2, column (7) is included. Interactions between the voucher school indicator and Other academic (non-science) program, Science program, and highly educated parents (top quartile of the educational attainment distribution) are included. In columns (3)-(6), the sample is split between vocational and academic programs. Regressions are weighted by the ratio of the total number of observations to the number of observations in each subject (by year). Standard errors are clustered by school. *** p<0.01, ** p<0.05, * p<0.1.

A distinguishing feature of the Swedish voucher school system is its openness to different types of providers. In particular, corporate providers are fully accepted and there are no restrictions on profit levels or dividend payouts. At the upper-secondary level, most providers are incorporated which is reflected in our sample (86 percent of the voucher school students attend corporate voucher schools). The different providers attract somewhat different types of students: among the corporate schools, the average GPA9 is 0.12 standard deviations below the mean, while it is 0.1 standard deviations above the mean among the non-corporate voucher schools. 24 percent of the students at corporate schools have highly educated parents which can be compared to 32 percent among the non-corporate ones.

The results from regressing external test scores and the difference between internal and external test scores on indicators of corporate and non-corporate voucher schools are shown in Table 6. Due to the low number of non-corporate schools, the coefficients for these are less precisely estimated but there is no indication that the providers are different. Students among both types of providers on average score around 0.06 standard deviations lower than students at municipal schools, and both types of providers are around 0.14 standard deviations more generous in their internal test grading compared to municipal schools. The results are essentially identical if we are using OLS or CEM as the method of estimation.

Table 6. Corporate and non-corporate voucher schools

	(1)	(2)	(3)	(4)
	OLS		CEM	
VARIABLES	External	Diff	External	Diff
Corporate	-0.056**	0.132***	-0.058**	0.141***
	(0.025)	(0.024)	(0.027)	(0.026)
Non-corporate	-0.053	0.143***	-0.066*	0.140***
	(0.037)	(0.049)	(0.039)	(0.048)
Observations	48,073	48,073	39,519	39,519
R-squared	0.437	0.138	0.467	0.196

Dependent variables are externally graded standardized test scores or the difference between internally and externally graded test scores. Same specifications as in Table 2, columns 7 and 9 are used. CEM refers to course exact matching where strata are defined using subject, county of residence, GPA quintile, gender, and immigrant background. Out of 1124 CEM strata, 599 are matched. Out of 9282 voucher school observations, 165 are unmatched using CEM. Standard errors are clustered by school. *** p<0.01, ** p<0.05, * p<0.1.

Because of the low number of students at non-corporate voucher schools, it is difficult to push an analysis of heterogeneity very far. In Appendix Table A6, we interact the corporate and non-corporate indicators with indicators of immigrant background and high parental education. The results for corporate voucher schools basically mimic the ones already presented: the negative impact of voucher school attendance on test scores is concentrated among non-immigrant students whose parents are not highly educated. Test grading is approximately 0.14 standard deviations more generous than at municipal schools and this difference is uniform across groups. Obviously, the estimates for non-corporate schools are much less precise but there is some indication that internal test grading is particularly generous among students with highly educated parents. Taking the – quite noisy – point estimates at face value suggest that students with highly educated parents at non-corporate schools on average are 0.2 standard deviations more generously graded than their municipal school counterparts.

As already shown in Table A4, voucher schools on average have a lower teacher student ratio and a lower share of teachers with teaching credentials. In order to analyze if this can account for the differences in outcomes between municipal and voucher schools, we control for these variables in the baseline specifications. It should be kept in mind that the data on personnel is quite crude at the upper-secondary level. A major reason for this is that schools offer several programs and teacher density and the share of teachers with credentials can differ widely across these. The reported numbers are, however, school-level averages.[34] In Table A7, we find that there is little indication that differences in reported teacher resources are behind the results we report.

