Teacher career opportunities and school quality *

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Abstract

What is the impact of improving teacher career opportunities on school quality? We study the effects of introducing a performance-based promotion program for teachers in Sweden on wages, separations, teacher composition and student performance. The program intended to make the teaching profession more attractive by raising wages for skilled teachers, thereby widening the wage distribution, and by taking advantage of teachers' professional competence. Our results suggest that: (i) high-wage, high-ability teachers are more likely to be selected for promotion (ii) the stipulated wage increase has full pass-through onto wages for the promoted teachers, i.e. there are no signs of compensatory behavior in general wage negotiations (iii) schools with promotions have lower teacher separations and an improved pool of teachers, and (iv) student performance improves when promotions are used. Together, these results lend support to that performance-based promotions could be an important tool for raising school quality.

Keywords: Career opportunities, Teacher labor market, Student performance

JEL Codes: J45; I21; J31; I28

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1 Introduction

Good teachers are an important input to schooling.[1] Still, most teacher labor markets are characterized by low wages; a compressed wage distribution (Hanushek and Rivkin 2006); and problems to recruit and retain talented individuals (Corcoran, Evans, and Schwab 2004; Bacolod 2007; Fredriksson and Öckert 2007; Grönqvist and Vlachos 2016; Leigh and Ryan 2008). Many countries also lack career opportunities for talanted teachers who want to stay in the profession (OECD 2005). The typical way for teachers to advance in their careers is instead to leave teaching for administrative or managerial tasks.

In this paper we study how the teacher labor market is affected by improved career opportunities by taking advantage of a unique promotion program for Swedish teachers. In response to deteriorating results in international comparisons like PISA and TIMMS, the Swedish government introduced a career step for experienced and skilled teachers by providing separate funding for a new position called 'career teachers' (Regeringen 2013b). Career teachers receive a 5,000 SEK (520 USD) wage increase and continue to teach, but are also tasked to work with the school's pedagogical development, like being a mentor, or initiating and leading development projects (Statskontoret 2015).[2]

The intention with the program was to make the teaching profession more attractive by rewarding skilled teachers, thereby increasing the wage dispersion, and to improve student outcomes by motivating, retaining and attracting high quality teachers (Regeringen 2013b). While similar types of career steps exist also in England, New Zealand, Australia, Scotland and Poland (Regeringen 2013c), we know little about the their impact on teachers and students.

We address five central questions. First, who is promoted to become a career teacher? Second, what is the pass-through of the stipulated wage increase relative to non-promoted teachers' wages? Third, is there an effect of the career step on teachers' separations from their school, and from the profession overall?[3] Fourth, is there an effect on the composition of teachers? Last, is there an impact on student performance?

The number of career teacher positions was increased gradually from 2013 to 2016 and the allocation of positions to school districts was rule based, where positions were distributed to districts in proportion to their student population. School districts had discretion to assign career teacher positions to individual schools, and at the schools it was delegated to the local

[1] There is a large and growing literature documenting that teachers matter for both short term student outcomes, like test scores (Rockoff 2004; Rivkin, Hanushek, and Kain 2005; Leigh 2010; Chetty, Friedman, and Rockoff 2014, and for longer term outcomes like college attendance and earnings (ibid.). It has however been difficult to find observable characteristics that are important for student outcomes (Jackson, Rockoff, and Staiger 2014). Factors like education, cognitive ability, and personality, which are found to be important in other parts of the labor market, are only of marginal importance (Hanushek and Rivkin 2006; Rockoff, Jacob, et al. 2011; Grönqvist and Vlachos 2016).

[2] In relation to the pre-reform mean teaching wage, this corresponds to a wage increase of about 15 to 20 percent.

[3] The focus is on separations rather than recruitment because teachers were mainly promoted internally (Statskontoret 2015).

principals to identify and recruit skilled teachers to the new position.[4]

We start by providing documentation of how the reform was implemented. This analysis suggests that school districts' allocated the number of teacher promotions across schools in relation to school size. No other pre-determined observable school characteristics systematically determine this allocation. Thus, even if school districts were free to allocate the promotions across schools, there is no sign that they targeted the promotions to schools with, for example, high teacher turnover or low student performance.

Considering who was promoted, the most salient pattern is that promotions within schools were given to teachers from the higher wage deciles of a compressed wage distribution. If higher wages are paid to more able individuals, this suggests that principals rewarded the most talented teachers with promotions. We find full pass-through of the state-funded stipulated wage increase onto wages. Thus, the reform increased wage dispersion both across and within schools, and there is no indication of compensatory behavior towards non-promoted teachers in regular wage negations.[6]

Our finding that the allocation of career teacher positions at the school-level was largely unrelated to observable characteristics enables us to study separations, teacher composition and student performance at the school-level by exploiting the *timing* of the introduction of promotions. Promotions can both attract and retain individuals with a higher innate ability and induce individuals to exert more effort (see Lazear and Shaw (2007) and Oyer and Schaefer (2011) for summaries of the personnel economics literature). We expect the career step to make the current job more attractive for promoted teachers, but as promotion signals quality these teachers also become more attractive to other schools. For non-promoted teachers, on the other hand, the likelihood of quitting may go up if individuals care about their relative position (see e.g. Card et al. 2012; Dube, Giuliano, and Leonard 2019). To quit may also be a rational response to a signal that you will not be promoted, but this signal is also observed by other schools. Quit rates may go down for non-promoted teachers if the career step improves school quality and the professional work environment.

We find that schools with career teacher promotions have lower teacher separations, both in general and in terms of teachers leaving the profession. This result is driven mainly by more senior teachers and applies both to teachers who were promoted and to those who were not promoted. In addition, the teaching pool improves in schools that participate in the reform as they are able to retain a higher share of certified and experienced teachers and teachers who themselves have higher compulsory school grades. We find non-negligible

[4]The career step reform can be thought of as a performance-based promotion program where talented teachers are awarded a pay rise (Jackson 2012). Given the difficulties to identify good teachers based on observable characteristics, this leaves the principal with a substantial amount of discretion. Still, there is evidence suggesting that principals can identify teacher skills and that teacher assessments can predict high quality teachers (Rockoff and Speroni (2011); Cantrell et al. (2008)).[5]

[6]In Sweden, teacher wages are set individually by the local principal. The idea is that competence, responsibilities and performance should determine the wage. Still, wages are very compressed and there is a strong equity norm among teachers. There can thus be pressure on principals to compensate non-promoted teachers in the regular wage revision.

positive effects on student test scores in Math, English and Swedish in grades 3 and 6. Together, these results suggest that improved career opportunities for teachers in the form of performance-based promotions could be an important tool for policy-makers who aim to increase school quality.

To the best of our knowledge, our study provides the first empirical evidence on the effectiveness of performance-based promotions. The most closely related studies are two recent papers on the impact of more flexible pay schemes on teacher sorting. Biasi (2018) finds higher effort and teacher quality in school districts in Wisconsin that start to pay high-quality teachers more, compared to districts retaining more rigid pay schemes. In contrast, Willén (2018) finds no support for changes in teacher composition or student outcomes when individualized wage setting was introduced to teachers in Sweden in the 1990s.[7] In spite of the intentions, this policy led to even more compressed teacher wages in Sweden.[8][9]

The direct evidence on the link between teacher pay and student outcomes is mixed but the focus is typically on general pay raises rather than on performance-based promotions or increased wage dispersion. Several studies from the last two decades find a positive relationship between general teacher wages and student outcomes. For example, Loeb and Page (2000) find that increasing teacher wages reduces high school drop-out rates; Dolton and Marcenaro-Gutierrez (2011) find that higher pay raises student performance using a panel of 39 countries; Britton and Popper (2016) exploit English wage regulation and find support for that teacher pay is important for school performance; and Alva et al. (2017) take advantage of a Peruvian teacher wage experiment to find that schools offering higher wages have higher test scores, and that this difference is likely driven by better teachers being recruited to these schools. On the other hand, Ree et al. (2018), who study an unconditional salary increase in Indonesia, and Cabrera and Webbink (2018), who study the impact of a wage policy program in Uruguay, find only modest to no effects of teacher pay on student outcomes. Given the ripple effect that teachers have on student outcomes, our study contributes to this literature by providing novel evidence on the (short-run) impact of the promotion program on student test scores in different grades.

The paper proceeds as follows. It begins by describing the Swedish educational system,

[7] Karbownik (2014) finds a negative relation between mobility and monetary compensation for teachers in Swedish lower and upper secondary schools.

[8] Similarly Söderström (2010) finds that the switch from centralized to individualized wage setting substantially increased entry wages, and wage dispersion late in the career.

[9] Another strand of the literature focuses on general wage increases for teachers, finding that higher wages attract higher quality teachers to schools (Figlio 1997; Gilpin 2012) and to the profession (Leigh 2012), and reduce teacher turnover (Clotfelter et al. 2008; Falch 2011; Hendricks 2014). There can also be indirect effects on school quality from policies impacting teacher turnover. If teacher turnover improves average teacher quality there would be positive effects on student outcomes (Hanushek (2011)), but to the risk of an uneven distribution of effective teachers across schools exacerbating differences in opportunities across students (Boyd et al. (2008); Clotfelter et al. (2008)). At the same time, Jackson (2013) finds that there are important match effects in the teacher labor market and that teacher effectiveness increases after a move to a different school. There can also be disruptive effect of turnover beyond changing the distribution in teacher quality Ronfeldt, Loeb, and Wyckoff (2013): for example Ost (2014) finds that curriculum specific experience is important for instructional quality.

the career teacher reform, and the data in Section 2. In Section 3, we present the results. Section 3.1 describes the roll-out of the reform and shows how the career teacher promotions were allocated across schools and teachers; Section 3.2 analyses the pass-through of the stipulated wage increase onto wages; and Section 3.3 contains empirical analyses of teacher turnover, composition, and student performance. Finally, Section 4 concludes.

2 Institutional setting and data

2.1 The Swedish education system

During the period we study, the Swedish schooling system can be split into three main parts: pre-school, compulsory school and upper-secondary school.[10] At age six, children can attend the voluntary pre-school before they are obliged to start compulsory school at age seven. Compulsory school spans grade 1–9 and is mandatory for all children. Using the GPA from the 9th grade, a young person can apply to continue to a three-year program at upper-secondary school, which is required in order to continue to higher education.

Schooling is provided both by the public and by the private sector. The main public provider is the municipality. During the 2016/2017 academic year, 85% of compulsory school students attended public schools run by one of 290 municipal providers while 15% of compulsory school students attended voucher schools run by one of the 729 non-public providers (Skolverket 2018). Children are free to choose which school to attend and incur no tuition fees regardless of provider. If a school is over-subscribed, proximity is the main guiding principle for allocation of places in public schools.[11] We restrict our attention to public compulsory schools.

To teach at a Swedish school, the teacher needs to certified.[12] Only certified teachers can in general be permanently employed and set grades. Teachers are formally hired by the school district ("huvudman") which, in the case of the public sector, is the municipality. In practice, principals at schools often make the hiring decision and set wages. Nearly all teachers in Sweden are covered by collective agreements. Since 1996, teacher wage bargaining is decentralised and individualised, primarily set in negotiations between the teacher and the principal.[13]

2.2 The career teacher reform

The career teacher reform is a Swedish government-initiated policy that introduced a new career step: the career teacher.[14] It was implemented in July 2013 and is financed by earmarked government funding.

[10] In addition, there are schools for children with special needs as well as Sami schools.

[11] See 10 ch. 30§ *Skollag 2010:800*.

[12] For a teacher to be certified to teach, the teacher must have proper credentials to teach in the current type of school, grade and subject. Qualifications are often obtained through higher-level teacher training. In 2011, the teacher training went from a general teacher exam to four specialised tracks, depending on the level and subject that the teacher wants to teach. Teacher certification was formalised with the introduction of the professional teacher certificate ("lärarlegitimation") in 2011. To obtain the certificate, the teacher must be qualified. In general it is the content of the teacher training that determines which types of schools, grades and subjects the teacher will receive credentials for. See *Skollag (2010:800)* and *Förordning (2011:326) om behörighet och legitimation för lärare och förskollärare.*

[13] See Hensvik (2012) and Willén (2018) for more details.

[14] The reform is regulated in Regulation 2013:70, see Regeringen (2013a). Formally, the reform introduces two career steps: lead teachers ("förstelärare") and lecturers ("lektor"). Only around 1% of career teachers are lecturers. We exclude teachers that are ever lecturers from our sample.

The reform, akin to a performance-based promotion (Jackson 2012), targets so-called talented teachers. Its intention is to improve student performance by improving teachers' career opportunities. Broadly speaking, it aims to make the teaching profession more attractive by raising wages for skilled teachers, thereby increasing wage dispersion in the profession, and by taking advantage of teachers' competencies (Regeringen 2013b). Conceptually, it may entail both a sorting effect, if teachers that otherwise leave the school stay to a larger extent, and an effort effect, if promoted teachers exert more effort. In addition, as outlined in more detail below, the reform may also entail spillovers within schools from promoted teachers onto their teacher peers.

2.2.1 Roll-out of reform

The number of career teaching positions are allocated annually to school districts based on the national share of students across all educational tiers in the school district.[15] For example, if a school district has 5% of students, it is allocated 5% of the career teaching positions. School districts in turn decide how to allocate the positions across schools within school districts, and to individual teachers. The total number of available positions each year is decided by the size of the total state grant. In 2013 the earmarked funding could finance around 4,000 positions across all educational tiers and types of school districts.[16] This increased to around 14,000 by 2014 (Skolverket 2014). By 2016, the number of available positions was around 16,000 (Skolverket 2016). However, while the allocation of positions available to school districts is rules-based, the school district need not acquire all the funding reserved to it. In 2013, approximately 75% of the funding (for approximately 3,000 positions) was acquired (Skolverket 2014). This increased to around 90% by 2016 (Skolverket 2016).

For municipal compulsory schools, the group that we study, there are 290 school districts, all of which are *potentially* treated from 2013 onward.[17] Out of the 290 school districts, approximately 70% in our sample participate in 2013, where participation is defined by having at least one career teacher. By 2014, 97% participate and in 2016, all but one school district participates. There is thus limited variation in participation across school districts over time. Figure 1 plots the school district's share of career teachers against the school district's share of students. The relationship is approximately linear, at least after 2013, which is in support of promotions being allocated approximately in proportion to school district size. The corresponding figure for the variation across schools (see Figure A.2 in the appendix) shows that there is more variation within school districts.

[15] Formally, state grants are allocated according to this rule. A grant of SEK 85 000 (approx. USD 9 600) is given per full-time career teacher. This also includes funding for employer contributions. School districts with fewer than 75 students apply for the grant from a common pool.

[16] The reform covered pre-school, compulsory school, upper-secondary school, Sami schools, schools for children with special needs and adult education from both public and private providers. In our main sample, we include municipal compulsory schools only.

[17] We restrict our attention to municipal schools both because take-up of the program among voucher schools is substantially lower (Statskontoret 2015) and because we can only observe wages for a sub-sample of the voucher schools.

