

Competition, wages and teacher sorting:

four lessons learned from a voucher reform*

by

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Abstract

This paper studies how local school competition affects teacher wages at markets where wages are set via individual wage bargaining. Using regional variation in private school entry generated by a Swedish reform which allowed private schools to enter freely and a comprehensive matched employer employee data covering all high school teachers in Sweden over 16 years, I analyze the effects of competition on wages as well as labor flows. The results suggest that competition translates into higher wages, also for teachers in public schools. While the average increases are modest new teachers gain 2 percent and high ability teachers in math and science receive 4 percent higher wages in the most competitive areas compared to areas without any competition from private schools. Several robustness checks support a causal interpretation of the results which together highlight the potential gains from school competition through a more differentiated wage setting of teachers.

Keywords: private school competition, teacher wages, monopsony power
JEL-codes: J31, J42, J24

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Table of contents

1	Introduction	3
2	School competition and wages: a background	6
3	Data	8
3.1	Measuring cognitive skills.....	9
3.2	Defining the local labor market and competition	10
4	Institutional framework	10
4.1	The voucher reform	10
4.2	Setting the teachers' wages	13
5	Competition and labor flows	14
6	Competition and wages	17
6.1	A first look at the data	17
6.2	Empirical strategy.....	18
6.3	Main results	20
6.3.1	Differential effects by teachers' field.....	21
6.4	Robustness checks	23
6.5	Differential effects: gender and cognitive skills.....	25
7	Conclusions	29
	References	31
	Appendix A: Descriptive patterns	34
	Appendix B: Additional robustness checks.....	38

1 Introduction

This study explores the impact of school competition on teacher flows and wages using local variation in private high school entry over more than ten years introduced by a Swedish voucher reform.¹ The reform allowed publicly funded private high schools to enter the market which gave rise to a sharp increase in private school openings (see Figure 1). Together with a rich matched employer employee data covering all teachers in Sweden, the within and cross-market differences in private competition are used to identify the effect on teacher wages.

Studying the relevance of employer competition in the teachers' market is important, both for understanding the determinants of wages in the teaching profession as well as the mechanisms of labor markets in general.² There is currently an ongoing debate about the desirability and consequences of introducing market oriented mechanisms in the teachers' market in many countries. While proponents argue that removing the entry regulations and the rigid pay regimes would increase efficiency in the public school system, it has been very difficult to prove that private competition leads to higher student achievement.³ Focusing the outcomes of teachers can provide insights to this debate, since a better allocation of teachers is one potential mechanism through which the competition effect may be realized.

Public schools could in theory exploit their role as single buyers of teachers' labor to keep wages below the competitive level (Boal and Ransom, 1997, Manning, 2003). Recent estimates of teachers' labor supply elasticity support that schools have substantial monopsonistic power over teachers although from these studies it is not clear whether this actually translates into lower wages or how schools respond to increased competition in the teachers' market (Falch, 2010, Ransom and Sims, 2010). Moreover,

¹ A similar reform was implemented in 1992 at the compulsory school level. The reason for focusing on the high school level is first of all that the expansion of private schools is larger here and second because teachers' field of specialization is well-defined.

² For instance several studies document large and systematic wage differences between observably identical workers, both across industries (Krueger and Summers, 1989, Katz and Summers, 1989 and Murphy and Topel, 1987, 1990) and local labor markets (Moretti, 2010). One theoretical explanation behind such differences is that they reflect variations in the competitiveness of markets, arising from e.g. search frictions or entry barriers (c.f. Manning, 2003). The economic relevance of imperfect competition is however far from fully understood in the empirical literature.

³ Several papers have estimated the relationship between private school penetration on test scores, grades and university attendance finding weak and inconsistent evidence of such student achievement gains both in Sweden and elsewhere (c.f. Ahlin, 2003, Böhlmark and Linddahl, 2009, Clark, 2009, Hoxby, 2003, Figlio and Hart, 2010).

while deregulation experiences from the US have increased our understanding of the impact of competition in the private sector (Black and Strahan, 2003, Peoples, 1998) empirical evidence on the wage effects of introducing market economics in the public sector is still very scarce.

The Swedish experience is particularly attractive since the early private school expansion introduced by the voucher reform allows for studying a long time period as well as high levels of competition compared to other countries. The Swedish private school penetration moreover took place in a context where wages are set via individual wage bargaining. By enabling schools to respond to local private competition, the Swedish experience thus provides a unique test of how wages are affected by private school entry.

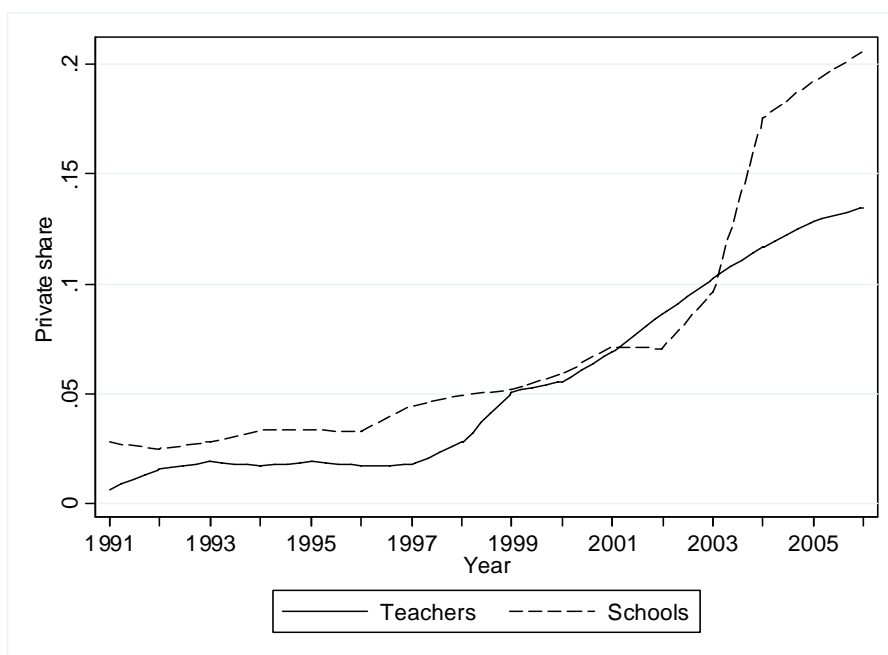


Figure 1 Change in privatization 1991–2006

The results deliver several findings about the teachers' market. First, to provide a better understanding of how private school entry affects competing public schools the paper exploits the matched employer employee structure of the data to study teacher flows. The results suggest that private schools differ significantly from public schools in their

recruitment behavior. Not only do they hire from a broader array of occupations than public schools but in line with Ballou and Podgursky (1997, 1998) and Hoxby (2002) I also find that private schools are more likely than public schools to attract teachers with subject area skills and high cognitive ability (rather than formal qualifications).

I then go on to look at wages. By focusing on *changes* in local school competition within and across local labor markets my empirical strategy accounts for permanent regional differences that could otherwise generate a spurious relationship between competition and wages. The data at hand enables me to include both local labor market linear trends and teacher fixed effects in the estimations, to account for the possible trends in underlying determinants of wages as well as for compositional changes in the teaching pool.

I find that the increased competition associated with private school penetration has led to higher teacher salaries. While the average effect is modest the wage gains are most pronounced among new teachers and teachers specialized in subject areas of needs; at current levels of privatization (at most 30 percent) teachers who are entering the most competitive areas and teachers specialized in math and science both receive about 2 percent higher wage than teachers in areas without competition from private schools. Importantly, the main effect persists once individual heterogeneity is controlled for suggesting that these effects are not explained by changes in teacher composition.

A number of robustness checks support that the estimated effects capture the impact of competition rather than secular trends in the determinants of wages. More specifically I show that the estimates are not significantly different from the main effect when regional trends are excluded from the model, when *county*×*year* fixed effects are included or when the Stockholm metropolitan area is removed from the sample. Private school expansion is in addition unrelated to the wage growth for pre-school teachers and the estimates are robust to alternative definitions of the labor market. Together these results strengthen a causal interpretation of the main results.

In the final part of the paper I examine the differential competition effect with respect to teachers' cognitive skills, measured by test scores from the military enlistment. The effects are most pronounced among high ability teachers (males only) in math and science and there is also a clear association between the local labor market

specific returns to ability and private school competition, which seems not to be driven by cross-market differences in general trends in the returns to ability.

Overall, these results suggest that monopsonistic exploitation is a non-trivial determinant of wages in the teachers market. Because the strong labor unions are likely to mitigate the monopsony effects in Sweden, these may be even more pronounced in other settings. Importantly school competition has in addition led to a more market based wage setting where wages respond to teacher mobility, teacher needs and cognitive skills. If the transition to better student performance goes through the retention and employment of better teachers then these results highlight that school competition can have positive effects on educational output that are not necessarily realized in the short run.