Next, we consider heterogeneity in the regional sense. The share of voucher school students differs substantially between different municipalities and we split the sample according to the median share of upper-secondary voucher school students. This could be seen as splitting the sample into highly competitive and less competitive school markets, but we caution against such an interpretation. As shown in Appendix Table A2, municipalities with a high share of voucher school students differ in essentially all dimensions; these municipalities tend to be large and densely populated areas where the population has relatively high educational attainment and high incomes. It is therefore not possible to here isolate the impact of competition from other factors. We undertake the analysis partly for descriptive purposes and present the results in Table 7. The somewhat noisy estimates suggest that the impact on test scores of attending a voucher school is less negative in regions with a higher share of voucher schools. There is little indication that the degree of test grading generosity differs between voucher schools in different regions.

[34] For 860 observations, data on personnel is missing. In order to keep the sample consistent, these observations are included together with indicator variables of missing values. We further truncate the teacher-student ratio at 20 teachers per 100 students (the 99.5th percentile).

Table 7. Municipalities below and above the median share of voucher school students

	(1)	(2)	(3)	(4)
	OLS		CEM	
VARIABLES	External	Diff	External	Diff
voucher	-0.130***	0.127***	-0.110**	0.114*
	(0.048)	(0.046)	(0.053)	(0.060)
× High voucher share	0.100*	0.008	0.065	0.035
	(0.051)	(0.051)	(0.057)	(0.066)
Observations	48,073	48,073	39,519	39,519
R-squared	0.437	0.138	0.467	0.196

The dependent variable is externally graded test scores or and the difference between internally and externally graded test scores. The same set of controls as in Table 2, column (7) is included. Interactions between the voucher school indicator and an indicator of municipality being above the median share of voucher school students at the upper-secondary level included. CEM refers to course exact matching where strata are defined using subject, county of residence, GPA quintile, gender, and immigrant background. Out of 1124 CEM strata, 599 are matched. Out of 9282 voucher school observations, 165 are unmatched using CEM. Regressions are weighted by the ratio of the total number of observations to the number of observations in each subject (by year). Standard errors are clustered by school. *** p<0.01, ** p<0.05, * p<0.1

5.5 Aggregate effects

While the findings in this study indicate that voucher school students achieve lower test scores in core subjects than students at municipal schools, it could be the case that – for example – competitive pressures of voucher schools result in better (or worse) outcomes across all schools. Böhlmark and Lindahl (2015) have found evidence that the degree of voucher school penetration is positively related to student outcomes at the compulsory level in Sweden. By analyzing outcomes within municipalities, we have so far abstracted from this possibility. As a final step of the analysis, we therefore ask if there is any indication that student achievement in the core subjects is systematically related to the degree of voucher school penetration. Due to the institutional differences between the compulsory and upper-secondary level in Sweden, it is further not obvious that voucher school penetration should have a similar impact at the different levels.

When undertaking this analysis, we regress the main outcomes on the share of upper-secondary voucher students at the municipal level, adding various municipal and individual level controls to account for confounding factors. An important question is whether or not to control for compulsory school achievement in these specifications. In a value added analysis, prior test scores should of course be included. At the municipal level, however, compulsory level achievement is likely to be endogenous to conditions at the upper-secondary level (Koerselman, 2013). Further, the degree of voucher school penetration is highly correlated between the compulsory and upper-secondary levels, making it difficult to separate the impact of one from the other. Within our framework,

there is no ideal solution to these problems and the results presented in Table 8 should therefore be seen as tentative.

Column (1) shows a bivariate regression of test scores on the share of upper-secondary voucher school students at the municipal level is positive and statistically significant. In column (2), we instead use the share of compulsory level voucher school students as a measure of voucher school penetration. Since the share of voucher students is highly correlated between levels, it is hardly surprising that this is positive and significant as well. In columns (3) and (4), we add a set of municipal level control variables, including compulsory school GPA in 1990, i.e. prior to the voucher school reform. The point estimates now switch signs but they are not statistically significant. The same is true in columns (5) and (6) where we add individual level controls to the regressions, and in (7) and (8) where we add lagged achievement. Due to the low precision of these estimates it is hard to draw any distinct conclusions from this exercise. In the final two columns, we see that the same is true when using the difference between internal and external test scores as the dependent variable. In Appendix Table A8, we present the same set of regressions where we weigh the observations such that each municipality is given equal weight. Again, the estimates are noisy and fail to reveal a clear relation between the share of voucher school students and student outcomes. As already stressed, these results should be seen as tentative.