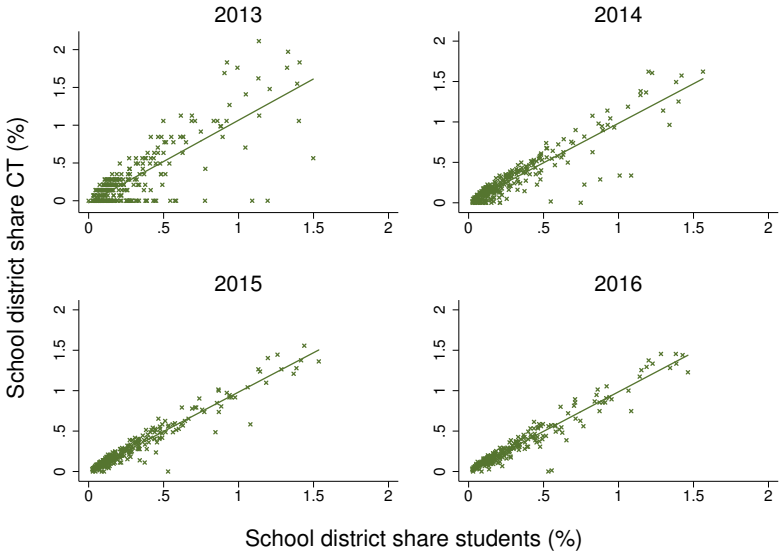


Figure 1: Allocation of promotions across school districts

Note: Based on data in our main sample. Each cross corresponds to one school district. The line is a linear prediction. For legibility, the figure excludes the four largest school districts. A figure with all school districts is included in Appendix Figure A.1.

2.2.2 The career teacher

A main aim of the reform was to ensure that talented teachers keep teaching, as opposed to, for example, becoming principals or leaving the profession. The reform stipulated that teaching and teaching-related tasks must constitute at least 50% of the career teachers' time. In addition, career teachers engage in development tasks aimed to, for example, improve teaching, train other teachers or work toward organizational change at their workplace. There may therefore be spillovers from the promoted teacher onto teacher peers in the same school (Statskontoret 2015).

While the formal decision rests with the school district, the career teacher position is placed at an individual school and the promotion decisions are generally taken by school principals. Four minimum requirements need to be fulfilled to qualify for promotion. The teacher needs to be formally certified; have at least four years of experience with good reviews; be able to demonstrate an ability to improve student outcomes and an interest to work with developing teaching; and be deemed particularly qualified by the school district in teaching and teaching-related tasks (Regeringen 2013a).

By 2016, around 14 percent of the compulsory school teachers in our sample have been promoted. The vast majority of promotions in our sample are internal – approximately 85-95% are working in the same school the year before they are promoted, depending on year. The career teacher positions are typically not permanent but only around 2.5% of career teachers have a contract that lasts fewer than 12 months. A reason for having temporary contracts is to induce effort and to maintain flexibility. The proportion of permanent posi-

tions has increased over time and in 2016, over 45% were permanent. The same position is not transferable across school or school districts.

A central component of the reform is to give career teachers a wage increase. According the reform's regulation, teachers who become career teachers should receive a monthly wage increase of SEK 5 000 (approx. USD 520). Ear-marked government funding is used to fund the wage increase. Considering aggregate wage effects on the teacher labour market, Figure 3 shows that mean teacher wages as well as wage dispersion has increased post-reform (Appendix Figure A.3 shows the wage distributions in 2010 and 2015). While mean full-time wages were around SEK 27 000 (approx. USD 2 800) before the reform between 2010 and 2012, mean wages grew to nearly SEK 31 000 (approx. USD 3 200) in 2015, representing a 15% increase in mean wages.[18] The gradual increase in mean wages is consistent with the roll-out of the reform.

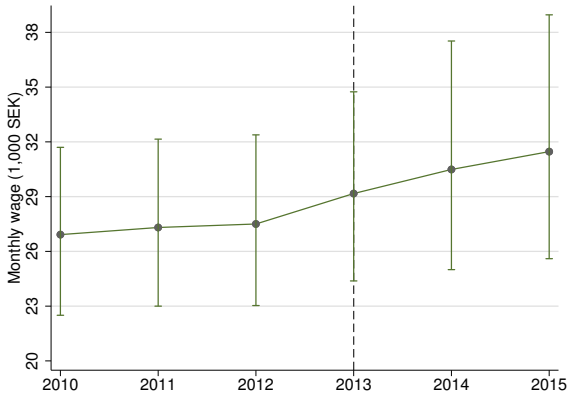


Figure 3: Teacher wages over time

Note: The figure shows the 5th percentile, mean and 95th percentile teacher wages in our sample.

2.3 Data

To analyze the impact of the career teacher reform we combine administrative data from different Swedish registries held at Statistics Sweden. The underlying population for the analysis is the panel of Swedish schools for the years 2010 to 2016 and the teachers working at these schools, and is based on information from the Swedish Teacher register (Lärarregistret).

The teacher register covers all school staff with educational duties employed at Swedish schools, and is collected as a part of the official statistics in the school area. Data is measured annually, in October each year, and for our purposes it contains information on person identifiers for teachers, information on where the teacher works; the teacher's experience and whether the teacher is certified.[19] The teacher register can be linked to a school register

[18]Wages are expressed in nominal terms since this is a zero inflation period: From 2010 to 2016 CPI increased with 4.3%, an average inflation rate of 0.07%.

[19]To be precise, there is information on whether the teacher is qualified, i.e. has pedagogical higher education. Information on the formal teacher certification introduced in 2011 is not available in the teacher register. The main requirement to become certified is to hold proper credentials.

that contains school level characteristics, such as number of students and school district.[20] Schools are defined using a combination of school name and municipality code.

Using person, school and year identifier, we link the teacher register to a career teacher register that specifies whether the teacher is a career teacher. Using person and year identifiers, we also link the teacher register to demographic registers that include variables such as age, gender, level of education and field of specialization. We have data on teacher's 9th grade GPA from 1988 onward (cohorts born after 1972) which can be linked to our data using person identifiers.[21] GPA is standardized in the full population by year of graduation to have mean 0 and standard derivation 1. In addition, we retrieve information on teachers' wages from the structural earnings statistics, which contains monthly full-time adjusted wages in SEK, measured in November each year. The wage data covers everyone working in the public sector (and about 50 percent of workers in the private sector). As we only include teachers working in municipal schools in our sample (see Section 2.3.1), we have complete wage data.

Our data on student performance are drawn from records of student test scores on centralized tests in Math, English and Swedish (*Ämnesprovsregistret*). The tests are taken in grade 3 (Math and English only), grade 6 and grade 9 and are typically graded by the students' own teachers using centrally provided guidelines.[22] In the first two years of our observation period (2010 and 2011), students took the national test in grade 5 instead of in grade 6. To use as much information as we can from the available data, we let the grade 5 test scores proxy for the performance in grade 6. Using the student-level data, the results of the exams are standardized by year to have mean 0 and standard deviation 1.[23]

2.3.1 Sample

We restrict our attention to teachers whose main occupation is teaching. In particular, we include only those individuals who receive their main source of income from teaching and who work at least 50% at their main school. If a teacher works at several schools in the same year, only the teacher's main school is included in the sample, defined as the school with the

[20] As we only include municipal schools in our sample, school district is proxied by municipality code.

[21] It follows that the share of teachers in our sample for which we observe GPA increases over time. In 2010, we have GPA for 26% of teachers. This increases by around three percentage points per year. In 2016, we have GPA for around 45% of the teachers in our sample.

[22] The tests are taken during the spring semester. In our analysis, we associate a spring test score with remaining data the preceding fall semester. For example, we link test scores from spring 2013 to our data from fall 2012. Consequently, regressions that use student test scores only use data until 2015.

[23] The tests consist of different parts that are graded separately. How many parts a test has can vary by subject and grade, and at times year. Most parts generate a test score, but some parts are pass/fail (P/F) only. An overall test score is provided for the grade 6 tests (from spring 2013) and for the grade 9 tests (all years). Whenever an overall score is provided, we use that score. When an overall score is missing, we calculate a mean test score as the aggregate number of points divided by the number of parts of the test taken, for all parts of the test that are not P/F. The Grade 5 test in all three subjects in spring 2010 only consisted of P/F questions. For this test we calculate an overall score based on the proportion of parts that the student passed. Once each student has one test score per subject and grade, we standardise the test scores by year to have mean 0 and sd 1. A school is assigned a mean standardized test score by year, subject and grade based on the students that attend the school.

most extensive contract. Moreover, we only include municipal compulsory schools, thereby excluding teachers who work at different tiers of education (notably, in upper secondary education) or at voucher schools. Finally, we only include schools that exist for seven years and employ at least three teachers per year between 2010 and 2016. Other sample restrictions are stated in the text where applicable.

2.3.2 Separation measures

We consider two main separation measures. The first, denoted *separations*, measures the fraction of teachers who separate from the current school. The second, denoted *exits*, measures the fraction of teachers separating from the school *and* the teaching profession. The difference between the separation and exit variables is that separations are defined from no longer working in the current school while exits applies the additional restriction that the teacher is not working with teaching at any compulsory or upper secondary, public or voucher school in any capacity.

As explained above, we observe teachers at schools in October each year, while career teacher promotions can take place at any time during the school year (Statskontoret 2015). In terms of timing, we therefore relate the fraction who separate between October in year *t–1* and October in year t to the presence of career teachers in the fall of year t. These career teachers are generally hired at some point during January to December in year t. Given data availability, the separation measures can be calculated from 2011 to 2016.

2.3.3 Number of observations

Table 1 shows the number of schools and teachers in our main sample. There are annually around 56,000 teachers working at just under 3,000 schools. Participating schools shows the number of schools that have had at least one career teacher in year t or earlier. Promoted teachers considers teachers that have been promoted and is equal to one if the teacher has held a career teaching position in year t or earlier. The number of participating schools and teachers are increasing over time from 2013 as the reform is rolled out.

Table 1: Schools and teachers per year

	2010	2011	2012	2013	2014	2015	2016
Schools	2,950	2,950	2,950	2,950	2,950	2,950	2,950
Teachers	56,150	56,080	55,785	55,864	56,787	56,711	58,583
Participating schools	0	0	0	1,039	2,277	2,532	2,636
Promoted teachers	0	0	0	1,420	6,317	7,457	8,157

3 Results

3.1 Allocation of career teacher positions across schools and teachers

3.1.1 Allocation across schools

We are interested in studying the effect of improved career opportunities for teachers on school quality. We first explore how school districts allocate career teacher positions across schools and teachers. Panel A of Figure 5 shows how many of the 2,950 schools that participate by year – i.e. the timing of treatment for the schools in our sample. Panel B instead considers treatment intensity by plotting the distribution of the share of promoted teachers at a school separately by year. On average, between 1.4 and 2.2 teachers are promoted at a school (see Appendix Table A.1, which includes school summary statistics). The number of teacher promotions increased by a factor of four between 2013 and 2014 followed by a more moderate increase between 2014 and 2016 (see also Table 1). As a result, we see that the fraction of schools without career teachers declined from 60 to 25 percent between 2013 and 2014. In 2016 around 13 percent of teachers were promoted at the average school, while around 15 percent of schools still lacked a career teacher.

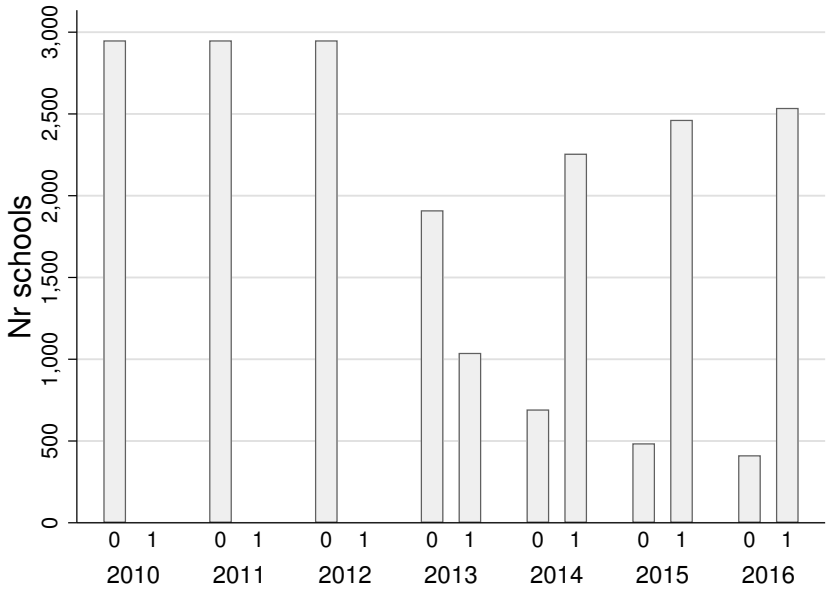
To descriptively consider how the career teacher positions were allocated across schools, Table 2 relates the presence of career teachers to lagged school characteristics. In particular, it presents the results of the regression:

$$CT_{sdt} = \phi_{dt} + \beta_t X_{sdt-1} + \epsilon_{sdt} \tag{1}$$

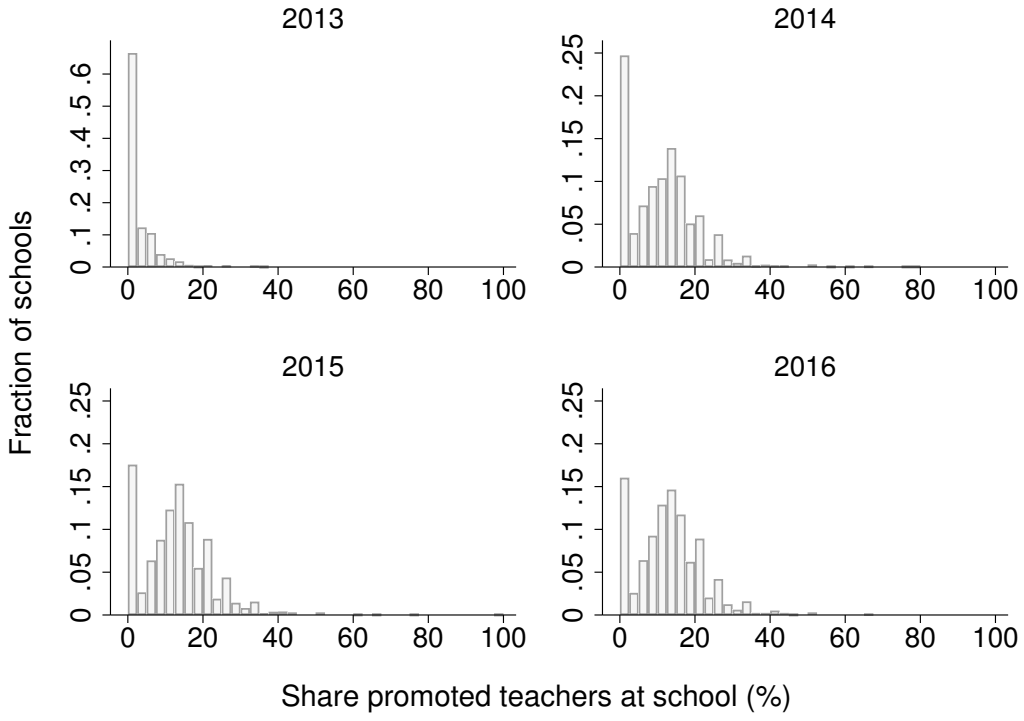
where CT_{sdt} is either a dummy equal to 1 if school s in school district d has a career teacher in year t (Table 2) or a variable equal to the percent of career teachers out of all teachers at the school in year t (Appendix Table B.1), ϕ_{dt} are school district fixed effects and X_{sdt-1} are lagged school characteristics. All variables are measured at the school level. We run separate regressions by year between 2013 and 2016. We focus on when the school first participates in the reform and thereby only include schools that have no (never or not yet) career teachers in $t-1$.