The rest of the paper outlines as follows. Section 2 provides the theoretical framework and related literature; Section 3 describes the data and Section 4 the reform generating the variation exploited in the paper as well as the wage setting for teachers in Sweden. Section 5 provides a detailed description of the hiring patterns and a descriptive analysis of the link between competition and wages; Section 6 presents the results and Section 7 concludes.

2 School competition and wages: a background

In the static textbook model of monopsony power employers can exploit the low labor supply elasticity of workers by setting wages below the competitive level (see Ashenfelter et al, 2010 or Boal and Ransom, 1997 for reviews on the literature on monopsony). An increase in school competition should therefore lead to higher teacher wages through a reduction in schools market power, even if workers are identical.

Recent estimates of the elasticity of teachers' labor supply provide indirect evidence of monopsonistic power in the teachers market although these studies do not say whether schools actually exploit their market power to lower wages (Falch, 2010,

Ransom and Sims, 2010).⁴ Another strand of the literature based on cross-sectional evidence shows that areas with more private schools have higher public school teacher salaries (Vedder and Hall, 2000, Medcalfe and Thornton, 2006). Given the inherent difficulties of isolating the impact of competition from other sources of regional wage differentials such as compensating differentials, labor quality or efficiency wages it is not clear that these studies capture the true relationship between of school competition and wages.

Market oriented reforms implemented in several countries improve the scope for credible identification of monopsony effects in the teachers' labor market. The most closely related paper to my study is Jackson and Cowan (2009) who study the effects of charter school entry on public school teacher turnover and wages. Exploiting the entry of nearby charter schools in North Carolina, they provide compelling evidence that private competition leads to higher public school teacher salaries. However, a limitation with their setting is that teacher pay is largely determined by fixed teacher credentials which restricts schools' ability to respond to local competition. In contrast, this paper examines the wage effects of competition in a context where wages are set via local negotiations between the school and the teacher.

In addition I provide a more detailed analysis of how the competition effect operates. In theory, school competition could not only contribute to higher teacher wages overall, but also lead to a more differentiated wage setting. Workers who bear low costs of switching jobs should for example require a higher wage to stay with the current employer. In a dynamic framework, schools may moreover pay attention to the costs associated with teacher turnover and could hence be more eager to keep teachers in areas of needs since these must be replaced by on-the-job workers with higher reservation wages (Manning, 2003).

Finally, on the demand side, schools that face competition should want to keep and attract teachers who help them to attract students. Relying on cross-sectional variation in local school competition, Hoxby (2002) provides results suggesting that schools put

⁴ Ransom and Sims (2010) find firm labor supply elasticities of 3.65 using data for school districts in Missouri and Falch (2010) studies the impact on the supply of teachers in Norway in response to an increase in wages in some schools with past recruitment difficulties finding an individual wage elasticity in the region 1.0-1.9.

more value on teachers' effort, independence, quality of college education and teachers' math and science skills when faced with school choice, and that charter schools value such characteristics more than public schools. In this paper I examine the heterogeneous impact of private competition on teacher flows and wages to forward our understanding of how schools respond to incentives.

3 Data

The data used in this study come from population-wide registers collected by Statistics Sweden. The analysis is based on two main sources. The first of these, the teacher register (Lärarregistret), contains all teachers employed in Swedish schools as well as information about where they are employed (region, public/private), whether the individual is certified to be a teacher and field of specialization. The information can be linked to standard demographic characteristics as well as to aggregated regional statistics such as the number of high school students. From 1995 onwards the data also hold information on the school in which the teacher is employed.

The second register, Strukturlönestatistiken, has information on monthly full time wages for all individuals employed in the public sector and for a sample of individuals in the private sector. Wages are measured in November each year which means that teachers in the academic year 1991–1992 are assigned to the 1991 wage observation. The sampling is stratified by firm size and industry and the register holds weights that can be used to obtain aggregated regional statistics that are nationally representative. Since part of the empirical strategy relies on within teacher variation in competitive pressure from private schools, only teachers who appear in the sample two or more years will help to identify the coefficient of interest. The sampling implies that the probability of observing the same privately employed teacher more than once during the study period will be fairly low. For this reason, I impute their log monthly wage for all teachers in private schools who are not sampled in a given year. This is possible since the data contains annual income for all workers that can be used to recover information

on wages for teachers in the private sector.⁵ I will check the sensitivity of the results using the weights contained in the data.

The main sample consists of all high school teachers in Sweden between the years 1991 to 2006.⁶ Individuals with appointments other than being a teacher, such as study counselors are excluded from the sample. In addition, for individuals with multiple observations i.e. for those who work in several schools in a year, I keep their main source of income.

3.1 Measuring cognitive skills

Part of the analysis uses measures of teachers' cognitive skills obtained from the military enlistment. The test scores provide an evaluation of cognitive ability based on several subtests of logical, verbal and spatial abilities and are similar to the AFQT in the US.⁷ The test scores have previously been related to future wages and earnings (Lindqvist and Vestman, 2008) and higher test scores among teachers have also been associated with higher student outcomes at the compulsory level (Grönqvist and Vlachos, 2009).⁸ Estimating the wage returns to cognitive ability in my sample I received an approximately linear wage-test score relationship (not in paper). Taken together it is reasonable to assume that these cognitive skills provide some information about teacher quality that schools and parents value. All males in Sweden were obliged to go through the military draft and for cohorts born prior to 1980 almost all males in each cohort went through the draft procedure at age 18 or 19. This implies that comparable data are available for cohorts born between 1951 and 1980.

⁵ To impute the monthly wage for private teachers that are not sampled in a given year I use the predicted monthly wage obtained from estimation of a traditional mincerian wage regression, which apart from standard wage controls (sex, education and the age earning profile) includes a dummy for whether the teacher worked in a private school, detailed type of teaching position as well as a measure of the approximated wage on the right hand side derived by dividing the total annual earnings by the number of months adjusted for hours worked.

⁶ 1991 is the first year that the data contains wage information for all teachers in the public sector.

⁷ For a more detailed description of these test scores, see Lindqvist and Vestman (2008).

⁸ Grönqvist and Vlachos (2008) show that teachers with high cognitive skills benefit high performing students but not low performing students. I am not aware of any study that estimates the impact of teacher test scores on student high school achievement.

3.2 Defining the local labor market and competition

An important aspect when estimating the effects of employer competition is to define the market in which schools compete for labor. This paper uses Statistics Sweden's definition of local labor market regions (LLMs). These are based on commuting distance and seem to capture the teacher's true labor market quite well; 88 percent of all teachers in the sample work in the same local labor market as they reside.⁹ As a sensitivity check I also consider alternative geographical boundaries when defining the local market.

To define competition I use the share of private school teachers in a given local labor market and year. An alternative available measure would be to use the share of private high schools in the local area.¹⁰ However since private schools are systematically smaller than public schools (see Figure 1) this definition would lead me to underestimate the impact of competition. For this reason I focus on the share of teachers as my preferred measure of competition throughout the analysis.

4 Institutional framework

4.1 The voucher reform

The expansion of private schools was induced by a voucher reform in 1994 that allowed municipality funded private schools to enter the market for high school education in Sweden. To qualify for opening, private schools must follow the national curriculum and the same rules for enrolment as public schools.¹¹ Importantly local governments who run the public schools cannot influence the approval which is made by the National Board of Education.

Besides the overall expansion in private schools illustrated in Figure 1, the reform gave rise to large regional variation in private school penetration. Figure 2 displays how the private high school teachers were distributed across Sweden in 2006 and Figure A1

⁹ There are 109 local labor markets in Sweden, which consists of on average 2.6 municipalities and 4200 teachers.

¹⁰ A third measure would be the share of private high school students but unfortunately this data is not available for the study period of interest in this paper.

¹¹ The schools are not allowed to charge tuition. I.e. top-up funding is not allowed over and above the voucher. Initially private schools were allowed to charge a tuition restricted to an amount considered 'reasonable' by the NAE but since 1997 the possibility to charge tuition is abolished.

and Figure A2 in Appendix show the distribution in 1991 as well as the kernel density plot of the local labor market specific changes in privatization between 1991 and 2006. One can see from these figures that local labor markets had very different levels of private school penetration during the study period; whereas some areas experienced increases in the share of private school teachers with up to 30 percentage points, in some locations there had still in 2006 been no entry of private schools. The empirical strategy uses this within- and cross regional variation in private school penetration to identify the effect of school competition on teachers' wages.