Table 8. Municipal share of voucher school students

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	External test scores								Diff	
Voucher share (upper-sec)	0.561**		-0.318		-0.224		-0.140		-0.044	
	(0.240)		(0.234)		(0.194)		(0.144)		(0.115)	
Voucher share (compulsory)		0.851***		-0.190		-0.193		-0.190		-0.086
		(0.294)		(0.383)		(0.309)		(0.191)		(0.222)
Observations	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073
R-squared	0.004	0.004	0.014	0.013	0.088	0.088	0.344	0.344	0.004	0.004
Municipal controls	no	no	yes	yes	yes	yes	yes	yes	yes	yes
Individual controls	no	no	no	no	yes	yes	yes	yes	yes	yes
Lagged achievement	no	no	no	no	no	no	yes	yes	no	no

The dependent variable is externally graded test scores in columns (1) to (8) and the difference between internally and externally graded test scores in (9) and (10). Municipal controls are (log) population size, (log) per capita income, the 1990 compulsory school GPA, unemployment rate, educational attainment, and the immigrant population share. Student controls are male student, quarter of birth, immigrant status, age of immigration (5 categories). Parental controls are indicators of educational attainment (8 groups), (log of) parental income, decile income indicators (by gender), age of parent (8 categories), civil status (5 categories), employment or self-employment indicators, indicators of social benefits (early retirement, welfare, housing, student, unemployment, active labor market program). Parental cognitive and non-cognitive abilities are imputed based on years and field of study. Indicators of missing parental characteristics are included. "Lagged achievement" include a cubic function of compulsory school grade point average (GPA9), quintile indicators of GPA9, and indicators of compulsory school grades in Swedish, English, and mathematics (interacted with subject indicators). Regressions are weighted by the ratio of the total number of observations to the number of observations in each subject (by year). Robust standard errors in parentheses, clustered by municipality. *** p<0.01, ** p<0.05, * p<0.1.

6 Conclusions and discussion

Sweden has a universal voucher system unusually open to different types of providers. Since the launch of this system in 1992, there has been a rapid expansion of voucher schools and 25 percent of all upper-secondary students now attend a voucher school. Using a value-added approach augmented with a rich set of controls, we find that attending a Swedish upper-secondary voucher school rather than a municipal school on average results in 0.06 standard deviations lower achievement on externally graded test scores in first year core subjects. By comparing internal and external evaluations of the exact same standardized tests, we further find that voucher schools on average are around 0.14 standard deviations more generous in their internal evaluations than municipal schools.

The negative impact of voucher school attendance is concentrated among relatively low-performing students, with the notable exception of students with an immigrant background. For students at vocational programs without highly educated parents, the estimated voucher impact on externally evaluated tests is -0.17 standard deviations. At the other end of the spectrum, the estimated voucher school impact among students at academic programs with highly educated parents is around zero. Greater grading leniency among voucher schools is relatively uniform across groups, but more pronounced among academic than vocational programs. Despite having similar external test scores, voucher school students at academic programs therefore come out around 0.15 standard deviations ahead of their municipal school counterparts when considering the internal test evaluations.

As a defining feature of the Swedish voucher system is its openness to different providers, it is noteworthy that results for corporate and non-profit voucher schools are essentially identical, both regarding test scores and more lenient grading standards. Although resources as measured by teacher density and the share of teachers with credentials are lower among voucher schools, there is little indication that this can account for the differences between municipal and voucher schools.

Our results are consistent with voucher schools being sensitive to consumer demand and that they differentiate to accommodate different groups of students. According to previous studies, academically high-achieving students and students of high socioeconomic background tend to value academic quality relatively highly. Although voucher

schools aimed at these students do not outperform municipal schools academically, their test scores are higher due to more lenient grading. It is also well-documented that lower achieving students and families with less educated parents place relatively lower weight on academic quality. It is therefore not surprising that voucher schools aimed at these students do not focus on core subject knowledge. An obvious question is if voucher schools specializing in vocational programs outperform municipal schools in other aspects. We cannot analyse this, but the qualitative evaluations of vocational voucher schools by the Swedish School Inspectorate (Skolinspektionen, 2011; 2013) and the National Agency of Education (Skolverket, 2013b) suggest otherwise. Rather, these reports stress quality problems in vocational training and non-core subject education.