The results suggest that the probability to have career teachers is increasing in school size: doubling the number of students increases the likelihood that the school has at least one career teacher (in any year) by between 10 to 20 percentage points. Besides this factor, there appear to be little systematic relation between having career teachers and observable school characteristics. Most surprising is perhaps that there is no systematic relationship between the allocation of career teacher positions across schools and the lagged separation rate. There is thus no indication that school district allocated the career positions to schools with greater difficulties of retaining their teaching pool.[24]

[24]In Table B.2, we also include the average test score among third- and six-graders, which are available for the subset of schools that have students in those grades (86/68 percent of the schools have students in grade 3/6). Reassuringly, student performance does not predict the selection of schools with promotions.



(a) Participating schools



(b) Share career teachers at schools

Figure 5: Variation in reform participation at school level

Note: Panel A shows the number of non-participating (0) and participating (1) schools between 2010 and 2016. Participation is defined as having at least one career teacher. Panel B shows the fraction of schools at different shares of career teachers per year between 2013 and 2016.

Table 2: Factors that predict selection of schools

	At least one CT at school			
	2013	2014	2015	2016
School characteristics in $t-1$:				
Log nr students	0.210***	0.290***	0.211***	0.162***
	(0.019)	(0.015)	(0.045)	(0.048)
Student-to-teacher ratio	-0.010***	-0.011***	-0.007	-0.003
	(0.003)	(0.003)	(0.007)	(0.006)
Separation rate	0.022	0.003	0.081	0.214
	(0.079)	(0.091)	(0.192)	(0.192)
Exit rate	-0.067	0.114	0.050	-0.287
	(0.106)	(0.120)	(0.220)	(0.216)
Certified (share)	0.014	0.252*	0.240	-0.199
	(0.157)	(0.145)	(0.246)	(0.246)
Female (share)	-0.066	0.170*	-0.139	0.098
	(0.076)	(0.091)	(0.153)	(0.170)
Mean age (years)	-0.010**	-0.006	-0.000	0.008
	(0.005)	(0.005)	(0.007)	(0.007)
Mean experience (years)	0.003	-0.001	0.000	-0.004
	(0.004)	(0.005)	(0.008)	(0.007)
Maths/natural science (share)	0.042	-0.110	-0.203	-0.036
	(0.079)	(0.110)	(0.146)	(0.171)
Swedish/social science (share)	0.073	-0.077	-0.092	0.232
	(0.063)	(0.089)	(0.132)	(0.143)
District FE	Yes	Yes	Yes	Yes
R^2	0.349	0.411	0.471	0.572
N	2,941	1,882	611	346
Mean dep. var.	.35	.65	.38	.25

Note: This presents the results of regressions of $CT_{sdt} = \phi_{dt} + \beta_t X_{sdt-1} + \epsilon_{sdt}$ where CT_{sdt} is a dummy equal to 1 if the school participates in the reform in year t. Variables are measured at school level. Regressions are estimated separately by year and only include schools that have not (never or yet) participated as well as schools that participate for the first time. Standard errors are clustered at school district level.

3.1.2 Allocation across teachers

Turning to *who* was promoted, Table 3 presents pre-reform (2012) summary statistics for our sample, separately by whether the teacher is ever promoted, never promoted and the full sample. The selection of teachers for promotion officially rested with the school district but was in practice often taken by the school principal. In line with the eligibility requirements, 97 percent of promoted teachers were employed on a permanent contract and were certified in 2012. We also see that promoted teachers are slightly more likely to be female, have slightly less experience and are slightly younger than those who are not promoted. Considering their educational field of specialization, over half of ever career teachers are specialized in either Swedish and social sciences or maths and natural sciences, which is higher than those who are are not promoted.

To more formally assess who has been promoted, we estimate linear models by OLS. We regress a dummy for being a career teacher CT_{ist} on lagged teacher characteristics X_{ist-1} (age, gender, education, teacher GPA, wage decile, field of specialization, tenure and experience):

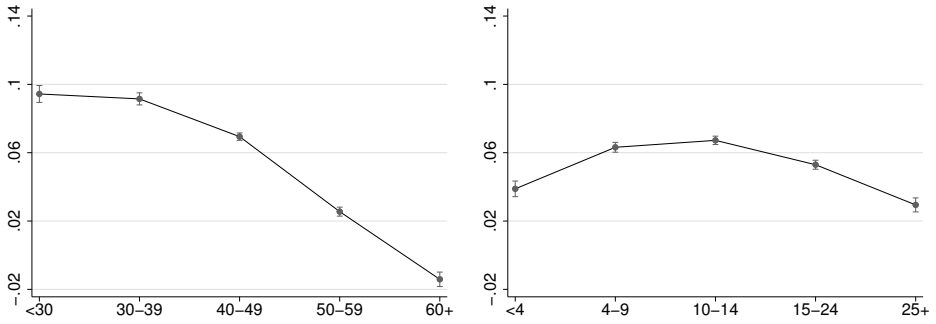
$$CT_{ist} = \beta X_{ist-1} + \delta_s \times \lambda_t + \epsilon_{ist} \tag{2}$$

Year by school fixed effects are also included. Regressions are pooled across 2013 to 2016, estimated for certified teachers only and censored to include only the first year of becoming a career teacher. Figure 7 presents the results of this analysis. It shows linear predictions of promotion with 95% confidence intervals. Full regression results are included in Appendix Table B.3.

The estimates confirm that the likelihood of being promoted increases slightly with tenure while it decreases with age. Experience shows an inverted U-shape. Wage decile, which measures in which decile in the school wage distribution the teacher is, appears to predict promotion most strongly. The results indicate, for example, that someone at the highest wage decile in their school has a 14% likelihood of being promoted. The likelihood of being promoted also increase slightly with teachers' compulsory school GPAs. In addition, we find that women as well as those who are specialized in Maths and natural sciences are slightly more likely to be promoted.

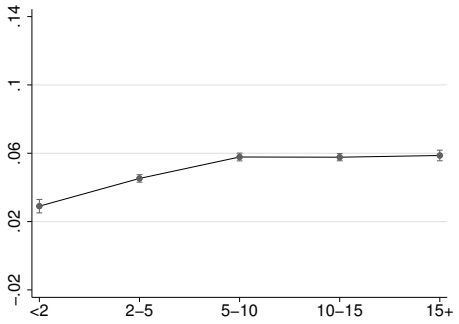
Table 3: Teacher summary statistics, 2012

	Ever career		Never career		Full sample	
	Mean	sd	Mean	sd	Mean	sd
Female (share)	0.83	(0.38)	0.78	(0.42)	0.78	(0.41)
Age (years)	43.27	(7.87)	47.02	(10.67)	46.47	(10.39)
Experience (years)	13.75	(7.77)	16.01	(11.27)	15.68	(10.86)
Permanent contract (share)	0.97	(0.16)	0.90	(0.30)	0.91	(0.28)
Certified (share)	0.97	(0.17)	0.90	(0.30)	0.91	(0.28)
Monthly wage (SEK)	27,943	(2639)	27,426	(2894)	27,501	(2864)
Educational specialization						
Maths/natural science	0.25		0.14		0.16	
Swedish/social science	0.28		0.19		0.20	
Other teaching	0.45		0.61		0.58	
Non-teaching	0.01		0.06		0.05	
Observations	8,160		47,625		55,785	

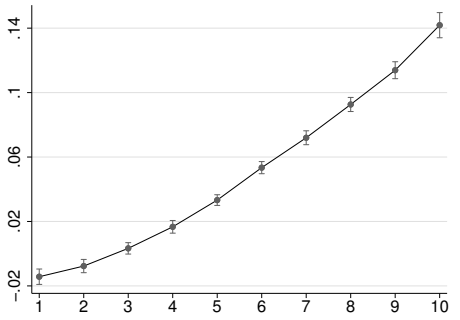


(a) Lagged age band

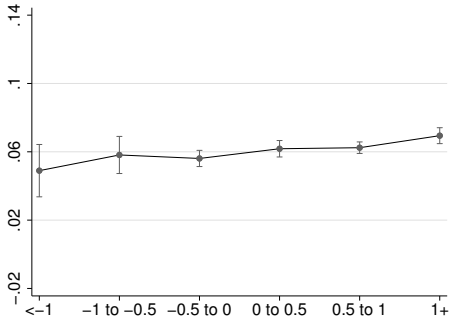
(b) Lagged experience band



(c) Lagged tenure band



(d) Lagged wage decile



(e) Standardised 9th grade GPA

Figure 7: Predicted probabilities of being promoted

Note: This presents linear predictions from the regression $CT_{ist} = \beta X_{ist-1} + \delta_s \times \lambda_t + \epsilon_{ist}$. Full results are in Appendix Table B.3. Only Panel (e) includes the teacher's lagged standardised 9th grade GPA. Regressions are pooled across 2013 to 2016, estimated for certified teachers only and censored to include only the first year of becoming a career teacher. Standard errors are clustered at school district level.

3.2 Pass-through of stipulated wage increase on promoted teacher's wages

As mentioned above, a central component of the reform was to give promoted teachers a wage increase. Figure 9 shows mean wages for those that become career teachers at some point during our observation period versus those that are never career teachers. Prior to the introduction of the reform, mean wages are very similar. While non-career teacher wages trend upwards slightly over time, mean wages for ever career teachers increase much more rapidly following the introduction of the reform.

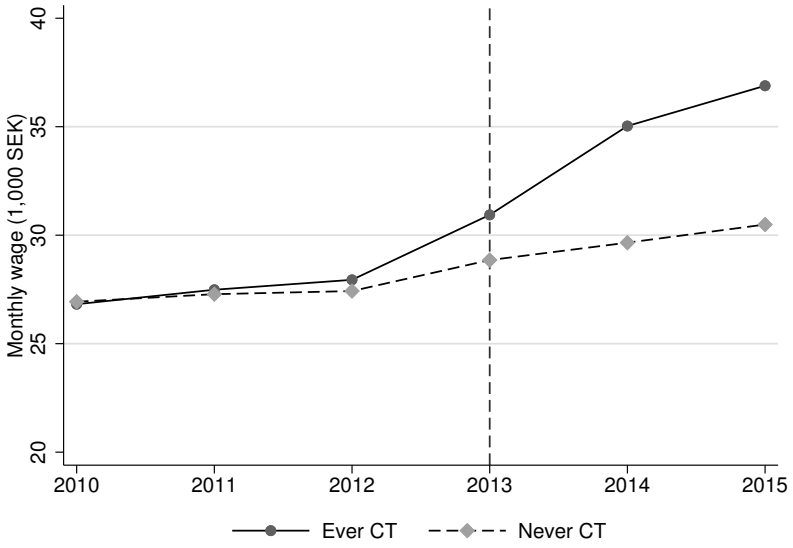


Figure 9: Ever career teacher vs. never career teacher mean wages

The above figure suggests that wages increased after the implementation of the reform. From a theoretical perspective it is not clear, however, that we should expect full pass-through of the stipulated wage increase onto promoted teachers wages. If, for example, job satisfaction depends on relative pay as shown by Card et al. (2012), school principals may have incentives to, at least partly, compensate non-promoted teachers in local wage negotiations. To more formally assess how wages for promoted teachers differ from those who are not promoted, we estimate regressions of the following form:

$$\ln(w_{ist}) = \alpha_i + \delta_s + \lambda_t + \theta CT_{ist} + \beta X_{ist} + \epsilon_{ist} \tag{3}$$

where $\ln(w_{ist})$ are log monthly full-time-equivalent teacher wages and CT_{ist} is a dummy equal to 1 if the teacher is promoted.[25] We include school fixed effects δ_s to control for mean differences in wages across schools and year fixed effects λ_t to control for time effects common to all schools. In our preferred specification, we also include teacher fixed effects

[25] As mentioned above, promotions are not necessarily permanent. However, once an individual has held a CT position, we consider the individual to be treated. The dummy is therefore equal to 1 from year t onward.

α_i to control for individual-specific heterogeneity in wages. We therefore rely on within-individual deviations to identify θ. To account for correlation between teachers that work in the same school district, standard errors are clustered at the school district level.

The results are shown by Panel A of Table 4. They suggest that the wage increase associated with a promotion is approximately 15%.[26] In Panel B, we use the monthly wage in Swedish crowns (SEK) as the outcome. These results confirm that the wage impact of a promotion is very close to the 5 000 SEK wage increase stipulated by the reform, in particular if we consider the wage increase associated with the first time a teacher is promoted shown in column 2.[27]

Table 4: Wage effects of promotion

	(1)	(2)
Sample	Full	First time CT
Panel A: ln*(wage)*		
Promoted	0.148***	0.141***
	(0.002)	(0.002)
R^2	0.961	0.904
N	374,108	260,619
Panel B: Monthly wage (SEK)		
Promoted	5322.5***	4744.3***
	(65.1)	(58.6)
R^2	0.956	0.900
N	374,108	260,619
Year FE	Yes	
School FE	Yes	
Individual FE	Yes	
Controls	Yes	Yes incl. lag wage

Note: The table provides results of the OLS regressions of $y_{ist} = \alpha_i + \delta_s + \lambda_t + \theta CT_{ist} + \beta X_{ist} + \epsilon_{ist}$. Controls are dummies for female, age, level of education, teacher certification, permanent contract, field of specialisation, experience and tenure. Standard errors are clustered at school district level. In specification (2) the sample is censored to only include the first year of becoming a career teacher.

Given that selection of career teachers is non-random, we may worry that those that are promoted are on a different wage trend than those who are not promoted. Indeed, the analysis above showed that career teachers are more often taken from higher wage deciles in

[26] Appendix Table B.6 shows results from alternative specifications including models without teacher fixed effects.

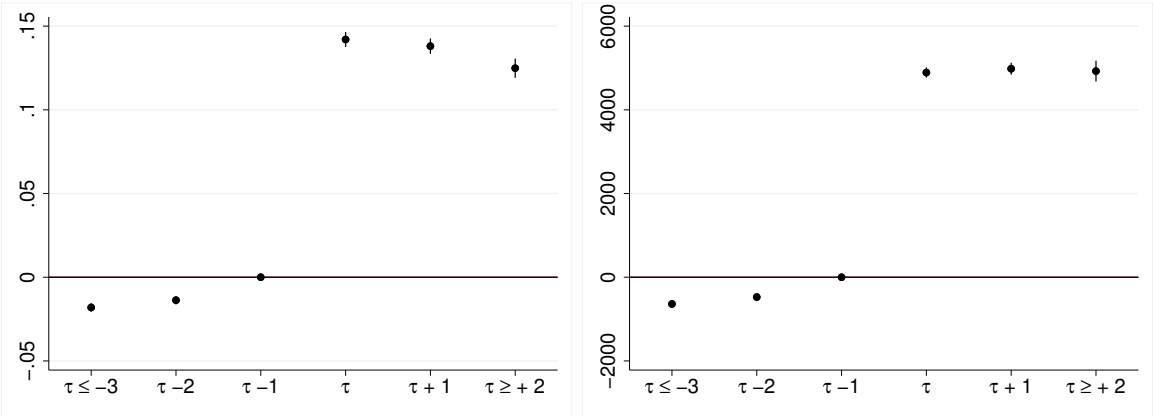
[27] The fact that the estimate in column (1) of Panel B is slightly larger probably reflects the outcome in subsequent wage negotiations, where pay raises are based on the current wage.

the schools that they work. As a more formal complement to Figure 9, we consider whether there are differences in pre-treatment wage trends as well as the dynamics after promotion by estimating an event-time specification similar to Jacobson, LaLonde, and Sullivan (1993):

$$\ln(w_{ist}) = \alpha_i + \delta_s + \lambda_t + \sum_{\tau \leq -3}^{-2} \gamma_\tau D_i \mathbb{1}[\tau] + \sum_{\tau=0}^{\geq 2} \theta_\tau D_i \mathbb{1}[\tau] + \beta X_{ist} + \epsilon_{ist} \tag{4}$$

where t is calendar time and τ is event-time. τ denotes the time relative to when the teacher is first promoted, which occurs when τ equals 0. Observations three or more event years before treatment ($\tau \leq 3$) or two or more event years after ($\tau \geq 2$) are grouped. D_i is a dummy variable indicating whether the teacher is promoted and $\mathbb{1}[\tau]$ is an indicator function equal to 1 in τ. The year before treatment is omitted.