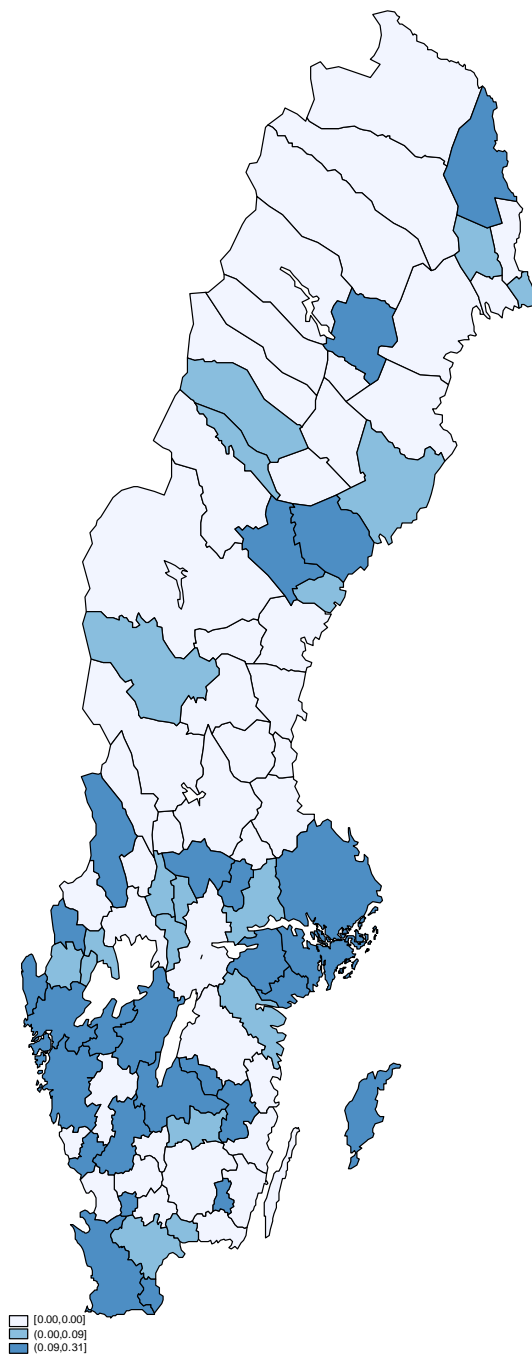


Figure 2 Variation in school privatization across Swedish local labor markets

Notes: The figure is based on the share of private high school teachers in each of the local labor markets measured in 2006.

4.2 Setting the teachers' wages

In Sweden, teacher wages are determined at the local level, typically through negotiations between the teacher and the principal. The involvement of a local union representative is also possible to endorse the proposed salary.

The individualized pay regime came in place in 1996 through an agreement between the employer's organization and the teacher labor unions with the intention to give employers more discretion over wages to reward teacher quality and effort. Prior to the introduction of individualized wages, salaries were largely determined by fixed credentials based on type of work and years of experience, although local deviations were common, for instance to overcome teacher shortages.

Interviews with single principals, support that local wage setting enables schools to reward teachers of high value and that teachers just entering the profession have benefitted most from the market based wages (Skolledningsnytt nr 06/2004). Quantitative evidence on the other hand suggests that the move to individualized pay had limited impact on the overall wage dispersion among high school teachers (Söderström, 2006).

There are several potential explanations for these observations. Because there were deviations from the wage scales already before 1996 it is perhaps not surprising that the transition to the new regime had little effect overall. In fact, the labor union of the majority of high school teachers (Lärarnas Riksförbund) had already in 1992 accepted individualized wage setting (Söderström, 2006). It is furthermore possible that schools have low incentives to enforce individualized pay in a non-competitive environment. Hence enforcement of individualized wages is an important mechanism through which competition could affect teacher salaries in Swedish schools. Finally, because the wage scales had a steep age-earnings profile in the old regime, wage increases in the lower parts of the age distribution could actually lead to a more compressed wage structure than before. To fully understand the effects on wage dispersion it is important to consider the interactions between individualized wages, local school competition and worker experience.

Finally, the high union coverage in Sweden may counteract the impact of school competition since the bargaining strength of workers reduces schools monopsony

power. It is moreover possible that the changes in competition could in itself affect union power since the costs of organizing employees should be higher in industries with a larger number of employers (Peoples, 1998). Since both of these mechanisms would understate the effect of competition the effects found in the Swedish context are likely to be even larger in a setting without labor unions.

5 Competition and labor flows

I start out with an empirical analysis of the teacher flows. Understanding how private schools differ from public schools in recruitment behavior is important since the new private schools have stronger incentives to employ teachers who attract students (Hoxby, 2002).

Table 1 provides a description of the hiring patterns in private and public schools respectively.¹² The data is a matched employer employee dataset where all teachers can be followed over time and across schools. New hires are defined as those not observed in the same school in the preceding three years and teachers recruited from other parts of the economy can also be identified.

As seen from the table, private schools differ from public schools in their recruitment behavior, both in terms of teacher characteristics and recruitment methods. Private schools hire younger and fewer certified teachers than public schools, which is also reflected in that private schools hire more of their teachers from other levels, the private sector and from non-employment.¹³ About 13 percent of the recruitments come from other public schools.

¹² Worker flows are studied from 1995 since this is the first year that the data contains school identifiers.

¹³ Among teachers hired from other levels, most hires come from primary schools and universities. Only a very low fraction (0.8 percent) is hired from pre-schools. Other sectors include e.g. adult education and labor market education.

Table 1 Who are the newly recruited?

	Private	Public
Age	38.8	43.6
Certified	0.42	0.66
Female	0.49	0.50
Ability (males only)	0.43	0.40
<i>Fraction hired from:</i>		
Public high schools	0.13	0.46
Private high schools	0.13	0.01
Other levels	0.34	0.29
Other sector	0.23	0.14
Non-employment	0.17	0.11
<i>Fractions from other sectors:</i>		
Manufacturing	10.1	9.9
Construction	2.3	4.7
Wholesale and retail trade	12.7	11.3
Hotels and restaurants	5.0	5.8
Transport, storage and communication	5.4	5.4
Financial intermediation	1.4	0.9
Real Estate, renting and business activity	23.3	14.5
Public administration and defense	6.4	9.2
Health and social services	14.8	19.7
Other community, social and personal services	17.5	17.4
Observations	66,212	9,609

Notes: The sample consists of all newly hired teachers during the period 1991-2006.

Next, I look at the characteristics of those who *leave* the public for private high schools. An advantage of the data used for this study is that it contains all teachers employed in each school. This means that I can explore whether teachers with certain characteristics are more likely to leave a public school for a private in comparison to her colleagues. In practice, the model includes a fixed effect at the *previous school*×*year* level which implies that it estimates the probability of a teacher being hired in a private/public school among *all* teachers in the same school and year. An advantage of this specification is that it accounts for all school characteristics that could influence the hiring decision in a given year, such as worker composition and regional location of the school.¹⁴ To contrast the results I also look at the probabilities to leave a public school for another public school.

¹⁴ I restrict the sample to fixed effects groups where there is variation in the dependent variable, i.e. to schools from where someone was actually hired. A similar method is applied in e.g. Bayer, Ross and Topa (2008) and Kramarz and Skans (2007).

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The results are reported in Table 2. As expected, younger teachers are always more likely to leave public schools, irrespectively if the recruiting school is public or private. Compared to public schools (column (4)-(6)) private schools are more likely to hire teachers without formal certification and teachers specialized in certain fields, such as social science and math and science (although in the latter case the difference is not statistically significant). Interestingly, they also seem to hire teachers with higher ability rank (Column 2) even within subjects (Column (3)).¹⁵ Overall, the results are consistent with Ballau and Podgursky (1998) or Hoxby (2002) who find that private schools hire teachers who lack formal skills but who are of higher ability than those demanded by public schools.

Table 2 Flows from public to private and public to public

	Recruiting school is:					
	Private			Public		
	(1)	(2)	(3)	(4)	(5)	(6)
	All	Males ^A	Within field	All	Males ^A	Within Field
Age	-0.107*** (0.007)	-0.153*** (0.020)	-0.150*** (0.022)	-0.123*** (0.007)	-0.083*** (0.021)	-0.071*** (0.024)
Certified	-0.674*** (0.193)	-0.985** (0.425)	-0.805* (0.475)	2.108*** (0.247)	1.982*** (0.395)	1.614*** (0.443)
Female	-0.024 (0.111)	-	-	-0.771*** (0.127)	-	-
<i>Field^B:</i>						
Math & Science	0.410 (0.262)	0.319 (0.583)	-	-0.425* (0.250)	0.885 (0.550)	-
Social Science	0.416** (0.184)	0.918* (0.547)	-	0.131 (0.188)	0.575 (0.466)	-
Vocational subjects	-0.508*** (0.114)	-0.478 (0.329)	-	-0.148 (0.167)	0.248 (0.368)	-
<i>Ability:</i>						
Ability rank	-	1.096** (0.449)	1.055** (0.507)	-	-0.824* (0.459)	-0.324 (0.530)
Mean of dep. variable	1.93	2.72	2.72	15.25	14.46	14.46
Observations	65,453	15,031	15,031	196,122	43,378	43,378
R	0.096	0.141	0.312	0.592	0.574	0.658

Notes: Each column represents a separate regression. **, * and *** denote statistical significance at 10/5/1 percent level respectively. Standard errors robust for serial correlation at the school level are shown in parentheses. The sample includes all actual hires as well as all teachers at the previous public school and the dependent variable is an indicator variable taking the value one if the teacher was the one being recruited to the new school. Columns (3) and (6) display the results when estimating the differential hiring probabilities for teachers within the same school, year and field. The dependent variable has been scaled by 100 hence the mean probability to be recruited is approximately 2 percent. A) Because this model estimates the impact of cognitive ability the sample is restricted to the cohorts for whom data is available, i.e. males born between 1951 and 1981. B) The omitted category contains all other teachers, i.e. non-certified teachers as well as teachers specialized in other fields.