Our analysis reveals that the share of voucher school students is the highest among the groups for whom the negative impact of voucher school attendance is the largest. We cannot answer if this is due to families who chose these voucher schools are uninformed about their quality or if they prefer them for other reasons. It is, however, unlikely that students with immigrant background are more well-informed about school quality than non-immigrant students. The result that students with an immigrant background tend to avoid low-performing voucher schools therefore suggests that a lack of information is not the main concern. Our results are also consistent with previous research showing that students with an immigrant background make more ambitious upper-secondary choices than non-immigrant students at the same achievement level.

Some caveats regarding the results should be mentioned. First of all, even if the tests are externally graded, they are not immune to manipulation. Schools can coach students excessively on standardized test, and provide excessive help prior to and during the test. We cannot observe such practices and therefore cannot tell if there are systematic differences between municipal and voucher schools in these dimensions as well. Second, our results only refer to first year outcomes in core subjects and do therefore not capture the entire set of outcomes. Third, by focusing on differences between voucher and municipal schools, we abstract from potential general equilibrium effects. However, a somewhat tentative analysis reveals no significant relation between the share of voucher school students at the municipal level and student achievement or grading standards.

Our study provides a word of caution for potential studies of the long term effects of voucher school attendance, at least in the Swedish context. More lax grading standards among voucher schools presumably translate into higher upper-secondary final grades. These grades are used to sort students into post-secondary education and possibly also into the labor market. Voucher school students can therefore outperform municipal students in post-secondary outcomes, despite not having built more or better human capital during upper-secondary school. The private returns from voucher school attendance can thus not be assumed to equate the social return.

Finally, it is worth stressing some differences between school choice at the compulsory and upper-secondary level in Sweden. At the compulsory level, parents most likely have a stronger say concerning which school to attend which may affect choice quality. Second, students at the upper-secondary level are sorted using compulsory school GPA, while sorting on aptitude or achievement is not allowed at the compulsory level. Social and academic stratification is thus much more pronounced at the upper-secondary level. Third, the curriculum is less strictly regulated at the upper-secondary than at the compulsory level. The scope for students and schools who want to game the system in various ways may therefore be greater at the upper-secondary level. Finally, there are no default schools at the upper-secondary level leading everyone to make an active choice. At the compulsory level, students who do not actively choose a school are assigned to a default municipal school. For these reasons, we caution against generalizing our results to the compulsory level.