From Figure 10, which plots the parameters γ_τ and θ_τ, we see a clear jump in wages the year the teacher becomes promoted relative to the year prior to promotion. The higher wage is persistent, but does not appear to grow, over time. The non-zero effect prior to promotion suggests that the wage trajectories for promoted and non-promoted individuals are nearly but not exactly parallel; those who are selected for promotion appear to be on a slightly higher wage trend.



(a) ln(wage) (b) Monthly wage (SEK)

Figure 10: Dynamic effects in wage outcomes

Note: Figure 10 displays the coefficients γ_τ and θ_τ from the regression $\ln(w_{ist}) = \alpha_i + \delta_s + \lambda_t + \sum_{\tau \leq -3}^{-2} \gamma_\tau D_i \mathbb{1}[\tau] + \sum_{\tau=0}^{\geq 2} \theta_\tau D_i \mathbb{1}[\tau] + \beta X_{ist} + \epsilon_{ist}$. τ denotes the time relative to when the individual first became a career teacher, which occurs when τ equals 0. $\tau - 1$ is omitted. D_i is a dummy variable indicating career teacher status. Controls included in X_{ist} are dummies for female, certification, permanent contract, age (in five age bands), level of education (in one of four categories), field of specialisation (in one of six categories), experience (in five bands) and tenure (in five bands). Standard errors are clustered at school district level.

3.3 Impact of promotions on teacher separations, composition and student performance

The results from section 3.2 suggest that the career teacher reform had a substantial impact on the wages of promoted teachers. In this section we examine its impact on teacher separations, teacher composition and student performance. To this end, we use data on outcomes aggregated to the school-level, and rely on variation in the *timing* of participation across schools, which we show below appears to be unrelated to observable school characteristics.

We first discuss the empirical model and the validity of the identifying assumptions in section 3.3.1. Section 3.3.2 present results on teacher turnover while Section 3.3.3 tests the robustness of our results. Section 3.3.5 focuses on teacher composition and 3.3.6 finally looks at student performance.

3.3.1 Empirical strategy and identification

An empirical challenge we face is the lack of a natural control group: all school districts can potentially participate in the reform, and the extent to which they can potentially participate is determined by their share of students (see Section 2.2). Indeed, all but one school district in our sample participates and there is limited variation in the timing of participation.

We estimate the impact of the new career opportunities using school-level variation, rather than school district-level variation, in the appointment of career teachers. More specifically, we employ a difference-in-differences strategy that compares outcomes such as the separation rate in schools that have at least one career teacher to schools that do not (never or yet) have career teachers. In particular, we estimate models of the following form:

$$y_{st} = \gamma CT_{st} + \delta_s + \lambda_t + \beta X_{st} + \epsilon_{st} \tag{5}$$

y_{st} is the outcome of interest in school s in year t and CT_{st} is a variable indicating if school s has at least one career teacher in year t (i.e. if it has participated in the reform in year t). We also report results when we use the fraction of career teachers at the school in year t relative to the total number of teachers in $t-1$ as CT_{st} to address that treatment intensity may vary across schools.[28] Furthermore, we control for the number of students in year t as the share of teachers in $t-1$ (i.e. the student to teacher ratio) and the log number of students in t, captured by X_{st}. Finally. δ_s and λ_t are school and year fixed effects respectively.

The empirical strategy will identify relative differences in outcomes across schools rather than aggregate effects on school quality. It relies on the assumption that, in absence of the reform, the outcome variable would have evolved in parallel in participating and non-participating schools. For our empirical strategy to work, the timing of when the reform is implemented at specific schools must be uncorrelated with other determinants of the outcome that we do not control for.

[28] We compute the share using lagged number of teachers as separations may be affected by the reform.

School districts decide how to allocate the career teaching positions across schools in their district – participation is not random. There is potential selection both with regards to which schools participate and when they participate. Reassuringly, the results in Table 2 suggest that no (lagged) observable school characteristics besides school size systematically predict the probability of participating in the reform in a given year. To further assess the identifying assumption, we consider whether any factors predict the *timing* of participation, conditional on having at least one promoted teacher between 2013 and 2016. In particular, we are interested in whether pre-reform school characteristics are orthogonal to the year of first participation, conditional on sometime participating in the reform. To this end, we estimate the regression separately by year:

$$Year_{st} = \beta_t X_{st-1} + \epsilon_{st} \tag{6}$$

where $Year_{st}$ is equal to the year that the school first participates (i.e. a year in the interval 2013 to 2016).[29] The results, included in Appendix Table B.4, suggest that schools with more students first participate earlier. No other factors appear to systematically influence the timing of participation. We control for the log number of students and the student-to-teacher ratio in the regressions below.

To further assess the validity of the identifying assumption, we also perform an event-study analysis to try to rule out pre-participation trend differences in wages and separation rates between teachers in promoting and non-promoting schools using a dynamic version of equation (3):

$$y_{st} = \sum_{\tau} \gamma_{\tau} D_s \mathbb{1}[\tau] + \delta_s + \lambda_t + \beta X_{st} + \epsilon_{st} \tag{7}$$

The results of this analysis, which suggests parallel trends pre-treatment, are included in Figure 12.

3.3.2 Results on teacher turnover

Table 5 shows the γ coefficients obtained when estimating the model given by equation 5. We focus on four outcomes. First, in column 1 we again confirm that the implementation of the new career step translates into a wage difference between promoting and non-promoting schools; the effect is of similar size as in section 3.2. We also see increased wage dispersion in schools with career teachers (see column 2). In columns 3 and 4 we consider separations and exits from teaching. In column 3, we look at school separations in general. Our results suggest that schools with at least one career teacher have a one percentage point lower separation rate, which corresponds to roughly four percent. In column (4), we focus on the

[29] This analysis was inspired by Deshpande and Li (2018) who provide a similar analysis to assess the systematic factors predicting the timing of closings of Social Security Administration field offices. It has many parallels to the methodology in Jackson (2010) who uses variation in the time of adoption to analyze a program in Texas that pays students and teachers for passing Advanced Placement exams.

fraction of teachers exiting the teaching occupation. This effect is also negative, but smaller in magnitude and not statistically significant.[30]

In Panel B, we show results when we take the treatment intensity into account by relating the outcomes of interest to the fraction of career teachers at the school-level. While this model gives us more variation, it also requires that the "share of promoted teachers" at the school level is exogenous. Bearing this in mind, the estimates suggest that increasing the share of career teachers by 10 percent at a school is associated with a reduction in the separation rate by around two percentage points, or nine percent.

Table 5: Wages and separations in participating vs. non-participating schools

	(1)	(2)	(3)	(4)
	Log wages	Wage dispersion	Separations	Exits
Panel A:				
At least one CT at school	0.019***	0.004***	-0.010*	-0.004
	(0.001)	(0.000)	(0.005)	(0.003)
R^2	0.914	0.583	0.339	0.238
N	17,689	17,689	17,689	17,689
Panel B:				
Share CT at school	0.165***	0.024***	-0.207***	-0.057***
	(0.007)	(0.001)	(0.025)	(0.015)
R^2	0.921	0.596	0.345	0.239
N	17,689	17,689	17,689	17,689
Year FE:s	Yes	Yes	Yes	Yes
School FE:s	Yes	Yes	Yes	Yes
School controls	Yes	Yes	Yes	Yes
Mean dep. var.	10.287	0.012	0.230	0.113

Note: In the table, we relate the change in the presence of career teachers within a school in year t to the change in mean wages (col. 1), wage dispersion (col. 2), school separations (col 3) and exits (col 4) (see Section 2.3 for the exact definition of these variables). Share CT at school is defined as the number of CT in t divided by the number of teachers in $t-1$. School controls included are the number of students in year t as share of the number of teachers in $t-1$ (i.e. the student to teacher ratio) and log number of students. Standard errors are clustered by school district.

[30]In Appendix Table C.1 and C.2, we show that results without school controls are very similar to those presented here.

Figure 12 plots γ_τ from equation 7. Reassuringly, outcomes evolve very similarly in promoting/non-promoting schools prior to the implementation of the new career step. It is also clear that the responses grow over time, which is likely to reflect that the number of career teachers increases after the first year of participation in the reform.

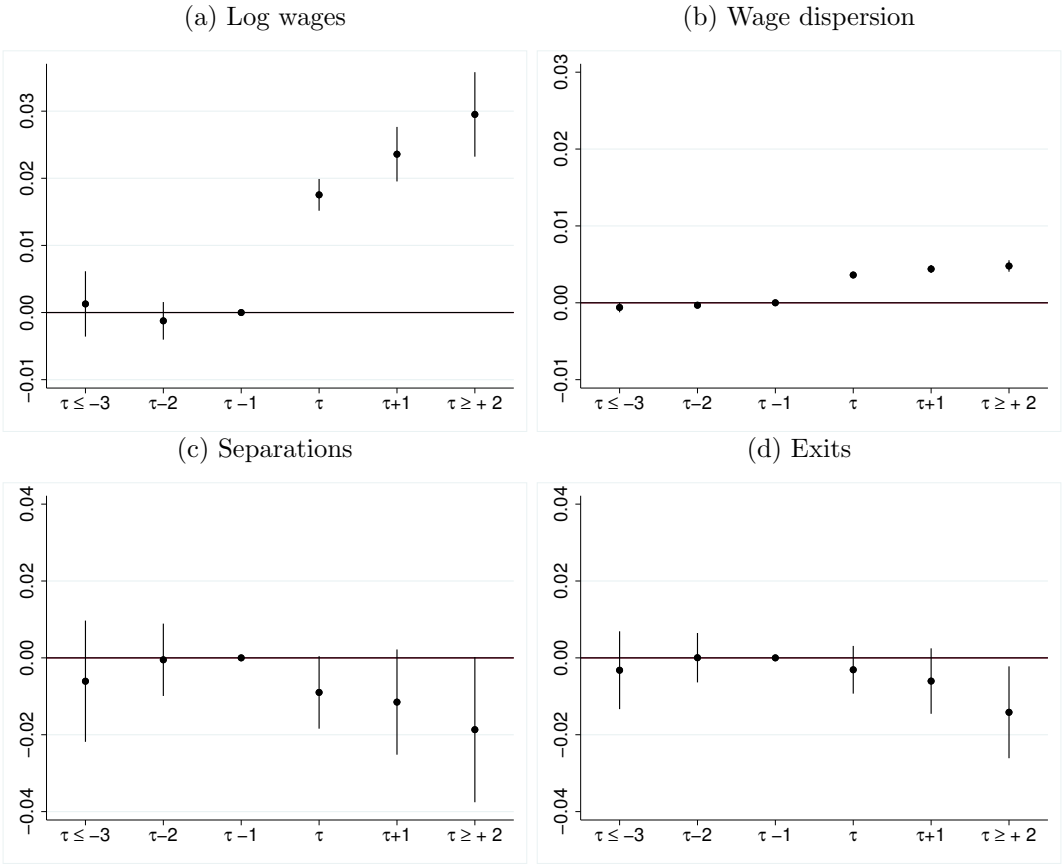


Figure 12: Dynamic responses

Notes: The figure plots the γ-coefficients from eq. 7. It shows the evolution of log wages, wage dispersion, school separations and exits from the teaching professions within schools before and after promoting at least one career teacher. $\tau - 1$ omitted.

3.3.3 Sensitivity analysis

Appendix C presents a number of robustness checks to study the sensitivity of our results to alterations of the empirical model. Table C.1 shows the results when the treatment is implementing the reform at the school (hiring at least one career teacher) whereas Table C.2 instead considers the share of teachers at the school that have been promoted. Panel A of Tables C.1 and C.2 first reports the baseline results from Table 5. To recap, we find that an increased share of promoted teachers is associated with higher wages and wage dispersion (columns 1 and 2) and lower teacher turnover (columns 3 and 4).

In Panel B we omit the time-varying school controls (i.e. the number of students and the student/teacher ratio); in Panel C we restrict the comparison to outcomes among teachers who were eligible for the career-teacher promotions, i.e. to certified teachers with at least four years of teaching experience; in Panel D we weight the regressions with the number of teachers in $t-1$, and in Panel E we restrict the comparison to schools that had at least one career teacher during 2013–2016. We conclude that the results are very stable across these different models and samples for both treatment variables.

Finally, Figure C.1 shows how the within-school wages and wage dispersion evolves before and after the promotion of a career teacher when we exclude the last year in our observation period, 2016. In 2016, the Swedish government launched yet another reform stipulating a pay increase to teachers (the so-called "Lärarlönelyftet"). This reform also aimed at increasing wage dispersion, and implied a general wage increase to half of the teaching pool financed by ear-marked money from the state. It was up to the school principals to decide which teachers to reward. It should be noted that the introduction of this reform would only invalidate our empirical strategy if it interacts with the career teacher reform. However, as shown by Figure C.1 we find very similar wage patterns when we exclude 2016, which suggests that this was not the case.[31]

3.3.4 Heterogeneity analysis

To better understand whether our results differ by type of school district, we have performed two types of heterogeneity analysis. First, we have estimated equation 5 separately for urban and rural school districts.[32] The results of this analysis, presented in Appendix Table B.7, show that the wage effects are very similar across urban and rural school districts. Given that schools have closely followed the rules stipulated by the reform, this is not surprising. The results on separations, on the other hand, suggest that the reduction in separations is largely driven by schools located in urban areas. For schools in urban areas, participating in the reform reduced separations by approximately 1.7 percentage points, or 7 to 8 percent. For schools in rural areas, the result is marginally negative but statistically insignificant.

[31] The same is true for the wage effects of promotion for individual teachers, i.e. the results discussed in Section 3.2. Results are available upon request.

[32] Urban and rural are defined using Eurostat's degree of urbanisation (degurba) variable, see Table B.7 for details.

The results that consider treatment intensity – share of teachers promoted – find negative and statistically significant effects for both urban and rural areas, but the effects in urban ares are of a magnitude 1.5 times higher than those in rural areas.

The second heterogeneity analysis focuses on school districts that appear to follow an explicit decision rule. As explained in Section 2.2, career teaching positions were allocated across school districts nationally using the school district's share of students. Figure A.2 shows that there is much more variation within school districts – school districts have not systematically followed this rule to allocate positions across schools. Nevertheless, the extent to which this rule is used may differ by school district. To identify school districts that allocate positions across schools according to this rule, we correlate the share of career teachers with the share of students within school districts. The distribution of the correlation coefficient is included in Figure B.1. We then estimate equation 5 for schools that are above the 50th and the 75th percentile of correlation coefficients. The results, presented in Appendix Table B.8, show that there is little heterogeneity irrespective of whether the school district allocated positions according to a rule or not.