¹⁵ This suggests that the effect is driven by different hiring probabilities across subjects.

6 Competition and wages

6.1 A first look at the data

Table A1 in Appendix presents descriptive statistics for the teachers included in the estimations in the pre- and post reform period respectively. As seen in the table the share of private teachers was close to zero before the reform and increased to on average 7 percent in the post reform years. In addition, the teacher labor pool has shifted towards fewer certified teachers. Columns (2) and (3) compare teachers in more or less competitive markets. There are substantially fewer teachers in regions without any future expansion of private schools due to the higher frequency of private schools in urban areas. While the teachers receive similar wages in the pre-reform period irrespectively of future expansion, wages are higher among teachers in competitive markets in the post-reform period.

Figure 3 displays the evolution of the median wage difference between regions with and without future private school expansion during the study period. There is no clear trend prior to 1994 whereas after the reform wages start to diverge in favor of teachers in more competitive labor markets. Unless this pattern is explained by unobserved time-varying differences between more or less competitive markets the figure clearly suggests that private competition has a positive effect on teacher wages.

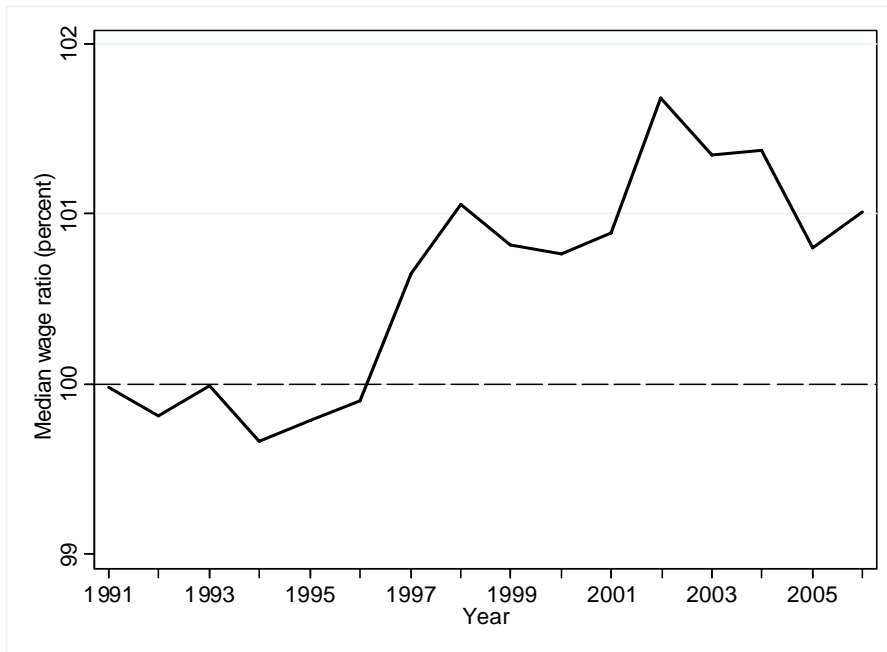


Figure 3 Median wage difference between teachers in competitive and non-competitive regions 1991–2006

Notes: The figure displays the median wage ratio between local labor markets with and without any post-reform private school expansion.

6.2 Empirical strategy

To estimate the impact of school competition on teacher wages I exploit the variation in private school expansion following the voucher reform using individual data. The empirical specification is given by:

$$\log w_{it} = \beta_1(\bar{P} \times \text{Post})_{it} + \mu_i + \mu_l + \mu_t \times \text{Year} + \beta_3 X_{it} + \varepsilon_{it} \quad (1)$$

where w is the wage for teacher i in local labor market l in time period t ; \bar{P} is the continuous measure of the degree of competition in local labor market, Post is a dummy taking the value one after the private school reform (=1 if after 1994)¹⁶, X_{it} is a vector of observable teacher characteristics (gender, age, educational attainment and certification status) as well as the number of pupils in high school age, μ_i and μ_l are

¹⁶ Since all variation comes from the post reform period. Exploiting the variation in the entire period (1991–2006) yields similar result.

year and local labor market dummies, $\mu_l \times Year$ are local labor market specific time trends and ε_{ilt} is the error term. The parameter of interest is β which captures the full reform impact of competition in the local labor market averaged across *all* teachers, both public and private. Importantly, this means that sorting of teachers or students between public and private schools within local labor markets will not bias the estimates.

The baseline specification takes into account many of the confounding factors that could generate a spurious relationship between competition and wages; the covariates in X account for compositional changes in the observed characteristics of the teaching pool as well as for changes in the local demand for schooling due to changes in cohort size; the year dummies control for smoothly evolving factors such as business cycle effects and long term national trends and the local labor market dummies account for time-invariant differences between different regions. Importantly the long time period also allows me to eliminate local linear labor market specific trends, which implies that the parameter of interest is identified from the residual variation in each labor market around its own linear time trend.

A potential concern is that teachers may sort into labor markets with more or less competition based on unobserved characteristics. If this is the case β may capture both direct effects of competition for incumbent teachers as well as compositional changes in the teacher pool. To account for such compositional changes I augment model (1) with a vector of teacher specific indicators, μ_i . This model is given by:

$$\log w_{ilt} = \mu_i + \beta_1 (\bar{P} \times Post)_{it} + \mu_l + \mu_t + \mu_l \times Year + \beta_3 X_{ilt} + \varepsilon_{ilt} \quad (2)$$

The model relies on variation in teachers' exposure to school competition and hence it accounts for all unobserved teacher characteristics that are fixed over time. Consequently, it identifies the impact of competition for incumbent teachers only. An

advantage with this specification is that it allows me to separate the wage effects for public and private teachers.¹⁷

The assumption maintained for identification is always that the regional private school expansion is uncorrelated with the error term once I have conditioned on all covariates included in (1) and (2). This means that β_1 will be biased if regions with private school openings even in its absence would have experienced increasing wages. To validate the empirical findings I will check the sensitivity of these results further below.

6.3 Main results

The estimate in the first column in Table 3 shows the baseline effect from estimation of equation (1), which relates teacher wages to the private school share in the assigned local labor market. The dependent variable is the individual log monthly wage and all specifications include individual wage controls, the number of individuals in high school age, year dummies, local labor market fixed effects and local labor market trends.¹⁸

The estimate is positive and implies a 3 percent wage increase from an increase in competition from 0 to 100 percent. Scaled at realized levels of competition (at most 30 percent) this can be considered as a rather small effect. Columns (2) and (3) continue to show the differential impact between entering and incumbent teachers, where entering teachers are defined as those who are not observed in the teacher register in any of the five preceding years. As previously discussed, the impact of competition is likely to be higher among teachers who are entering the profession than among incumbent ones, due to the higher mobility in this group. Consistent with this prediction I find that the effect is twice as large for new teachers; those who enter the most competitive areas receive 2 percent higher wages than those who enter labor markets without any competition from

¹⁷ As mentioned above, this cannot be achieved in (1) since the decision to move between schools may be endogenous to the wage. To see this, if private schools attract teachers of high ability (as was suggested by the mobility patterns described in Section 5) then looking at public school teachers separately in (1) would produce estimates that are negatively biased by the outflow of teachers from the upper part of the ability distribution.

¹⁸ To conserve space I do not report the estimates of the control variables but it should be noted that all of these enter with expected signs; wages are higher for males than for females, increases with age and level of education and are higher for certified teachers. Weighting the sample instead of using imputed wages does not alter any of these results. These results are available upon request.

private schools.¹⁹ Evaluated at the mean entry wage this effect corresponds to roughly 400 SEK/ €40/USD 50.

Columns (4) and (5) present the result from the teacher fixed effects model. As argued above it is possible that the main effects capture both the direct impact of competition as well as compositional changes in the teachers' labor pool. However, sorting of teachers does not seem to constitute any large issue of concern. Finally the last column shows that the estimated effect remains approximately the same when the sample is restricted to public school teachers only, suggesting that public schools respond to private school competition by raising the wages for incumbent teachers.