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Appendix

Table A1. Summary statistics

		All		Public		Voucher	
VARIABLES	**N**	**mean**	**sd**	**mean**	**sd**	**Mean**	**sd**
			By observation				
Test score (external)	48,073	0.00	1.00	0.01	0.99	-0.01	1.05
Test score (internal)	48,073	0.00	1.00	-0.01	0.98	0.04	1.05
Diff (int-ext)	48,073	0.00	0.72	-0.02	0.71	0.05	0.74
Swedish	48,073	0.24	0.43	0.23	0.42	0.27	0.44
Mathematics	48,073	0.34	0.47	0.34	0.47	0.33	0.47
English	48,073	0.42	0.49	0.43	0.49	0.40	0.49
Vocational	48,073	0.38	0.48	0.38	0.48	0.40	0.49
Academic science	48,073	0.12	0.33	0.13	0.34	0.08	0.26
Other academic	48,073	0.50	0.50	0.49	0.50	0.53	0.50
			By student				
Voucher	27,422	0.22	0.42	0	0	1	0
Corporate	27,422	0.19	0.39	0	0	0.86	0.35
GPA9	27,422	217	53.4	219	52.7	212	55.5
Foreign (1^{st})	27,422	0.06	0.24	0.06	0.24	0.06	0.24
Foreign (2^{nd})	27,422	0.08	0.28	0.08	0.27	0.09	0.29
Immigration age	1,976	7.72	4.52	7.80	4.56	7.44	4.37
Edlevel (mother)	26,788	3.87	1.41	3.88	1.41	3.83	1.42
Edlevel (father)	25,850	3.54	1.51	3.54	1.51	3.56	1.52
Lnwage (mother)	23,867	7.77	0.89	7.78	0.87	7.75	0.96
Lnwage (father)	22,293	8.09	0.87	8.09	0.86	8.09	0.89
Cog (mother)	27,379	-0.11	0.51	-0.11	0.51	-0.12	0.51
Noncog (mother)	27,379	-0.04	0.40	-0.04	0.39	-0.05	0.40
Cog (father)	27,387	-0.09	0.58	-0.09	0.58	-0.08	0.57
Nogcog (father)	27,387	-0.06	0.43	-0.06	0.43	-0.06	0.42
Emp (mother)	26,855	1.970	0.37	1.97	0.37	1.96	0.39
Emp (father)	25,914	2.065	0.47	2.07	0.47	2.06	0.49
Early retire (mother)	26,855	0.07	0.25	0.07	0.25	0.07	0.26
Early retire (father)	25,914	0.05	0.21	0.04	0.21	0.05	0.21
Welfare (mother)	26,855	0.05	0.22	0.05	0.21	0.06	0.23
Welfare (father)	25,914	0.04	0.20	0.04	0.19	0.05	0.21
Housing (mother)	26,855	0.11	0.31	0.11	0.31	0.12	0.32
Housing (father)	25,914	0.06	0.23	0.05	0.23	0.06	0.24
Student (mother)	26,855	0.03	0.16	0.03	0.16	0.03	0.17
Student (father)	25,914	0.00	0.07	0.00	0.07	0.01	0.07
Sickleave (mother)	26,855	0.12	0.33	0.12	0.33	0.12	0.33
Sickleave (father)	25,914	0.08	0.27	0.08	0.27	0.08	0.26
Unemp (mother)	26,855	0.06	0.24	0.06	0.24	0.07	0.25
Unemp (father)	25,914	0.05	0.22	0.05	0.22	0.05	0.22
LMP (mother)	26,855	0.05	0.22	0.05	0.22	0.05	0.22
LMP (father)	25,914	0.04	0.19	0.04	0.19	0.04	0.18
Age (mother)	26,855	29	4.99	29.0	4.98	28.9	5.04
Age (father)	25,914	31.9	5.91	31.9	5.88	31.9	6.01
Civil (mother)	26,855	1.62	0.81	1.61	0.81	1.66	0.83
Civil (father)	25,914	1.58	0.79	1.57	0.78	1.63	0.81
Famsize (mother)	27,422	1.26	0.53	1.26	0.52	1.27	0.53
Famsize (father)	27,422	1.17	0.53	1.18	0.53	1.16	0.54

Table A2. Voucher school share and municipal characteristics

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Municipal share upper-secondary voucher students					
Income	0.523***					
	(0.079)					
High edu share		0.717***				
		(0.100)				
Right share			0.480***			
			(0.075)			
Ln population				0.052***		
				(0.007)		
Ln pop density					0.042***	
					(0.005)	
Unemp rate						-2.666***
						(0.567)
Observations	142	142	142	142	142	142
R-squared	0.330	0.365	0.224	0.194	0.390	0.166

Bivariate regressions where the dependent variable is the share of upper-secondary voucher students. The explanatory variables are (log) municipal per capita income, the share of municipal adult population with at least three years of post-secondary education, the 2010 municipal vote share for right wing parties (Moderaterna, Kristdemokraterna, Centern, and Folkpartiet), (log) population size, (log) population density, and the municipal unemployment rate. All variables are from Statistics Sweden (Statistikdatabasen) and refer to the year 2011. Robust standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

Table A 3a. External and internal test scores (observation level)