To understand how the results differ for different types of teachers, we perform an additional type of heterogeneity analysis. In particular, we calculate the four outcomes (log wages, wage dispersion, share separate and share exit) separately for junior and senior teachers.[33] We then estimate equation 5 using the outcomes for senior and junior teachers respectively. The results, presented in Appendix Table B.9, show that the effects of the reform are driven by the senior teachers. In particular, it is wages and wage dispersion for senior teachers that respond positively to the reform, and it is senior teachers who quit to a lower extent. This is in line with the reform's design, which was targeted at more experienced teachers.

3.3.5 Teacher composition

Since our results suggest a reduction in teacher turnover in response to the career teacher promotions, it is interesting to also consider compositional effects. Table shows the γ estimates from equation 5 for each of four teacher composition outcomes: the fraction of certified teachers, the fraction experienced teachers, the median years of experience among teachers per school, and teacher average compulsory school grades. The corresponding event study results are shown in Figure B.2 in the appendix.

The results suggest a positive impact on the quality of the teaching pool within schools that have career teachers but the magnitudes are fairly small: a ten percent increase in the fraction of promoted teachers is associated with an increase in the fraction of certified and experienced teachers by between 0.5 and 1 percent and an increase in average teacher grades.[34]

[33] We define senior teachers as those with at least five years of teaching experience.

[34] As explained in Section 2.3, we only have teacher grades for a subset of teachers. When we restrict the sample to those teachers for which we have teacher grades, we find similar effects of the reform on share certified and share experienced. Results are available upon request.

Table 6: Teacher composition

	(1)	(2)	(3)	(4)
	Certified	Experienced	Med. experience	Teacher grades
Panel A:				
At least one CT at school	0.005***	0.007*	0.361***	0.027***
	(0.002)	(0.004)	(0.135)	(0.010)
R^2	0.627	0.468	0.620	0.608
N	17,689	17,689	17,689	17,057
Panel B:				
Share CT at school	0.060***	0.101***	2.229***	0.149***
	(0.010)	(0.021)	(0.670)	(0.054)
R^2	0.628	0.470	0.621	0.608
N	17,689	17,689	17,689	17,057
Year FE:s	Yes	Yes	Yes	Yes
School FE:s	Yes	Yes	Yes	Yes
School controls	Yes	Yes	Yes	Yes
Mean dep. var.	0.920	0.874	13.24	0.561

Note: In the table, we relate the effect of introducing the reform in a school in year t to the change in the share of certified teachers (col. 1), the share of experienced teachers, defined as the share with at least four years of experience (col. 2), the average (median) level of experience at the school (col. 3), and the average grades among teachers (col. 4). Share CT at school is defined as the number of CT in t divided by the number of teachers in $t-1$. School controls included are the number of students in year t as share of the number of teachers in $t-1$ (i.e. the student to teacher ratio) and log number of students.

3.3.6 Impact of promotions on student performance

Finally, we look at student performance. The fact that the reform had a substantial impact on teacher wages and wage dispersion, a negative response on teacher separations and a small positive response on teacher composition implies that the career teacher reform may also affect student outcomes via teacher quality (through teacher sorting or effort). Jackson and Bruegmann (2009) and Papay et al. (2016) find a positive influence of the quality of teacher peers on student outcomes, suggesting that also the quality of non-promoted teachers can be affected by the reform. In addition, career teachers are generally also tasked with improving teaching practices, to be a mentor, and to lead pedagogical development projects at their schools.

As described in the data section, we measure student performance using standardized test scores on national exams in Math, English and Swedish at different grade levels.[35] While

[35]Note that Chetty, Friedman, and Rockoff (2014) show that teachers who improve test scores improve

we can link teachers to students using the school identifier, unfortunately we cannot match teachers to classes. However, to make the analysis more precise, we can use information about the teachers' subject and tier of teaching in order to associate the standardized result from the subject-specific national exams in grade 3, 6 and 9 on subject and teaching level-specific reform variables.[36]

Table 7 displays the γ estimates from equation 5 when we use average student test scores in different grades and subjects as the outcome of interest. The results suggest that a higher fraction of promoted teachers is associated with higher student performance in grades three and six. To appreciate the size of these effects, consider a school with three parallel classes in the lower tier (grade 1-3) where one of the three class teachers (teaching both Swedish and Math) in each parallel class is promoted to career teacher. The results suggest that this would increase the school's grade 3 national exam scores in Swedish and Math with around 3 percent of a standard deviation.[37] The results for grade 6 are similar in magnitude for Math, but somewhat smaller for English and Swedish.[38] In a placebo analysis, presented in Appendix C Table C.3, we include the lead share of promoted subject teachers in addition to the share of promoted subject teachers. The main effect is very similar to that in Table 7, while the coefficient on the lead is neither significant in grade 3 nor in grade 6. This lends support to the promotions leading to improved test performance in line with the aforementioned results.[39]

As a comparison, it is instructive to note that Rockoff (2004) finds that raising teacher quality by one standard deviation translates into 0.10 standard deviation increase in student test scores; Fryer (2017) finds that 300 hours of principal training, including coaching and feedback to teachers improves test scores by 0.10 standard deviations. In this respect, our results suggest a non-negligible impact of career teachers on student performance. Our results also resonate with the finding of Jackson and Bruegmann (2009) that about 20 percent of the teacher effectiveness is due to the influence from teachers' peers during the previous three years.

students' high school completion, college attendance, and earnings, which supports that teachers' impact on students' test scores is a relevant outcome in this case

[36]This is defined as having at least one career teacher in a specific subject (Maths, English, Swedish) and teaching tier (grade 1-3, grade 4-6, grade 7-9), or alternatively as the number of subject and teaching tier career teachers at the school in year t as a share of the number of subject and teaching tier teachers in $t-1$.

[37]The average number of career teachers in 2016 teaching Swedish and Math in the lower tier (grade 1-3) is 24 and 25 percent.

[38]In Table C.3 in Appendix C we show the estimates obtained when we instead relate student performance to (i) the number of promoted teachers as a fraction of all teachers in $t-1$, or (ii) the presence of at least one career teacher, irrespective of subject and level.

[39]We have also performed an event-study that is included in Appendix B Figure B.3. Treatment is defined as having at least one promoted teacher in the specific subject and level. With the exception of Math and English in the treatment year in grade 6, no coefficients are statistically significantly different from 0. Note, however, that we have worse precision for this analysis. We lack student test scores for 2016 and therefore the analysis only uses data until 2015. Moreover, the analysis is split by subject and grade.

Table 7: Student performance

	Grade 3		Grade 6			Grade 9		
	Maths	Swedish	Maths	English	Swedish	Maths	English	Swedish
Panel A								
At least one subject CT at school	0.015	0.023**	0.035***	0.018*	0.022*	-0.009	0.009	0.015
	(0.014)	(0.010)	(0.012)	(0.010)	(0.012)	(0.013)	(0.011)	(0.012)
R^2	0.465	0.489	0.596	0.585	0.583	0.681	0.727	0.697
N	12,599	12,608	10,566	10,564	10,572	5,263	5,267	5,270
Panel B								
Subject CT as share of subject teachers	0.094**	0.096***	0.111***	0.056**	0.082***	0.002	0.037	0.049
	(0.039)	(0.028)	(0.029)	(0.025)	(0.030)	(0.032)	(0.027)	(0.031)
R^2	0.465	0.489	0.597	0.585	0.583	0.680	0.727	0.697
N	12,596	12,607	10,560	10,552	10,565	5,259	5,266	5,265
Year FE:s	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School FE:s	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
School controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: In the table we regress the standardised result from the subject-specific national exams on subject & teaching level-specific reform variables. In Panel A we use the presence of at least one subject & level teacher at the school. In Panel B we use the number of subject (Maths, English, Swedish) & teaching level (grade 1-3, grade 4-6, grade 7-9) career teachers at the school in year t as a share of subject & level teachers in $t-1$. School controls are log number of students as well as the number of students in t over the number of teachers in $t-1$. The results of the national exams are standardised by year and subject to have mean 0 and st.d. 1. Each school obtains a mean standardised score. Standard errors are clustered at school district level.

4 Conclusions

Despite the wide-spread interest in the determinants of student outcomes among policy-makers and researchers, evidence on how policies aimed at improving the teaching pool impacts teachers and students remains scarce. One likely reason is the rigidity of the teacher labor market in many countries, which often prevents large-scale interventions. We contribute to this gap in the literature by analyzing the impact of a Swedish reform which introduced a new career step for teachers starting in 2013. The reform allowed schools to promote particularly talented teachers to a new title ("career teacher") with a substantial associated wage increase financed entirely through ear-marked state funding. The reform intended to reward talented teachers, to increase the attractiveness of the profession through higher wage dispersion, and to take advantage of professional competence. While the allocation of the number of promotions across school districts was rules-based, the school districts had discretion over the allocation of promotions across schools and teachers within each district.

The paper provides evidence on the response to this reform, both in terms of the teachers selected for promotion and the impact it had on wage structure, teacher separations and student performance. Our estimates capture the overall impact of the promotion program, which entails both higher pay and increased responsibilities for planning the pedagogical work and coaching other teachers. We show that the allocation of teacher promotions across schools is related to school size but unrelated to other pre-determined school characteristics such as teacher turnover rates. Within schools, high-wage teachers were more likely to be promoted. Our interpretation is that principals complied with the intentions of the reform and promoted the most talented teachers.

The reform induced significant changes in teacher pay. The stipulated wage increase had full pass-trough onto promoted teachers' wages and lead to an increase in wage dispersion both within and across schools. Compared to schools that did not introduce the career step, we find that the promotion program led to a reduction in teacher separations and small but positive changes in the teaching pool, despite very similar trajectories before the reform. It is important to highlight that our estimates capture relative differences in teacher turnover (and other outcomes) across schools and not aggregate effects on school quality. Nevertheless, the fact that we find a reduction in the fraction of teachers exiting the teaching profession in schools with career teachers suggests that promotions can incentivize teachers to stay in the profession. We also find sizable effects on student test scores in Math, English and Swedish in grades 3 and 6: promoting a third of the grade 1-3 teachers in Math increases the test scores at the grade 3 national Math tests by 3 percent of a standard deviation. As a comparison, previous studies suggest that these effects are about a third of the size of improving teacher quality by one standard deviation, which we regard as fairly substantial effects. Together, our results lend support to that performance-based promotions could be an important tool for raising school quality.

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Appendix A: Supplementary description

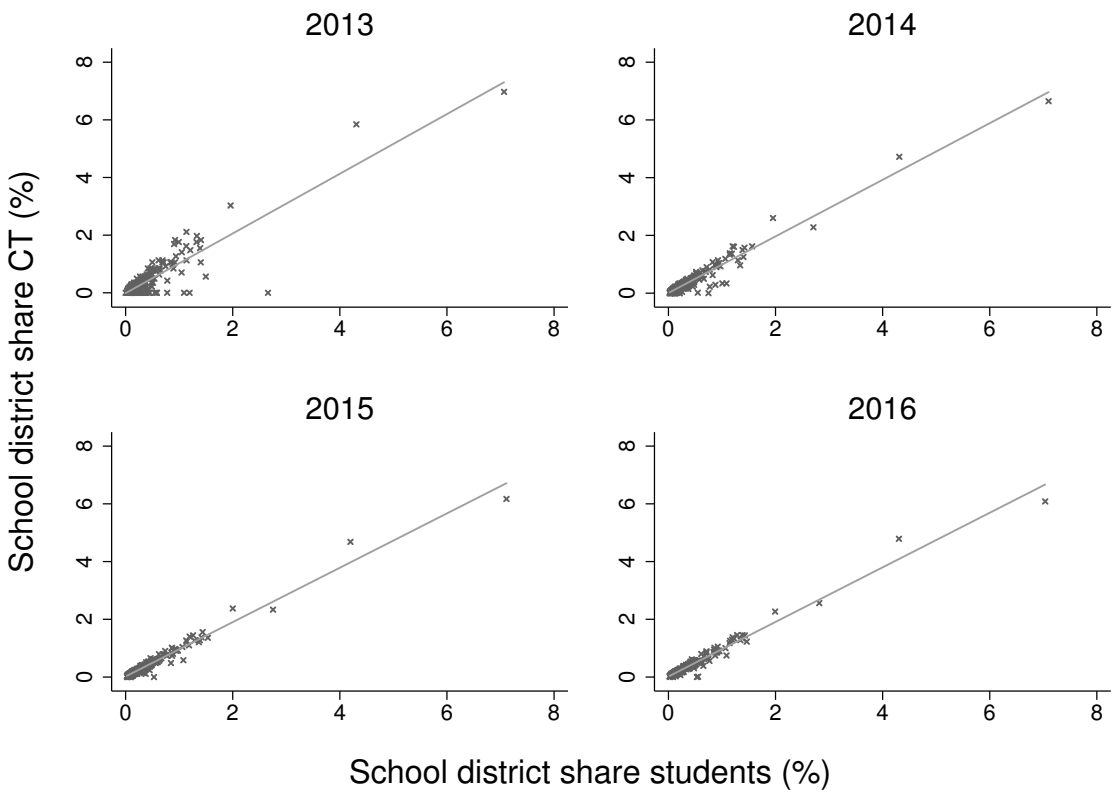

Figure A.1: Allocation of promotions across school districts - all school districts

Note: Based on data in our main sample. Municipal compulsory schools only. Each cross corresponds to one school district. The line is a linear prediction.

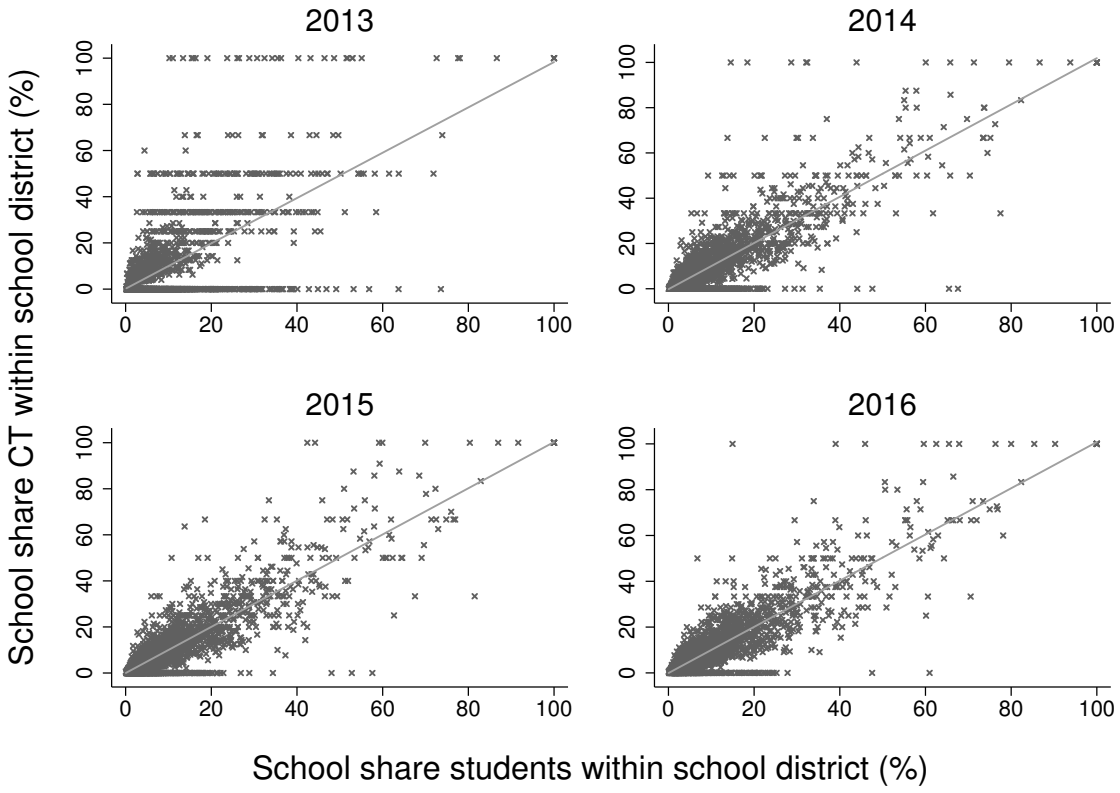

Figure A.2: Allocation of promotions within school districts

Note: Based on data in our main sample. Municipal compulsory schools only. Each cross corresponds to one school. The line is a linear prediction.