Table 3 Baseline estimates of private school share on wages

	All (1)	Entering (2)	Incumbent		
			(3)	Teacher fixed effects	
			All	All	Public
Share private × After	0.032* (0.017)	0.068* (0.036)	0.031* (0.017)	0.037** (0.017)	0.032* (0.018)
Observations	408,731	47,169	361,562	361,562	341,689
R ²	0.716	0.632	0.723	0.900	0.901
LLM fixed effects	yes	yes	yes	yes	yes
LLM linear trends	yes	yes	yes	yes	yes
Teacher fixed effects	yes	yes	yes	yes	yes

Notes: *,** and *** denote statistical significance at 10/5/1 percent level respectively. Standard errors robust for serial correlation at the local labor market level are shown in parenthesis. In addition to the fixed effects indicated by the table all regressions control for year fixed effects and a dummy indicating whether the individual wage is imputed or not. The individual controls include gender, age, age², education dummies (6 bins) and the number of pupils in the given labor market and year.

6.3.1 Differential effects by teachers' field

Although the estimates in Table 3 were positive and significant, the average effects suggested a rather small economic impact from competition on incumbent teachers' wages. From the theoretical framework outlined in Section 2 we know that that these effects could mask heterogeneity across teachers with different characteristics. This section therefore continues to explore how these effects are distributed among teachers specialized in different fields.

¹⁹ To arrive at 2 percent I scale the estimate with the highest realized levels of competition, i.e. $0.068 \times 0.3 = 0.0204$.

Table 4 reports the results from estimation of fully interacted versions of model (2) w.r.t. teachers' field defined by their field of education. As we can see in Table 4, the effect of private competition is concentrated to teachers in math and science.²⁰ One potential explanation for this is that there is less available supply of these teachers than of teachers e.g. social science which increases the turnover costs in this group. Figure A3 illustrates the fraction of newly hired teachers in different fields from non-employment. The measure is proposed by Manning (2003) to proxy for labor market tightness. As illustrated by the figure there seems to be a greater supply of teachers in social science which may partly explain why private competition has not translated into higher wages in this group.²¹

Table 4 Effect by teacher's field

	Incumbent teachers			
	(1)	(2)	(3)	(4)
	All	Math and Science	Social Science	Vocational subjects
Share private × After	0.037** (0.017)	0.079** (0.037)	0.020 (0.019)	0.031 (0.025)
Observations	361,562	22,135	45,401	113,846
LLM fixed effects	yes	yes	yes	yes
LLM linear trends	yes	yes	yes	yes
Teacher fixed effects	yes	yes	yes	yes

Notes: *,** and *** denote statistical significance at 10/5/1 percent level respectively. Standard errors robust for serial correlation at the local labor market level are shown in parenthesis. In addition to the fixed effects indicated by the table all regressions control for year fixed effects and a dummy indicating whether the individual wage is imputed or not. The individual controls include gender, age, age², education dummies (6 bins) and the number of pupils in the given labor market and year. Because the model includes teacher fixed effects it estimates the effect for incumbent teachers only. Column (1) includes all teachers employed in Swedish high schools. Besides those specialized in the fields mentioned in the table a large fraction is the non-certified teachers as well as teachers defined as having "other" as their field of specialization.

²⁰ Since the model controls for local labor market fixed effects as well as local labor market trends time invariant differences between regions such as e.g. higher demands for math teachers in metropolitan areas with more employment in high technology industries will not bias the estimates.

²¹ The figures are consistent with other descriptions of the teachers' labor market suggesting that while there is an ample supply of teachers in social science the shortages are most pronounced among teachers in vocational subjects (SACO, 2009). Furthermore among female vocational teachers the largest shares are found in Health and Social Care (34.5 percent), (Business and Administration (13 percent) and Sports (11.1 percent). Males are most often found in Manufacturing (60 percent), Sports (12.4 percent) and Music (8.7 percent).

6.4 Robustness checks

The empirical strategy is based on several assumptions. First, the expansion of private schools should be uncorrelated with regional trends in other underlying determinants of wages. Second, there should be no other changes that could influence wages and that coincide with the regional expansion of private schools. To check the validity of these assumptions I perform a number of robustness checks.

As mentioned before, the scope for local wage setting was limited prior to 1996. If the fixed salary schemes were binding in the pre-reform period one concern is that the association between competition and wages captures a spurious relationship generated by differential trends in (unobserved) factors that would show up only after the wage scales were removed. Systematically different trends in economic growth, local amenities or school quality could for instance give rise to such omitted variable bias.²² While the identifying assumption cannot be tested directly, I can investigate whether the estimates are sensitive to the exclusion of covariates and use of alternative specifications.

Panel A in Table 5 presents results where I omit covariates included in the baseline model. Because the average effects were concentrated among teachers in math and science Panel B in addition present estimates for this group only. Overall, these results are inconsistent with that the main effects are reflecting omitted variables rather than the true effect. Although the estimates are somewhat sensitive to the omission of regional linear trends, the estimates when excluding them from the model are not statistically different from the main effect.²³ Importantly, the estimates also seem robust to the inclusion of *county*×*year* fixed effects.²⁴ This is reassuring since it suggests that time-varying factors at the county level are not driving the main effect.

Finally in column (4) the estimate based on the sample without the Stockholm metropolitan area is reported. As the capital and largest metropolitan area of Sweden,

²² Böhlmark and Lindahl (2009) provide a deeper assessment of the determinants of private high school openings at the municipality level. While there seems to be no relationship between private school openings and pupil achievement levels, they do find that municipalities whose pupils most have increased their GPA in the 5 years prior to the reform have less growth in private schooling. This is a serious concern since it suggests that the degree of competition is negatively related to trends in school quality, which could motivate higher compensatory wages in these markets.

²³ I also tried including quadratic trends in the model yielding an estimate very close to the baseline (0.031 (0.017)).

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Stockholm constitutes an important labor market for teachers and it is therefore plausible that differences between Stockholm and other labor markets in Sweden could have large influence on the main effect. Moreover the city of Stockholm implemented an additional reform in 2000 enlarging the catchment area at the high school level.²⁵ Excluding the Stockholm area from the sample does however not significantly change the baseline estimate.

Table 5 Robustness checks

	Incumbent teachers			
	(1) Baseline effect	(2) - trends	(3) + County × Year	(4) - Stockholm
Panel A: All teachers	0.037** (0.017)	0.104*** (0.029)	0.060*** (0.023)	0.048** (0.022)
Observations	361,562	361,562	361,562	298,995
R ²	0.900	0.899	0.724	0.730
Panel B: Math & Science	0.079** (0.037)	0.109*** (0.035)	0.073* (0.042)	0.059 (0.043)
Observations	24,235	24,235	24,235	22,584
R ²	0.875	0.873	0.881	0.879

Notes: *,** and *** denote statistical significance at 10/5/1 percent level respectively. Standard errors robust for serial correlation at the local labor market level are shown in parenthesis. The baseline effect reported in column (2) repeats the estimate from model (2) described in the empirical section. All specifications in the table control for teacher fixed effects, year fixed effects, a dummy indicating whether the individual wage is imputed or not, gender, age, age², education dummies (6 bins) and the number of pupils in the given labor market and year.

Appendix B reports results from additional robustness specifications. First, I test whether pre-school teachers are also experiencing higher wages when the share of private high schools increases. Because the analysis of the recruitment patterns in Section 5 indicated that the inflow of private high school did not impose any competitive pressure on pre-schools (only 0.8 percent of the total hires come from pre-schools) I assume that pre-school teachers should be unaffected by the variation generated by the voucher reform, unless it is correlated with other factors that influence public wages such as trends in e.g. public spending, demands for private schooling, area amenities or labor quality. Reassuringly I find no relationship between private high

²⁴ There are 21 counties in Sweden, each containing 7 (sd 3.2) local labor markets on average.

²⁵ Before this reform, students in the city of Stockholm, just as in the rest of Sweden could choose high school but were assigned to their neighborhood school in case of space limitations. After the reform student admission is based solely on grades, which means that compared to the rest of Sweden, the scope for competition over students is larger.

school expansion and wages among pre-school teachers (Table B1) which supports the conclusion that the main effect is not driven by local trends in omitted factors, at least to the extent that these are common to teachers at these levels.²⁶

Finally, I look at the sensitivity of the results with respect to the definition of the labor market. Failure in defining the correct labor market may lead to downward biased estimates due to measurement error. Table B2 reports estimates using two alternative measures of competition, the municipality and the county. The estimates increase with the definition of the labor market although both specifications produce positive and significant estimates that are in the vicinity of the baseline results.²⁷

6.5 Differential effects: gender and cognitive skills

Having concluded that the results seem not to be driven by omitted variable bias, I turn to the association between school competition and the link between teacher wages and teacher ability. The results are reported in Table 6. Because cognitive skills are likely to be correlated with the selection of teachers across different fields, estimates are obtained using within field variation only. Moreover since the data on cognitive skills is available for male teachers only, I also report the estimates separately by gender.

The effect is primarily concentrated among male teachers and there are also substantial differences by field. While the effect is concentrated among male teachers in math and science, female teachers in vocational subjects are the only ones benefiting from private competition. Again, these results are consistent with that competition matters more for teachers in areas of needs; the largest bulk of female vocational teachers are in the field “health and social” work, which is suffering from great shortages according to the Swedish National Board of Education.