VARIABLES	(1) External	(2) External	(3) Internal	(4) External	(5) Internal	(6) External	(7) Internal	(8) External	(9) Internal	(10) External	(11) Internal
Internal	0.719***										
	(0.005)										
GPA9		0.444***	0.466***								
		(0.006)	(0.006)								
Edyr (mother)				0.091***	0.095***						
				(0.003)	(0.003)						
Ln inc (father)						0.106***	0.102***				
						(0.008)	(0.007)				
Cog (father)								0.332***	0.334***		
								(0.020)	(0.019)		
Noncog (f)								0.085***	0.094***		
								(0.027)	(0.026)		
Cog (mother)										0.381***	0.397***
										(0.021)	(0.021)
Noncog (m)										0.086***	0.068**
										(0.027)	(0.027)
Observations	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073
R-squared	0.513	0.195	0.216	0.041	0.045	0.013	0.013	0.050	0.053	0.051	0.052

The dependent variables are externally or internally graded standardized tests. Indicators of missing parental controls are included but not reported. Regressions are weighted by the ratio of the total number of yearly observations to the number of observations in each subject-year ($weight_1$ in text). Standard errors are clustered by student. *** p<0.01, ** p<0.05, * p<0.1.

Table A3b. External and internal test scores (school level)

VARIABLES	(1) External	(2) External	(3) Internal	(4) External	(5) Internal	(6) External	(7) Internal	(8) External	(9) Internal	(10) External	(11) Internal
Internal	0.801***										
	(0.036)										
GPA9		0.479***	0.436***								
		(0.051)	(0.065)								
Edyr (mother)				0.288***	0.312***						
				(0.029)	(0.029)						
Lninc (father)						0.925***	0.988***				
						(0.114)	(0.132)				
Cog (father)								0.977***	1.266***		
								(0.230)	(0.244)		
Noncog (f)								0.582	0.091		
								(0.362)	(0.365)		
Cog (mother)										1.490***	1.375***
										(0.323)	(0.303)
Noncog (m)										-0.271	-0.019
										(0.533)	(0.447)
Observations	376	376	376	376	376	376	376	376	376	376	376
R-squared	0.715	0.523	0.390	0.367	0.378	0.231	0.189	0.521	0.446	0.409	0.398

School level regressions. The dependent variables are externally or internally graded standardized tests. Controls for the share of parents with missing indicators are included but not reported. Robust standard errors. *** p<0.01, ** p<0.05, * p<0.1.

Table A4. Resource availability

	(1)	(2)	(3)	(4)	(5)	(6)
	Teacher-student ratio			Teacher degree (%)		
VARIABLES	**All**	**Voc**	**Academic**	**All**	**Voc**	**Academic**
voucher	-0.93***	-1.01**	-0.87**	-23.81***	-27.94***	-22.19***
	(0.30)	(0.44)	(0.36)	(1.68)	(2.27)	(1.67)
Mean dep var	8.5	8.9	8.2	78	74	80.4
Observations	27,069	10,324	16,745	27,069	10,324	16,745
R-squared	0.818	0.824	0.829	0.655	0.757	0.706

The dependent variable is the number of full time equivalent teachers per 100 students and the percent of teachers with a teacher degree. The sample is split by vocational and academic program. Year and municipal fixed effects are included. Standard errors are clustered by school. *** p<0.01, ** p<0.05, * p<0.1.

Table A5. Changing the comparison group

	(1)	(2)	(3)	(4)	(5)	(6)
	LLM			**Both types in municipality**		
VARIABLES	**external**	**diff**	**external**	**diff**	**external**	**diff**
voucher	-0.045**	0.126***	-0.057**	0.134***	-0.051**	0.128***
	(0.022)	(0.022)	(0.024)	(0.022)	(0.024)	(0.023)
Observations	48,073	48,073	32,993	32,993	32,993	32,993
R-squared	0.433	0.129	0.458	0.155	0.452	0.149
Region FE	LLM	LLM	Mun	Mun	LLM	LLM
Mun controls	yes	yes	no	no	yes	yes

Dependent variables are externally graded standardized test scores or the difference between internal and external test scores. LLM refers to local labor market fixed effects and Mun to municipal fixed effects. Municipal controls are (log) population size, (log) per capita income, the 1990 compulsory school GPA, unemployment rate, educational attainment, immigrant population share, and the right wing vote share in 2010. Other controls are as in table 2, column 7. Regressions are weighted by the ratio of the total number of observations to the number of observations in each subject (by year). Standard errors are clustered by school. *** p<0.01, ** p<0.05, * p<0.1.