Table A.1: School summary statistics

	No CT		At least one CT	
	Mean	sd	Mean	sd
Year: 2013				
Nr career teachers	0.00	(0.00)	1.37	(0.68)
Nr teachers t-1	15.76	(11.26)	24.70	(13.03)
Nr students t-1	204.92	(140.32)	323.39	(169.24)
Student teacher ratio t-1	13.65	(3.27)	13.56	(3.04)
Share separate t-1	0.22	(0.15)	0.22	(0.12)
Share exit t-1	0.11	(0.10)	0.11	(0.08)
N	1,911		1,039	
Year: 2014				
Nr career teachers	0.00	(0.00)	2.23	(1.49)
Nr teachers t-1	10.64	(8.35)	18.31	(11.45)
Nr students t-1	145.42	(111.07)	243.70	(147.15)
Student teacher ratio t-1	14.36	(4.41)	13.95	(3.80)
Share separate t-1	0.23	(0.17)	0.23	(0.15)
Share exit t-1	0.11	(0.12)	0.11	(0.10)
N	673		1,238	
Year: 2015				
Nr career teachers	0.00	(0.00)	1.56	(0.88)
Nr teachers t-1	8.89	(7.04)	13.48	(9.01)
Nr students t-1	125.29	(104.26)	187.20	(121.69)
Student teacher ratio t-1	14.64	(4.43)	14.53	(3.77)
Share separate t-1	0.24	(0.18)	0.23	(0.15)
Share exit t-1	0.11	(0.13)	0.11	(0.11)
N	418		255	
Year: 2016				
Nr career teachers	0.00	(0.00)	1.40	(0.70)
Nr teachers t-1	7.96	(6.36)	11.41	(7.17)
Nr students t-1	117.74	(109.16)	161.63	(95.47)
Student teacher ratio t-1	14.89	(4.37)	14.81	(4.04)
Share separate t-1	0.26	(0.20)	0.24	(0.17)
Share exit t-1	0.12	(0.14)	0.11	(0.11)
N	314		104	

Note: In each year, we only include schools that have not (never or yet) participated as well as schools that participate for the first time.

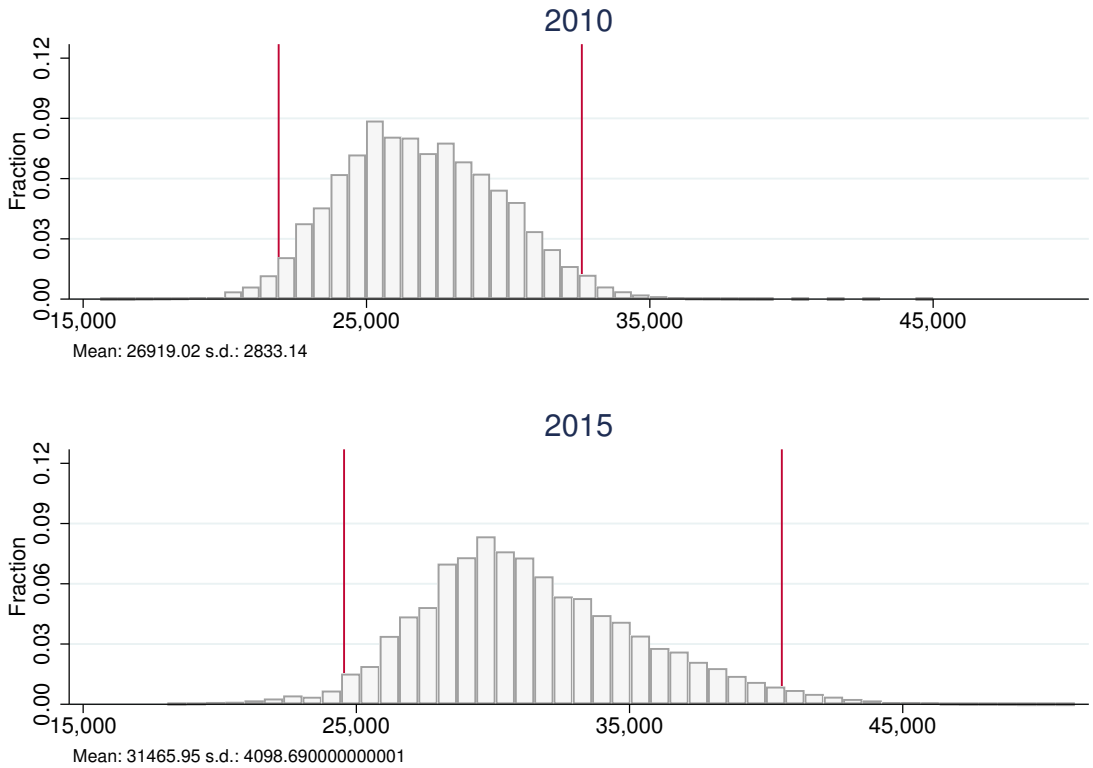

Figure A.3: Teacher wage distribution including 95% CI (2010 and 2015)

Appendix B: Additional results

Table B.1: Factors that predict selection of schools

	Share CT at school			
	2013	2014	2015	2016
School characteristics in $t-1$:				
Log nr students	0.001	0.008**	0.000	-0.005
	(0.002)	(0.004)	(0.006)	(0.009)
Student-to-teacher ratio	0.000	-0.000	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Separation rate	-0.000	-0.022	0.014	0.009
	(0.010)	(0.022)	(0.037)	(0.048)
Exit rate	-0.003	0.039	0.021	-0.046
	(0.015)	(0.027)	(0.045)	(0.045)
Certified (share)	0.014	0.036	0.078*	-0.029
	(0.015)	(0.034)	(0.044)	(0.041)
Female (share)	0.006	0.022	-0.030	-0.006
	(0.008)	(0.023)	(0.034)	(0.034)
Mean age (years)	-0.001*	-0.001	-0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.002)
Mean experience (years)	0.000	0.000	0.001	-0.001
	(0.001)	(0.001)	(0.002)	(0.001)
Maths/natural science (share)	-0.008	-0.003	-0.056*	0.018
	(0.010)	(0.027)	(0.030)	(0.034)
Swedish/social science (share)	0.004	0.024	-0.010	0.068**
	(0.009)	(0.020)	(0.032)	(0.029)
District FE	Yes	Yes	Yes	Yes
R^2	0.183	0.253	0.404	0.458
N	2,941	1,882	611	346
Mean dep. var.	.02	.09	.05	.04

Note: This presents the results of regressions of $CT_{sdt} = \phi_{dt} + \beta_t X_{sdt-1} + \epsilon_{sdt}$ where CT_{sdt} is a variable equal to the share of career teachers at the school in year t. Variables are measured at school level. Regressions are estimated separately by year and only include schools that have not (never or yet) participated as well as schools that participate for the first time. Standard errors are clustered at school district level.

Table B.2: Factors that predict selection of schools – with student test scores

	At least one CT at school				Share CT at school			
	2013	2014	2015	2016	2013	2014	2015	201
Panel A: Includes 3rd grade test results								
Log nr students	0.228***	0.302***	0.234***	0.144***	0.001	0.008*	0.002	-0.0
	(0.021)	(0.018)	(0.046)	(0.046)	(0.002)	(0.004)	(0.007)	(0.0
Student-to-teacher ratio	-0.009***	-0.010***	0.000	-0.005	0.000	-0.000	0.001	0.0
	(0.003)	(0.003)	(0.007)	(0.006)	(0.001)	(0.001)	(0.001)	(0.0
Separation rate	0.009	-0.068	0.003	0.252	0.004	-0.024	0.005	0.0
	(0.088)	(0.095)	(0.217)	(0.222)	(0.010)	(0.023)	(0.044)	(0.0
Exit rate	-0.084	0.213	0.051	-0.312	-0.008	0.054*	0.026	-0.0
	(0.110)	(0.133)	(0.232)	(0.230)	(0.015)	(0.029)	(0.048)	(0.0
Certified (share)	-0.109	0.192	0.134	-0.308	0.003	0.019	0.076*	-0.0
	(0.172)	(0.159)	(0.249)	(0.214)	(0.017)	(0.041)	(0.046)	(0.0
Female (share)	-0.029	0.270**	-0.129	0.047	0.009	0.047*	-0.028	-0.0
	(0.087)	(0.106)	(0.172)	(0.186)	(0.009)	(0.025)	(0.039)	(0.0
Mean age (years)	-0.007	-0.006	-0.002	0.011	-0.001	-0.001	-0.001	0.0
	(0.005)	(0.005)	(0.007)	(0.008)	(0.001)	(0.001)	(0.001)	(0.0
Mean experience (years)	0.003	0.001	0.002	-0.010	0.000	0.000	0.001	-0.0
	(0.005)	(0.005)	(0.008)	(0.008)	(0.001)	(0.001)	(0.002)	(0.0
Maths/natural science (share)	0.068	-0.072	-0.244	-0.083	-0.007	0.003	-0.068**	0.0
	(0.081)	(0.115)	(0.153)	(0.170)	(0.011)	(0.029)	(0.033)	(0.0
Swedish/social science (share)	0.133**	-0.009	-0.109	0.205	0.009	0.041*	-0.015	0.06
	(0.066)	(0.091)	(0.145)	(0.161)	(0.010)	(0.021)	(0.036)	(0.0
3rd grade maths score	-0.008	-0.047	0.020	0.081	-0.000	-0.002	0.012	0.0
	(0.021)	(0.029)	(0.043)	(0.069)	(0.003)	(0.006)	(0.009)	(0.0
3rd grade Swedish score	0.013	0.045	-0.039	-0.029	0.006	0.012*	-0.017	0.0
	(0.031)	(0.029)	(0.060)	(0.076)	(0.004)	(0.006)	(0.013)	(0.0
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Ye
R^2	0.360	0.415	0.481	0.586	0.194	0.272	0.417	0.4
N	2,509	1,635	543	307	2,509	1,635	543	30
Mean dep. var.	.35	.65	.38	.25	.02	.09	.05	.0
Panel B: Includes 6th grade test results								
Log nr students	0.210***	0.298***	0.255***	0.103*	-0.001	0.010**	0.007	-0.0
	(0.022)	(0.019)	(0.051)	(0.052)	(0.002)	(0.005)	(0.008)	(0.0
Student-to-teacher ratio	-0.009**	-0.008***	-0.002	-0.008	0.000	0.000	0.000	0.0

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Table B.2 – continued from previous page

	At least one CT at school				Share CT at school			
	2013	2014	2015	2016	2013	2014	2015	201
	(0.004)	(0.003)	(0.008)	(0.008)	(0.001)	(0.001)	(0.001)	(0.00
Separation rate	0.072	-0.197	0.329	0.551**	0.001	-0.044	0.070	0.06
	(0.081)	(0.120)	(0.241)	(0.233)	(0.011)	(0.029)	(0.046)	(0.05
Exit rate	-0.107	0.366**	-0.484	-0.615**	-0.010	0.074**	-0.091	-0.119
	(0.125)	(0.156)	(0.298)	(0.254)	(0.016)	(0.034)	(0.056)	(0.04
Certified (share)	-0.031	0.181	0.020	-0.452*	0.003	0.030	0.034	-0.0
	(0.162)	(0.166)	(0.292)	(0.248)	(0.016)	(0.041)	(0.058)	(0.05
Female (share)	-0.024	0.127	-0.207	0.093	0.002	0.042	-0.042	-0.0
	(0.087)	(0.120)	(0.189)	(0.202)	(0.010)	(0.028)	(0.040)	(0.03
Mean age (years)	-0.011**	-0.007	0.005	0.018*	-0.001**	-0.002*	0.001	0.004
	(0.005)	(0.006)	(0.008)	(0.009)	(0.001)	(0.001)	(0.002)	(0.00
Mean experience (years)	0.004	0.001	0.009	-0.007	0.000	0.001	0.002	-0.0
	(0.005)	(0.006)	(0.009)	(0.010)	(0.001)	(0.001)	(0.002)	(0.00
Maths/natural science (share)	-0.091	-0.142	-0.247	-0.182	-0.020	-0.023	-0.047	-0.0
	(0.101)	(0.132)	(0.197)	(0.260)	(0.015)	(0.034)	(0.040)	(0.04
Swedish/social science (share)	0.140*	-0.055	0.333*	-0.054	0.006	0.029	0.096**	0.03
	(0.078)	(0.119)	(0.177)	(0.216)	(0.010)	(0.026)	(0.041)	(0.04
6th grade maths score	-0.035	-0.001	0.122	-0.025	-0.005	0.009	0.011	0.00
	(0.033)	(0.047)	(0.074)	(0.068)	(0.004)	(0.010)	(0.013)	(0.01
6th grade English score	0.007	0.006	-0.072	0.001	-0.002	-0.004	-0.008	-0.0
	(0.036)	(0.046)	(0.079)	(0.074)	(0.005)	(0.010)	(0.015)	(0.01
6th grade Swedish score	0.015	-0.028	-0.117	0.046	0.006	-0.009	-0.006	0.00
	(0.029)	(0.047)	(0.084)	(0.085)	(0.004)	(0.010)	(0.015)	(0.01
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Ye
R^2	0.397	0.450	0.585	0.629	0.217	0.287	0.504	0.55
N	2,041	1,280	390	206	2,041	1,280	390	20
Mean dep. var.	.35	.65	.38	.25	.02	.09	.05	.04

Note: This presents the results of regressions of $CT_{sdt} = \phi_{dt} + \beta_t X_{sdt-1} + \epsilon_{sdt}$ where CT_{sdt} is a dummy equal to 1 if the school partici in the reform in year t in the first four columns, and a variable equal to the share of career teachers at the school in year t in the las columns. Variables are measured at school level. Regressions are estimated separately by year and only include schools that have not (or yet) participated as well as schools that participate for the first time. Standard errors are clustered at school district level.