The last panel reports the differential effect of competition with respect to cognitive skills using model (2) described in the empirical section. For simplicity, I divide the male teachers into two groups, *high* and *low* ability teachers as separated by the median

²⁶ Pre-school teachers constitute a valid placebo group for at least two reasons. First, although there has been an increase in private alternatives also at the pre-school level this is much less dramatic than at the high school level and has not led to any significant wage effects among existing pre-school teachers (Hanspers and Hensvik, 2010). In addition, because the funding of schools is based on the number of pupils enrolled any potential negative spill-over effects of wage increases among high-school teachers are likely to be small.

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percentile rank in the distribution of cohort specific military test scores. For teachers in math and science the estimates clearly suggest that the positive impact is concentrated among teachers with *high* cognitive ability. Among teachers specialized in other fields there is no clear pattern.

Table 6 Estimates by field, gender and cognitive skills

	Incumbent teachers			
	(1)	(2)	(3)	(4)
	All	Math and Science	Social Science	Vocational subjects
Panel A:	females	females	females	females
Share private × After	0.029 (0.018)	0.022 (0.039)	0.001 (0.022)	0.062** (0.027)
Observations	174,041	7,771	28,165	50,312
Panel B:	males	males	males	males
Share private × After	0.040* (0.020)	0.104** (0.049)	0.053* (0.027)	0.005 (0.030)
Observations	187,521	14,364	17,236	63,534
Panel C:	IQ	IQ	IQ	IQ
Share private × After	0.035 (0.026)	-0.103 (0.068)	0.061 (0.047)	0.019 (0.038)
× High ability	0.017 (0.033)	0.236** (0.090)	-0.054 (0.036)	0.048 (0.042)
Observations	69,326	6,315	9,905	25,268
LLM fixed effects	yes	yes	yes	yes
LLM linear trends	yes	yes	yes	yes
Teacher fixed effects	yes	yes	yes	yes

Notes: *,** and *** denote statistical significance at 10/5/1 percent level respectively. Standard errors robust for serial correlation at the local labor market level are shown in parenthesis. In addition to the fixed effects indicated by the table all regressions control for year fixed effects and a dummy indicating whether the individual wage is imputed or not. The individual controls include gender, age, age2, education dummies (6 bins) and the number of pupils in the given labor market and year. Column (1) includes all teachers employed in Swedish high schools. Besides from those specialized in the fields mentioned in the table a large fraction is the non-certified teachers as well as teachers defined as having “other” as their field of specialization. The estimates in Panel C are based on a sample of male teachers belonging to the cohorts born between 1951 and 1980. An individual is recorded to be of high ability if having a military test score above the 50th percentile within each cohort.

Second I estimate the slope of the relationship between teachers’ log earnings and ability among teachers in the same year and local labor market and relate these estimates to the degree of competition in the assigned local labor market. To net out fixed differences between local labor markets two observations are obtained for each

²⁷ This is consistent with results in Jackson and Cowan (2009) who show that whereas teacher mobility is affected by competition at close distances teacher salary effects seem to occur at higher (the district) levels.

local labor market (2000 and 2006). In practice this means that I relate the changes in local school competition to changes in the local returns to cognitive skills.

The estimated returns to ability, reported in Table B3 in Appendix suggest that there is substantial variation in the returns to cognitive skills across locations.²⁸ Figure 4 in turn shows the plotted relationship between these returns and the degree of competition in the local labor market which suggests that there is a positive correlation between the two, both when looking at levels as well as changes between 2000 and 2006. Hence teachers in labor markets with the largest increase in private competition have also experienced the largest increases in the returns to cognitive skills. The association is confirmed when estimating this relationship using the within local labor market variation in private competition (see Table B4, Appendix).²⁹

A potential concern is that the relationship reflects general regional trends in the returns to ability that are correlated with private high school expansion. To explore whether this concern is valid I estimate the returns to ability for workers in a non-teaching profession in the same region. If there is no association between school competition and returns to ability for these workers it seems reasonable to conclude that the association found for teachers reflects a true relationship. Figure 4 plots the relationship for engineers, an occupation that should be a potential alternative for teachers educated in math and science. As expected, engineers have higher returns to ability compared to teachers. There is also a positive relationship between the level of returns and private school expansion suggesting that private schools tend to locate themselves in regions where the returns to ability are higher in general (figure 3c). In contrast however, there is no association between the *changes* in high school competition and returns to ability for these individuals. This is reassuring since it suggests that the increase in the returns to ability among teachers is at least not driven by trends that are common for these two groups of workers.³⁰

²⁸ The restrictions of the sample (male teachers born between 1951 and 1981) require me to focus the analysis on 1/3 of the largest local labor markets. Furthermore I choose the base year in the middle of the sample period (2000) since this allows me to include younger cohorts thereby increasing the number of teachers in the estimations. Apart from lowering precision, choosing an earlier base year does not alter the main conclusions.

²⁹ Weighting the observations according to their precision in the first stage produces very similar results.

³⁰ Figure B1 in Appendix shows the same plots for the weighted returns.

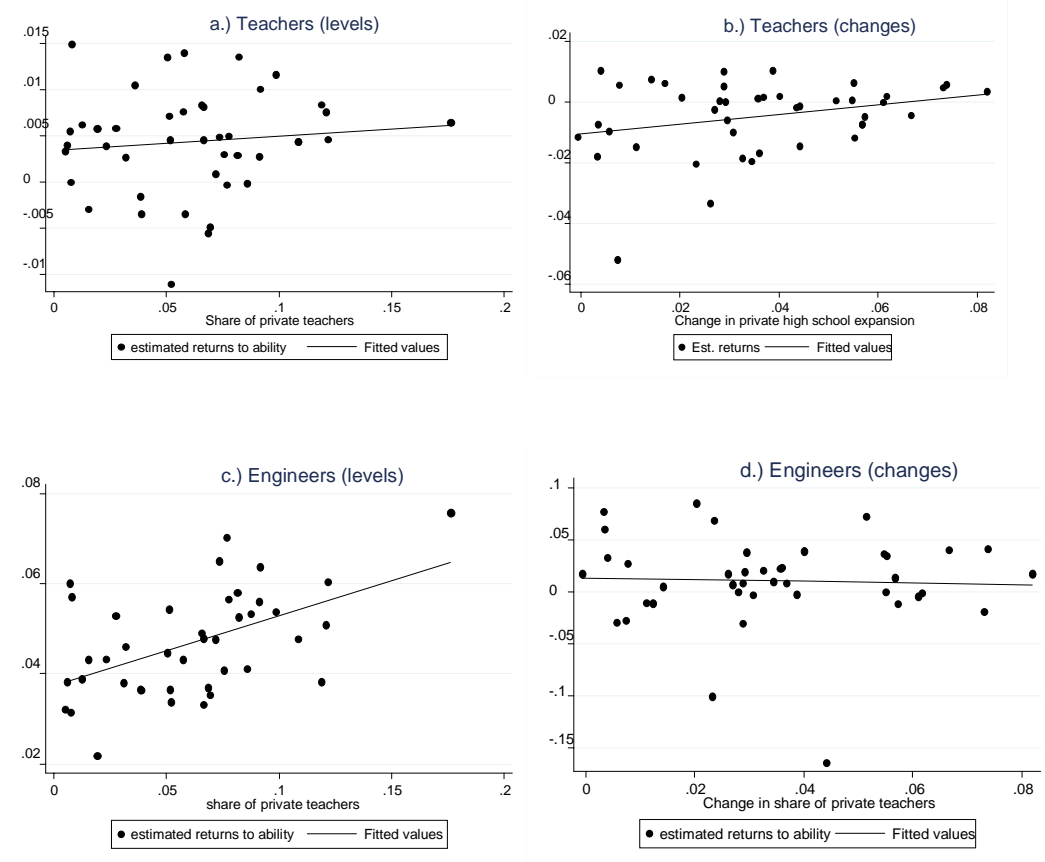


Figure 4 Association between the estimated returns to ability and school competition

Notes: The estimated returns to cognitive test scores are obtained from traditional wage regressions that apart from the test scores include the age earnings profile and detailed field of education. The estimations are based on a sample of male teachers belonging to cohorts born between 1951 and 1980.

7 Conclusions

This paper has examined the impact of local private school competition in Sweden, introduced by a voucher reform, on teacher flows and wages. There are four main conclusions to be drawn about this relationship:

(1) Private schools deviate substantially from public schools in their recruitment behavior; while private schools do not necessarily hire the most qualified teachers in terms of formal certification they do seem to attract younger teachers, teachers specialized in math and science and social science as well as teachers in the upper part of the skill distribution. In line with previous research these results suggest that the new private schools, with assumingly stronger incentives to attract students value other teacher characteristics than traditional public schools.