Table A6. Corporate and non-corporate voucher schools

	(1)	(2)	(3)	(5)
	OLS		CEM	
VARIABLES	External	Diff	External	Diff
Corporate	-0.099***	0.130***	-0.105***	0.144***
	(0.025)	(0.025)	(0.027)	(0.028)
× Foreign	0.087**	0.010	0.119***	-0.032
	(0.035)	(0.033)	(0.042)	(0.041)
× High ed	0.123***	0.003	0.117***	0.011
	(0.025)	(0.027)	(0.028)	(0.030)
Non-corporate	-0.035	0.121**	-0.058	0.125**
	(0.041)	(0.049)	(0.043)	(0.050)
× Foreign	0.039	-0.011	0.070	-0.057
	(0.096)	(0.088)	(0.107)	(0.093)
× High ed	-0.064	0.078*	-0.046	0.076*
	(0.061)	(0.043)	(0.065)	(0.045)
Observations	48,073	48,073	39,519	39,519
R-squared	0.438	0.138	0.468	0.196

The dependent variable is externally graded test scores or the difference between internally and externally graded test scores. The same set of controls as in Table 2, columns 7 and 9. Regressions are weighted by the ratio of the total annual number of observations to the number of observations in each subject-year ($weight_1$ in text). CEM refers to course exact matching where strata are defined using subject, county of residence, GPA quintile, gender, and immigrant background. Out of 9282 voucher school observations, 165 are unmatched. Standard errors are clustered by school. *** p<0.01, ** p<0.05, * p<0.1

Table A7. Controlling for resources

	(1)	(2)	(3)	(4)	(5)	(6)
	All		Vocational		Academic	
VARIABLES	External	Diff	External	Diff	External	Diff
voucher	-0.050	0.155***	-0.199***	0.135**	-0.027	0.156***
	(0.034)	(0.030)	(0.064)	(0.054)	(0.031)	(0.034)
Teacher density	0.005*	0.005	-0.008	0.014*	0.005	0.000
	(0.003)	(0.004)	(0.006)	(0.007)	(0.004)	(0.004)
Teacher cred	-0.000	0.001	-0.001	0.001	-0.000	0.000
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Observations	48,073	48,073	18,247	18,247	29,826	29,826
R-squared	0.437	0.138	0.436	0.218	0.442	0.173