Table B.3: Selection of teachers for promotion

	(1)	(2)	(3)
Female	0.012***	0.010***	0.006**
	(0.001)	(0.001)	(0.003)
Age			
30-39	0.012***	-0.003	-0.006**
	(0.002)	(0.002)	(0.003)
40-49	-0.000	-0.025***	-0.025***
	(0.003)	(0.003)	(0.005)
50-59	-0.039***	-0.069***	
	(0.003)	(0.003)	
60 and over	-0.072***	-0.109***	
	(0.003)	(0.004)	
Experience			
4-9	0.049***	0.024***	0.021***
	(0.002)	(0.002)	(0.003)
10-14	0.080***	0.028***	0.013***
	(0.002)	(0.003)	(0.005)
15-24	0.082***	0.014***	-0.001
	(0.003)	(0.003)	(0.007)
25 and over	0.084***	-0.009**	
	(0.003)	(0.004)	
Tenure			
2-5		0.016***	0.021***
		(0.002)	(0.003)
5-10		0.029***	0.037***
		(0.003)	(0.004)
10-15		0.029***	0.044***
		(0.003)	(0.005)
15 and over		0.030***	0.037***
		(0.003)	(0.008)
Level of education			
Upper secondary		0.017	
		(0.045)	
Post-secondary		0.003	0.056**
		(0.043)	(0.026)
Doctoral		0.006	0.112**
		(0.045)	(0.052)

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Table B.3 – continued from previous page

	(1)	(2)	(3)
Field of specialization			
Swedish and social sciences		-0.006***	-0.004
		(0.002)	(0.004)
Languages		-0.011***	-0.009
		(0.003)	(0.006)
Vocational		-0.031***	-0.029***
		(0.002)	(0.005)
Other teaching		-0.023***	-0.015***
		(0.002)	(0.003)
Non-teaching		-0.028***	-0.027**
		(0.004)	(0.012)
School wage decile			
2nd decile		0.007***	0.010***
		(0.002)	(0.003)
3rd decile		0.018***	0.019***
		(0.002)	(0.003)
4th decile		0.031***	0.037***
		(0.002)	(0.004)
5th decile		0.048***	0.055***
		(0.003)	(0.004)
6th decile		0.068***	0.081***
		(0.003)	(0.006)
7th decile		0.086***	0.111***
		(0.004)	(0.007)
8th decile		0.107***	0.154***
		(0.004)	(0.009)
9th decile		0.128***	0.205***
		(0.004)	(0.015)
10th decile		0.156***	0.280***
		(0.006)	(0.024)
Teacher 9th grade GPA			
-1 to -0.5			0.009
			(0.010)
-0.5 to 0			0.007
			(0.008)
0 to 0.5			0.013
			(0.008)
0.5 to 1			0.013
			(0.008)

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Table B.3 – continued from previous page

	(1)	(2)	(3)
Greater than 1			0.020**
			(0.008)
Constant	-0.006**	-0.005	-0.082***
	(0.003)	(0.044)	(0.025)
Year × school FE	Yes	Yes	Yes
R^2	0.118	0.143	0.277
N	156,882	156,804	54,880

Note: This shows the results of the OLS regression $CT_{ist} = \beta X_{ist-1} + \delta_s \times \lambda_t + \epsilon_{ist}$. Omitted categories are "Under 30" (Age), "Under 4" (Experience), "Under 2 (Tenure), "Compulsory" (Level of education), "Maths and natural sciences" (Field of educational specialization), "1" (Wage decile), and "Less than -1" (Teacher GPA). Regressions are pooled across 2013 to 2016, estimated for certified teachers only and and censored to include only the first year of becoming a career teacher. As we only have data on teacher's 9th grade GPA from 1988 onward, the sample size that includes this variable is smaller than in the other specifications. Standard errors are clustered at school district level.

Table B.4: Factors that predict timing of participation

	2013	2014	2015
School characteristics in $t-1$*:*			
Log nr students	-0.358***	-0.216***	-0.078
	(0.032)	(0.025)	(0.051)
Student-to-teacher ratio	0.016***	0.012**	0.003
	(0.006)	(0.005)	(0.009)
Separation rate	0.008	-0.079	0.015
	(0.158)	(0.140)	(0.301)
Exit rate	0.009	-0.107	-0.188
	(0.198)	(0.180)	(0.324)
Certified (share)	-0.020	-0.367	-0.225
	(0.249)	(0.243)	(0.414)
Female (share)	0.036	-0.164	0.045
	(0.139)	(0.142)	(0.216)
Mean age (years)	0.022**	0.011	-0.002
	(0.009)	(0.007)	(0.012)
Mean experience (years)	-0.009	0.000	0.000
	(0.008)	(0.007)	(0.011)
Maths/natural science (share)	0.002	0.037	0.166
	(0.168)	(0.163)	(0.216)
Swedish/social science (share)	0.082	0.205*	0.118
	(0.118)	(0.111)	(0.253)
District FE	Yes	Yes	Yes
R^2	0.362	0.366	0.536
N	2,620	1,562	297

Note: This presents results of the OLS regressions of $Year_{st} = \beta_t X_{st-1} + \epsilon_{st}$ where $Year_{st}$ is equal to the year that the school first has promoted a career teacher. Regressions are estimated separately by year, as indicated by the column headings. Regressions only include schools that at some point participate in the reform between 2013 and 2016, and that at the earliest participate in the year indicated by the column heading. Standard errors are clustered at school district level.

Table B.5: Factors that predict timing of participation – with student test scores

	2013	2013	2014	2014	2015	2015
School characteristics in $t-1$:						
Log nr students	-0.383***	-0.360***	-0.244***	-0.239***	-0.094	-0.163***
	(0.033)	(0.039)	(0.030)	(0.035)	(0.057)	(0.060)
Student-to-teacher ratio	0.016**	0.012	0.010**	0.005	0.000	0.009
	(0.006)	(0.008)	(0.005)	(0.005)	(0.009)	(0.013)
Separation rate	0.063	-0.080	-0.013	0.121	-0.072	-0.680*
	(0.172)	(0.172)	(0.151)	(0.197)	(0.327)	(0.373)
Exit rate	-0.017	0.074	-0.231	-0.348	-0.026	0.570
	(0.214)	(0.238)	(0.207)	(0.229)	(0.330)	(0.463)
Certified (share)	0.234	-0.009	-0.309	-0.168	-0.082	-0.249
	(0.262)	(0.276)	(0.249)	(0.263)	(0.506)	(0.568)
Female (share)	-0.101	0.114	-0.225	-0.039	-0.079	0.396
	(0.178)	(0.179)	(0.175)	(0.185)	(0.274)	(0.243)
Mean age (years)	0.021**	0.031***	0.014*	0.018*	0.005	0.019
	(0.009)	(0.009)	(0.008)	(0.010)	(0.012)	(0.013)
Mean experience (years)	-0.012	-0.017*	-0.003	-0.009	-0.006	-0.025*
	(0.009)	(0.009)	(0.008)	(0.010)	(0.011)	(0.014)
Maths/natural science (share)	-0.081	0.213	0.017	0.182	0.229	0.710**
	(0.175)	(0.215)	(0.172)	(0.204)	(0.239)	(0.273)
Swedish/social science (share)	-0.044	0.031	0.093	0.174	0.063	-0.238
	(0.128)	(0.165)	(0.118)	(0.160)	(0.271)	(0.232)
3rd grade maths score	0.006		0.096**		-0.029	
	(0.043)		(0.040)		(0.067)	
3rd grade Swedish score	0.017		-0.062		0.073	
	(0.057)		(0.043)		(0.091)	
6th grade maths score		0.140**		-0.001		-0.182*
		(0.062)		(0.067)		(0.100)
6th grade English score		-0.039		-0.029		0.144*
		(0.066)		(0.067)		(0.083)
6th grade Swedish score		-0.080		0.005		0.062
		(0.054)		(0.067)		(0.116)
District FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.381	0.420	0.371	0.418	0.567	0.669
N	2,205	1,828	1,332	1,060	254	185

Note: This presents results of the OLS regressions of $Year_{st} = \beta_t X_{st-1} + \epsilon_{st}$ where $Year_{st}$ is equal to the year that the school first has promoted a career teacher. Regressions are estimated separately by year, as indicated by the column headings. Regressions only include schools that at some point participate in the reform between 2013 and 2016, and that at the earliest participate in the year indicated by the column heading. Columns (2) and (3) therefore includes schools that had not yet promoted teachers earlier than 2014 (col. 2) or 2015 (col. 3). Standard errors are clustered at school district level.

Table B.6: Wage effects of promotion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sample	Full	Full	Full	Full	Full	Full	First time CT	First time CT
Panel A: ln*(wage)*								
Promoted	0.212***	0.210***	0.179***	0.179***	0.179***	0.148***	0.141***	
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	
2012 mean wage	10.22							
R^2	0.404	0.512	0.800	0.796	0.807	0.961	0.904	
Panel B: Monthly wage (SEK)								
Promoted	7176.4***	7104.4***	6253.5***	6231.7***	6243.3***	5322.5***	4744.3***	5303.6***
	(90.5)	(84.9)	(73.2)	(74.4)	(73.9)	(65.1)	(58.6)	(57.2)
2012 mean wage	27501.3							
R^2	0.438	0.542	0.799	0.795	0.808	0.956	0.900	0.952
Year FE	Yes	Yes	Yes		Yes	Yes		Yes
School FE		Yes	Yes	Yes	Yes	Yes		Yes
Individual FE						Yes		Yes
Year × district FE					Yes			
Linear & quadratic time trends				Yes				
Controls			Yes	Yes	Yes	Yes	Yes incl. lag wage	Yes
N	395,960	395,960	395,083	395,083	395,083	374,108	260,619	360,260

Note: This table provides the results of OLS regressions of $y_{ist} = \alpha_i + \delta_s + \lambda_t + \theta CT_{ist} + \beta X_{ist} + \epsilon_{ist}$. Controls are dummies for female, teacher certification, permanent contract, age (in five age bands), level of education (in four categories), field of specialisation (in one of six categories), experience (in five bands) and tenure (in five bands). Standard errors are clustered at school district level. In specification (7) and (8) the sample is censored to only include the first year of becoming a career teacher as well as those that are not (yet) promoted.

Table B.7: Heterogeneous effects for urban and rural school districts

	(1)	(2)	(3)	(4)
	Log wages	Wage dispersion	Separations	Exits
Panel A: Baseline results				
At least one CT at school	0.019***	0.004***	-0.010*	-0.004
	(0.001)	(0.000)	(0.005)	(0.003)
R^2	0.914	0.583	0.339	0.238
N	17,689	17,689	17,689	17,689
Share CT at school	0.165***	0.024***	-0.207***	-0.057***
	(0.007)	(0.001)	(0.025)	(0.015)
R^2	0.921	0.596	0.345	0.239
N	17,689	17,689	17,689	17,689
Panel B: Urban areas				
At least one CT at school	0.019***	0.004***	-0.017**	-0.007
	(0.002)	(0.000)	(0.007)	(0.004)
R^2	0.926	0.589	0.354	0.240
N	10,874	10,874	10,874	10,874
Share CT at school	0.164***	0.023***	-0.237***	-0.071***
	(0.008)	(0.002)	(0.031)	(0.021)
R^2	0.932	0.601	0.361	0.241
N	10,874	10,874	10,874	10,874
Panel C: Rural areas				
At least one CT at school	0.020***	0.004***	-0.001	-0.001
	(0.002)	(0.000)	(0.007)	(0.005)
R^2	0.890	0.572	0.318	0.235
N	6,815	6,815	6,815	6,815
Share CT at school	0.166***	0.025***	-0.171***	-0.040*
	(0.010)	(0.003)	(0.042)	(0.024)
R^2	0.899	0.587	0.323	0.236
N	6,815	6,815	6,815	6,815
Year FE:s	Yes	Yes	Yes	Yes
School FE:s	Yes	Yes	Yes	Yes
School controls	Yes	Yes	Yes	Yes

Note: In the table, we relate the change in the presence of career teachers in a school in year t to the change in mean wages (col. 1), wage dispersion (col. 2), school separations (col 3) and exits (col 4) separately for urban and rural areas. School controls are the number of students in year t as share of teachers in $t-1$ (i.e. the student to teacher ratio) as well as log number of students. Urbanisation is defined using Eurostat's degree of urbanisation (degurba) variable. School districts that are in cities (code 1) or towns and suburbs (code 2) are treated as urban, while school districts that are in rural (code 3) areas are treated as rural. There are 111 urban school districts and 179 rural school districts.

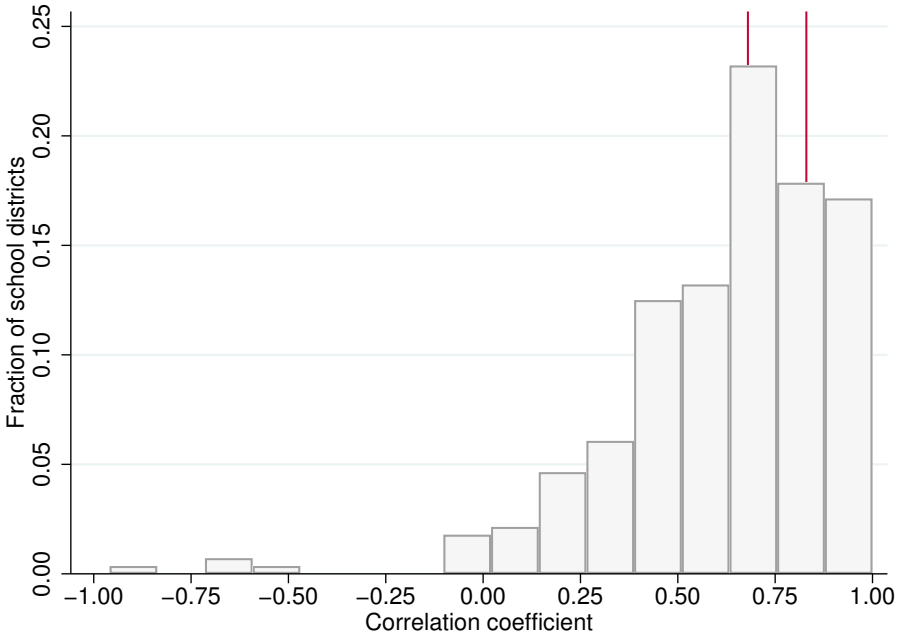


Figure B.1: Distribution of correlation coefficients between share career teachers and share students

Note: The figure plots the distribution of correlation coefficients between the share of career teachers and share of students within school districts. The two red lines mark the 50th and 75th percentiles. A correlation coefficient closer to 1 identifies school districts that appear to allocate career teaching positions according to the same rule used to allocate positions across school districts on the national level. Only school districts that at some point participate in the reform and that have more than one school are included. The figure is based on 280 school districts.

Table B.8: Heterogeneous effects for school districts that follow decision rule

	(1)	(2)	(3)	(4)
	Log wages	Wage dispersion	Separations	Exits
Panel A: Baseline results				
At least one CT at school	0.019***	0.004***	-0.010*	-0.004
	(0.001)	(0.000)	(0.005)	(0.003)
R^2	0.914	0.583	0.339	0.238
N	17,689	17,689	17,689	17,689
Share CT at school	0.165***	0.024***	-0.207***	-0.057***
	(0.007)	(0.001)	(0.025)	(0.015)
R^2	0.921	0.596	0.345	0.239
N	17,689	17,689	17,689	17,689
Panel B: 50th percentile and above				
At least one CT at school	0.023***	0.004***	-0.014	-0.006
	(0.002)	(0.000)	(0.008)	(0.005)
R^2	0.904	0.572	0.341	0.238
N	6,655	6,655	6,655	6,655
Share CT at school	0.174***	0.026***	-0.188***	-0.069**
	(0.011)	(0.003)	(0.044)	(0.028)
R^2	0.911	0.585	0.345	0.239
N	6,655	6,655	6,655	6,655
Panel C: 75th percentile and above				
At least one CT at school	0.022***	0.004***	-0.014	-0.012
	(0.003)	(0.001)	(0.012)	(0.009)
R^2	0.880	0.569	0.320	0.239
N	2,237	2,237	2,237	2,237
Share CT at school	0.184***	0.028***	-0.221***	-0.094**
	(0.016)	(0.005)	(0.070)	(0.045)
R^2	0.889	0.579	0.325	0.241
N	2,237	2,237	2,237	2,237
Year FE:s	Yes	Yes	Yes	Yes
School FE:s	Yes	Yes	Yes	Yes
School controls	Yes	Yes	Yes	Yes

Note: In the table, we relate the change in the presence of career teachers to the change in mean wages (col. 1), wage dispersion (col. 2), separations (col. 3) and exits (col. 4) separately by whether school districts follow a rule to allocate promotions. The rule considered is whether school districts allocate career teaching positions in proportion to the share of students at the school within the school district (i.e. whether they apply the national rule in the school district). School controls are the student to teacher ratio and log number of students. The 50th percentile correlation coefficient is 0.683 (140 school districts) and the 75th percentile is 0.829 (70 school districts).