(2) The increase in local school competition associated with the entry of private schools has led to a modest rise in average teacher wages. This effect cannot be explained by compositional changes in the teaching pool and it remains when restricting the sample to public school teachers. The relationship suggests that the limited competition in the educational market has contributed to the depressed wages in the teaching profession, and that the increased competition over teachers has translated into higher wages through a reduction in schools monopsonistic power.

(3) While the average effects are modest there are substantial differences in the effect of private competition with respect to teacher characteristics. The effect is first of all twice as large for new teachers who are entering the profession. One potential explanation is that these teachers have higher wage elasticity than incumbent teachers which implies that they can exploit the increased number of employers when negotiating about the entry wage. Second, there are also differences with respect to teachers' field of specialization; the effects are particularly pronounced for teachers in areas of needs, such as male teachers in math and science and female teachers in vocational subjects.

(4) Finally, private competition is also associated with to a stronger link between teacher pay and teachers' cognitive skills. This relationship does not appear for other

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groups of workers (engineers) which is consistent with that that school competition increases schools' incentives to attract and retain the most able teachers.

To summarize, in contrast to deregulation experiences in the private sector which document falling wages from an increase in competition, this paper shows that abolishing the local monopoly in the Swedish educational market led to higher teacher salaries, also among incumbent teachers in public schools. Given the high union coverage in Sweden these effects may be even more pronounced in other countries.

Importantly, private competition has also generated a more differentiated wage setting according to teacher mobility, supply and cognitive skills. Given the literature highlighting the relationship between the pay structure and the secular declines in teacher quality observed in many countries, these results are promising since stronger incentives in the teachers' market can have implications both for the choice of becoming a teacher as well as for the effort and output levels in a given teaching pool.

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Appendix A: Descriptive patterns

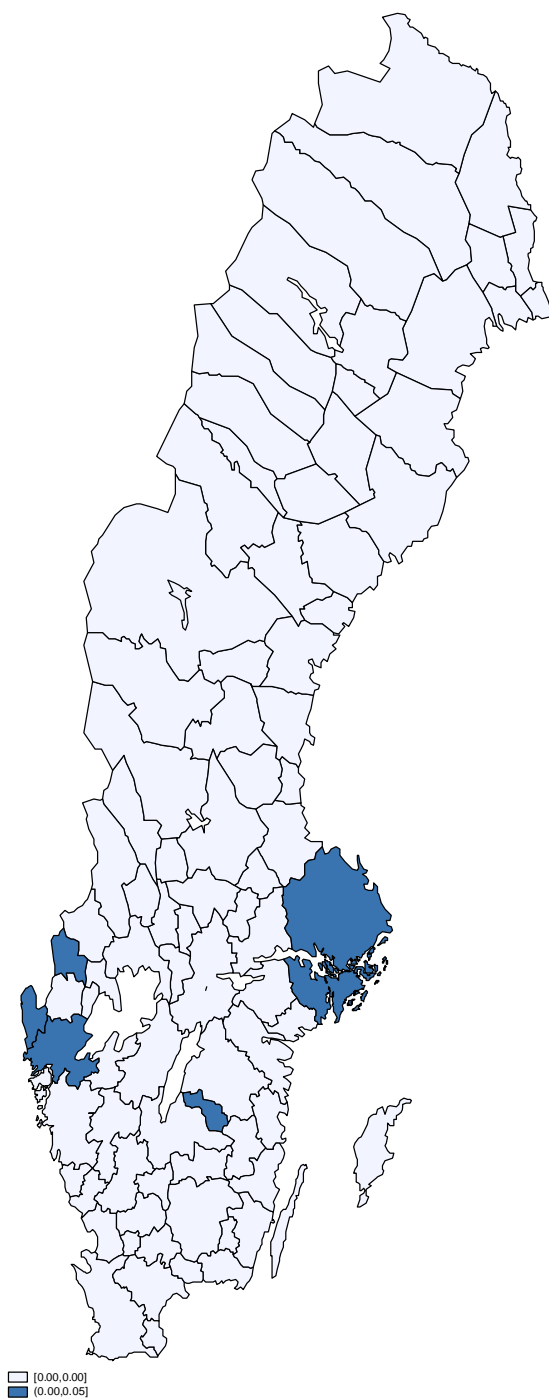


Figure A1 Variation in privatization across Swedish local labor markets (1991)

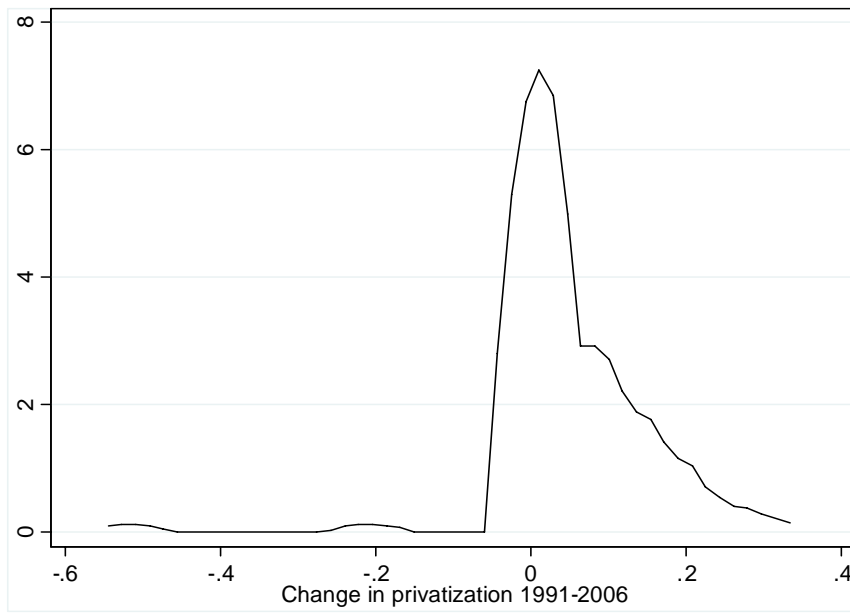


Figure A2 Kernel density distribution of LLM specific changes in the share of private high school teachers

Notes: The figure is based on calculations of the local labor market specific changes in the share of private high school teachers within each labor market between 1991 and 2006.

Table A1 Descriptive statistics

	(1)	(2)	(3)
PERIOD		PRE 1991-1993	
Sample:	All	Treated	Non-treated
Share private	0.015	0.015	0.012
Log(wage)	17430	17,442	17,338
Sd	2628	2624	2659
Age	47	47	47
Female	0.47	0.48	0.40
Certified	0.91	0.92	0.86
Observations	76,642	67,415	9,227
PERIOD		POST 1994-2006	
Sample:	All	Treated	Non-treated
Share private	0.069	0.078	0.005
Log(wage)	22,050	22,089	21,776
Sd	3,835	3,836	3,821
Age	47	47	47
Female	0.49	0.49	0.43
Certified	0.80	0.79	0.76
Observations	390,075	342,488	47,587

Notes: The table compares local labor markets with positive expansion (Treated) and no expansion (Non-Treated) of private school teachers during the entire study period (1991–2006).

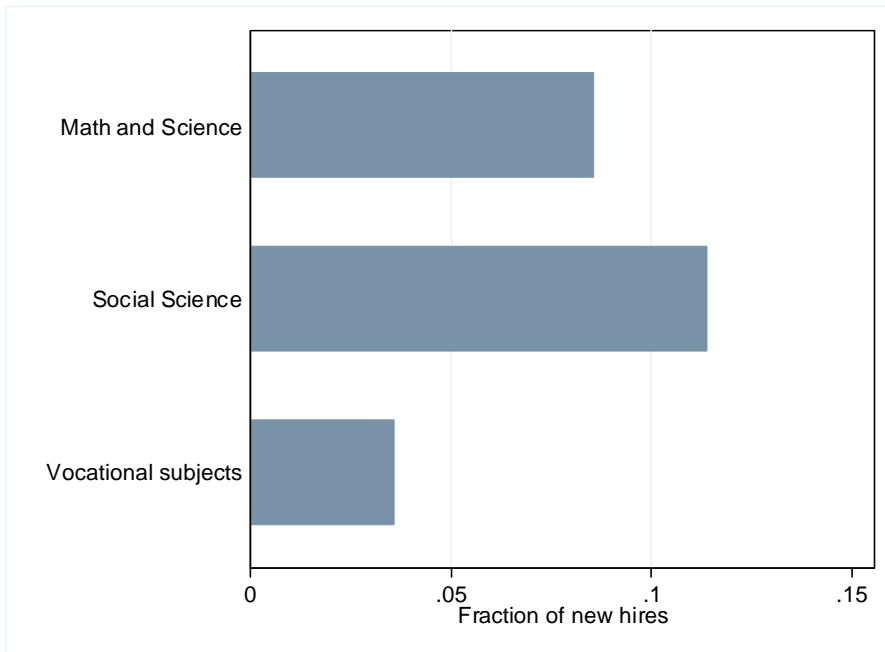


Figure A3 Fraction of recruits from non-employment

Notes: The fraction of recruits from non-employment is calculated by taking the number of newly recruited teachers who were observed as being non-employed in the previous year.