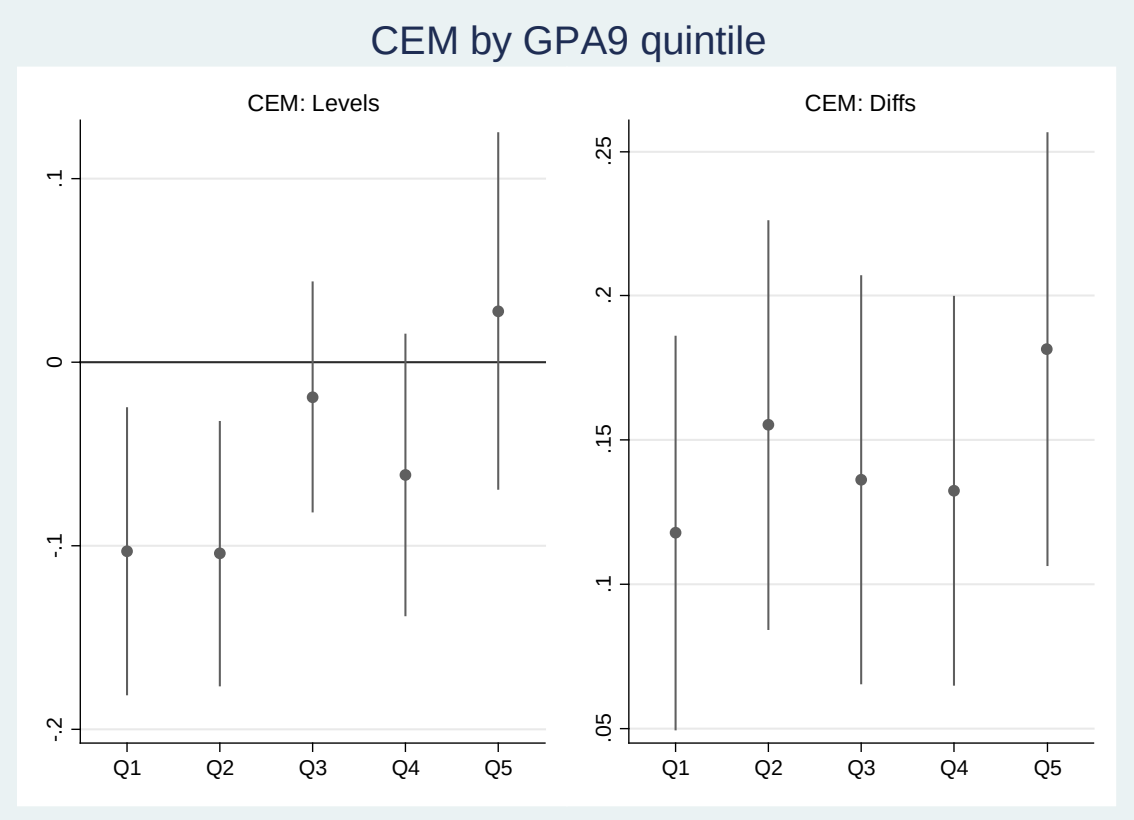
The dependent variable is externally graded test scores or the difference between internally and externally graded test scores. The same set of controls as in Table 2, columns 7 and 9. Teacher density is the number of full-time equivalent teachers per 100 students. Teacher cred is the share of teacher with teaching credentials. Indicators of missing values are included for 860 observations. Teacher-student ratio is truncated at 20. Regressions are weighted by the ratio of the total annual number of observations to the number of observations in each subject-year (weight1 in text).

Table A8. Municipal voucher school share

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	External								Diff	
Voucher share (upper-sec)	0.585**		0.022		0.169		0.313		-0.241	
	(0.272)		(0.340)		(0.300)		(0.249)		(0.182)	
Voucher share (compulsory)		0.564		-0.544		-0.428		-0.389		0.012
		(0.378)		(0.557)		(0.460)		(0.298)		(0.286)
Observations	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073	48,073
R-squared	0.004	0.002	0.015	0.016	0.096	0.096	0.339	0.338	0.029	0.029
Municipal controls	no	no	yes	yes	yes	yes	yes	yes	yes	yes
Individual controls	no	no	no	no	yes	yes	yes	yes	yes	yes
Lagged achievement	no	no	no	no	no	no	yes	yes	no	no

The dependent variable is externally graded test scores in columns (1) to (8) and the difference between internally and externally graded test scores in (9) and (10). Municipal controls are (log) population size, (log) per capita income, the 1990 compulsory school GPA, unemployment rate, educational attainment, and the immigrant population share. Student controls are male student, quarter of birth, immigrant status, age of immigration (5 categories). Parental controls are indicators of educational attainment (8 groups), (log of) parental income, decile income indicators (by gender), age of parent (8 categories), civil status (5 categories), employment or self-employment indicators, indicators of social benefits (early retirement, welfare, housing, student, unemployment, active labor market program). Parental cognitive and non-cognitive abilities are imputed based on years and field of study. Indicators of missing parental characteristics are included. "Lagged achievement" include a cubic function of compulsory school grade point average (GPA9), quintile indicators of GPA9, and indicators of compulsory school grades in Swedish, English, and mathematics (interacted with subject indicators). Each municipality is given equal weight in the regressions. Robust standard errors in parentheses, clustered by municipality. *** p<0.01, ** p<0.05, * p<0.1.

Figure A 1. Coarsened exact matching by GPA9 quintile



Voucher school effects on external test scores and the difference between internally and externally graded tests, by GPA9 quintile. The same CEM specifications as in Table 3, columns 9 and 10 are used is used. Standard errors are clustered by school and 95% confidence intervals are indicated.

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