Appendix B: Additional robustness checks

Table B1 Placebo-test: Pre-school teachers

	Pre-school teachers
Share private × After	-0.007 (0.016)
Observations	1,410,021
R ²	0.775
LLM dummies	yes
LLM specific trends	yes
Teacher fixed effects	yes

Notes: *,** and *** denote statistical significance at 10/5/1 percent level respectively. The estimate is obtained from estimation of model (2) described in Section 6.2 where the sample consists of all pre-school teachers in Sweden between 1991 and 2006. The dependent variable is the individual log monthly wage and standard errors are clustered at the local labor market level. Since there is no reliable information on hours worked for pre-school teachers, observations for those working in the private sector have been weighted according to the individual sampling probabilities.

Table B2 Alternative labor market definitions

	All (1)	Entering (2)	Incumbent		
			(3)	Teacher fixed effects	
				All	Public
Panel A:			Baseline		
Share private × After	0.032* (0.017)	0.068* (0.036)	0.031* (0.017)	0.037** (0.017)	0.032* (0.018)
Panel B:			County		
Share private × After	0.077** (0.033)	0.143** (0.060)	0.071** (0.033)	0.062 (0.036)	0.059 (0.035)
Panel C:			Municipality		
Share private × After	0.009* (0.005)	-0.002 (0.006)	0.012** (0.005)	0.014 (0.009)	0.021* (0.011)
Observations	408,731	47,169	361,562	361,562	341,689
LLM fixed effects	yes	yes	yes	yes	yes
LLM linear trends	yes	yes	yes	yes	yes
Teacher fixed effects	no	no	no	yes	yes

Notes: *,** and *** denote statistical significance at 10/5/1 percent level respectively. Standard errors robust for serial correlation at the local labor market/county/municipality level are shown in parenthesis. In addition to the fixed effects indicated by the table all regressions control for year fixed effects and a dummy indicating whether the individual wage is imputed or not. The individual controls include gender, age, age², education dummies (6 bins) and the number of pupils in the given labor market and year.

Table B3 Estimated returns to ability

YEAR:	2000		2006		2000-2006	
Labor market:	Estimated returns	Sd	Estimated returns	Sd	Δ returns	Δ privatization
1	0.001	0.002	0.006	0.002	0.005	0.074
2	0.019	0.009	0.004	0.004	-0.015	0.036
3	0.002	0.017	0.009	0.01	0.007	0.055
4	0.014	0.031	0.003	0.022	-0.011	-0.001
5	0.011	0.009	-0.005	0.007	-0.016	0.011
6	0.003	0.007	0.005	0.005	0.002	0.04
7	0.012	0.008	0.004	0.005	-0.008	0.057
9	0.009	0.017	0.015	0.029	0.006	0.008
10	0.008	0.007	0.008	0.005	0	0.029
14	0.005	0.018	-0.005	0.011	-0.009	0.044
17	0.023	0.014	0.006	0.013	-0.018	0.003
19	0.006	0.006	0	0.005	-0.006	0.057
23	0.025	0.022	-0.003	0.011	-0.027	0.026
24	-0.011	0.018	-0.003	0.014	0.008	0.014
29	-0.002	0.011	0	0.009	0.002	0.055
31	0.014	0.006	0.004	0.004	-0.01	0.006
32	0.01	0.004	0.01	0.003	0	0.061
33	0.012	0.005	0.007	0.003	-0.005	0.067
35	0.015	0.01	0.014	0.006	-0.001	0.044
36	0.01	0.009	0.011	0.011	0.001	0.017
37	0.007	0.007	0.003	0.01	-0.004	0.028
38	0.004	0.003	0.005	0.002	0.001	0.036
40	-0.002	0.01	0.008	0.006	0.01	0.029
43	0.004	0.006	0.005	0.009	0.001	0.051
44	0.026	0.008	0.007	0.006	-0.018	0.033
47	0.024	0.035	0.004	0.011	-0.02	0.023
48	-0.003	0.009	0.005	0.005	0.008	0.039
54	0.006	0.007	0.008	0.006	0.002	0.062
62	0.001	0.005	0.003	0.004	0.002	0.037
64	0.024	0.019	0.004	0.007	-0.02	0.035
66	0.052	0.017	0.004	0.025	-0.048	0.007
71	0.009	0.009	0.013	0.004	0.005	0.029
76	-0.002	0.032	-0.003	0.009	-0.002	0.043
77	0.008	0.009	0.013	0.005	0.005	0.073
80	0.013	0.016	0.006	0.011	-0.007	0.003
83	0.006	0.011	0.011	0.007	0.005	0.082
85	-0.004	0.027	0.006	0.015	0.01	0.004
86	0.008	0.008	-0.001	0.006	-0.01	0.031
90	0.014	0.009	0.001	0.012	-0.013	0.055
96	0.001	0.006	-0.006	0.004	-0.006	0.029
98	0.001	0.007	0.002	0.005	0.001	0.02
107	0.009	0.006	0.006	0.005	-0.003	0.027

Notes: The table reports the local labor market specific estimated wage returns to cognitive skills for on 1/3 of the largest local labor markets. The estimates are obtained from traditional wage regressions that apart from the test scores include the age earnings profile and detailed field of education.

Table B4 OLS estimates of privatization on returns to ability

	(1)	(2)
	Not weighted	Weighted
Private share	0.170** (0.083)	0.148*** (0.050)
Observations	85	85
R-squared	0.618	0.684
Year dummies	Yes	Yes
Local labor market dummies	Yes	Yes

Notes: The table shows the estimated relationship between the share of private high school teachers and the estimated returns to cognitive test scores in the assigned local labor market. Column (2) weights each observation with its inverted sampling variance of the estimated return to ability.

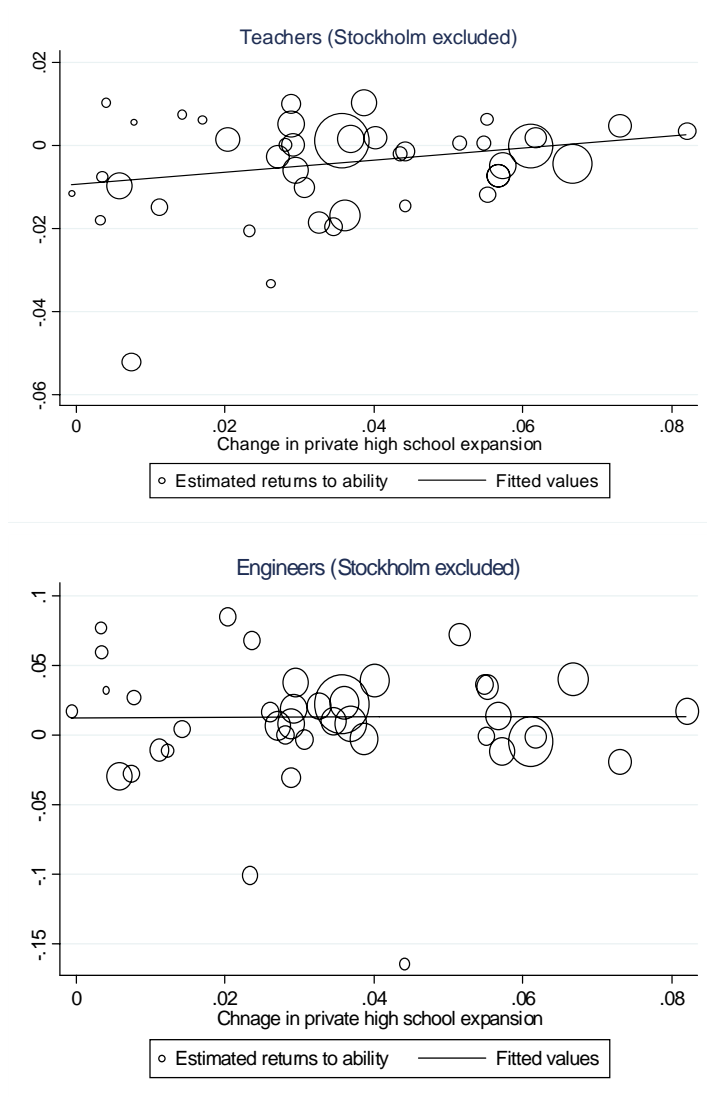


Figure B1 The association between the estimated returns to ability and school competition

Notes: The estimated returns to cognitive test scores are obtained from traditional wage regressions that apart from the test scores include the age earnings profile and detailed field of education. Each observation is weighted according to its inverted sampling variance of the estimated returns in 2006. When including Stockholm in the plot there is a positive association between the returns to ability and school competition. For engineers however, this relationship is entirely driven by Stockholm. For this reason I chose to exclude Stockholm when doing this comparison.