Table B.9: Heterogeneous effects w.r.t. seniority status

	(1)	(2)	(3)	(4)
	Log wages	Wage dispersion	Separations	Exits
Panel A: Baseline results				
At least one CT at school	0.019***	0.004***	-0.010*	-0.004
	(0.001)	(0.000)	(0.005)	(0.003)
R^2	0.914	0.583	0.339	0.238
N	17,689	17,689	17,689	17,689
Share CT at school	0.165***	0.024***	-0.207***	-0.057***
	(0.007)	(0.001)	(0.025)	(0.015)
R^2	0.921	0.596	0.345	0.239
N	17,689	17,689	17,689	17,689
Panel B: Outcomes for senior teachers				
At least one CT at school	0.022***	0.004***	-0.009*	-0.004
	(0.001)	(0.000)	(0.005)	(0.003)
R^2	0.929	0.552	0.301	0.206
N	17,682	17,622	17,677	17,677
Share CT at school	0.174***	0.022***	-0.240***	-0.077***
	(0.007)	(0.001)	(0.026)	(0.017)
R^2	0.936	0.568	0.308	0.208
N	17,682	17,622	17,677	17,677
Panel C: Outcomes for junior teachers				
At least one CT at school	0.000	0.000	-0.001	0.003
	(0.002)	(0.000)	(0.013)	(0.011)
R^2	0.798	0.426	0.265	0.240
N	14,709	10,905	12,970	12,970
Share CT at school	0.034***	0.005***	-0.036	-0.008
	(0.010)	(0.002)	(0.065)	(0.049)
R^2	0.798	0.427	0.265	0.240
N	14,709	10,905	12,970	12,970
Year FE:s	Yes	Yes	Yes	Yes
School FE:s	Yes	Yes	Yes	Yes
School controls	Yes	Yes	Yes	Yes

Note: In the table, we relate the change in the presence of career teachers within a school in year t to the change in mean wages (col. 1), wage dispersion (col. 2), school separations (col 3) and exits (col 4) separately for junior and senior teachers. Share CT at school is defined as the number of CT in t divided by the number of teachers in $t-1$. The school controls included are the number of students in year t as share of the number of teachers in $t-1$ (i.e. the student to teacher ratio) as well as log number of students. Senior status is defined by having at least five years of experience in teaching.

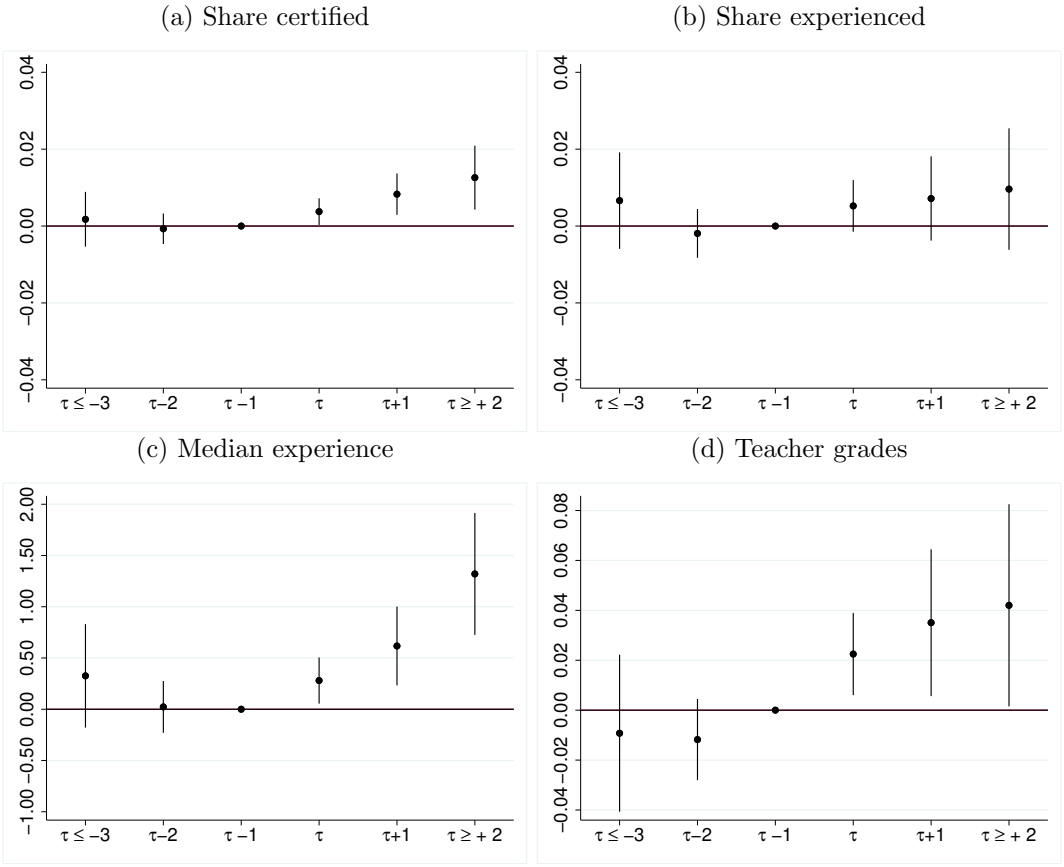
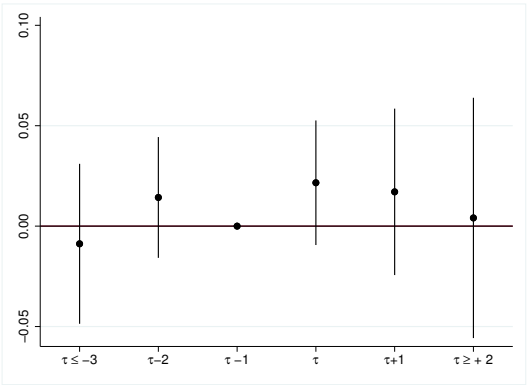


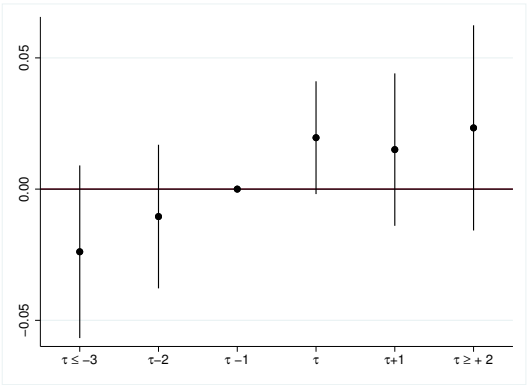
Figure B.2: Dynamic responses: teacher composition

Notes: The figure plots the γ-coefficients from eq. 7. It shows the evolution of the share of certified teachers, the share of experienced teachers, the median level of experience at the school, and the average grades among teachers within schools before and after promoting at least one career teacher. $\tau - 1$ is omitted.

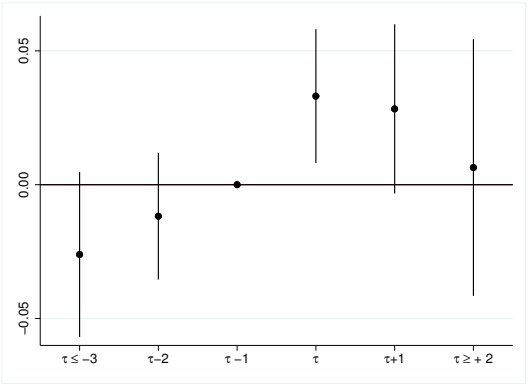
(a) Maths Grade 3



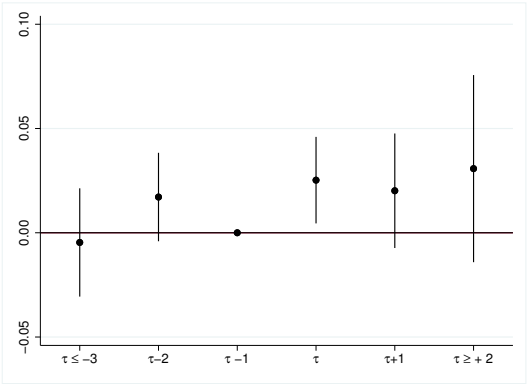
(b) Swedish Grade 3



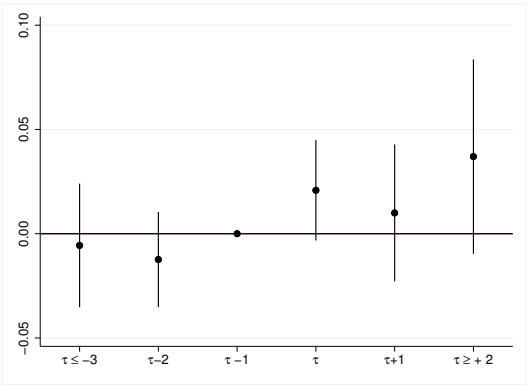
(c) Maths Grade 6



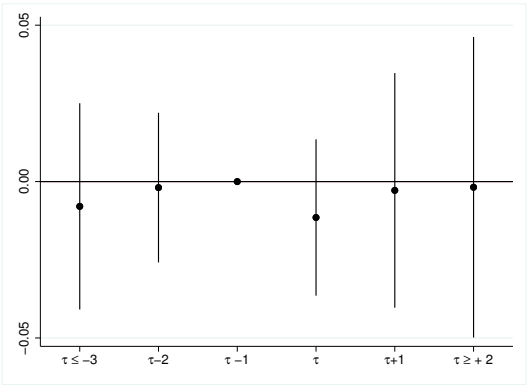
(d) English Grade 6



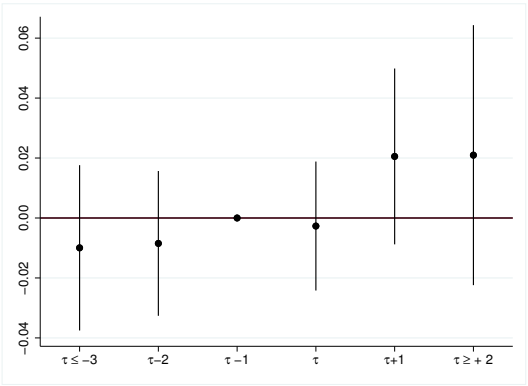
(e) Swedish Grade 6



(f) Maths Grade 9



(g) English Grade 9



(h) Swedish Grade 9

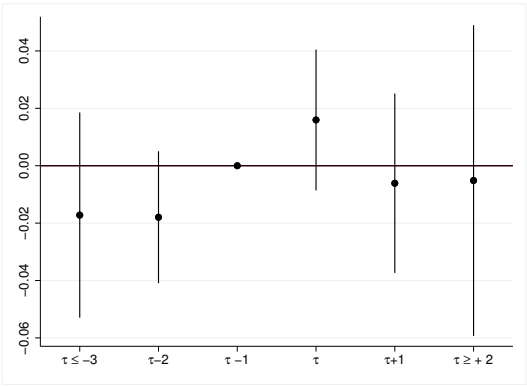


Figure B.3: Dynamic responses: student performance

Notes: The figure plots the γ-coefficients from eq. 7. It shows the evolution of student performance within schools before and after promoting at least one career teacher in the specific subject and level. $\tau - 1$ is omitted.

Appendix C: Robustness checks

Table C.1: Sensitivity checks – Participating schools

	(1)	(2)	(3)	(4)
	Log wages	Wage dispersion	Separations	Exits
Panel A: Baseline results				
At least one CT at school	0.019***	0.004***	-0.010*	-0.004
	(0.001)	(0.000)	(0.005)	(0.003)
R^2	0.914	0.583	0.339	0.238
N	17,689	17,689	17,689	17,689
Panel B: No school controls				
At least one CT at school	0.019***	0.004***	-0.010**	-0.003
	(0.001)	(0.000)	(0.005)	(0.003)
R^2	0.914	0.582	0.311	0.230
N	17,700	17,700	17,700	17,700
Panel C: Only eligible teachers				
At least one CT at school	0.022***	0.004***	-0.011**	-0.004
	(0.001)	(0.000)	(0.005)	(0.003)
R^2	0.930	0.560	0.304	0.212
N	17,684	17,628	17,684	17,684
Panel D: Weighted regressions				
At least one CT at school	0.013***	0.003***	-0.009**	-0.003
	(0.001)	(0.000)	(0.004)	(0.003)
R^2	0.936	0.641	0.377	0.249
N	17,689	17,689	17,689	17,689
Panel E: Dropping never participating schools				
At least one CT at school	0.015***	0.003***	-0.009*	-0.002
	(0.001)	(0.000)	(0.005)	(0.004)
R^2	0.921	0.588	0.342	0.241
N	15,808	15,808	15,808	15,808

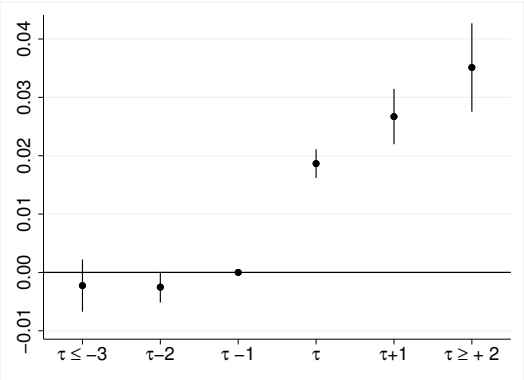
Note: In the table, we relate the change in the presence of career teachers within a school in year t to the change in mean wages (col. 1), wage dispersion (col. 2), school separations (col 3) and exits (col 4) (see Section 2.3 for the exact definition of these variables). At least one CT at school is a dummy equal to 1 when the school has participated (i.e. has at least one CT). The school controls included are the number of students in year t as share of the number of teachers in $t-1$ (i.e. the student to teacher ratio) as well as log number of students. We include year and school FE in all regressions. Standard errors are clustered by school district.

Table C.2: Sensitivity checks – Share of career teachers

	(1)	(2)	(3)	(4)
	Log wages	Wage dispersion	Separations	Exits
Panel A: Baseline results				
Share CT at school	0.165***	0.024***	-0.207***	-0.057***
	(0.007)	(0.001)	(0.025)	(0.015)
R^2	0.921	0.596	0.345	0.239
N	17,689	17,689	17,689	17,689
Panel B: No school controls				
Share CT at school	0.161***	0.024***	-0.264***	-0.078***
	(0.006)	(0.001)	(0.024)	(0.015)
R^2	0.921	0.596	0.321	0.231
N	17,700	17,700	17,700	17,700
Panel C: Only eligible teachers				
Share CT at school	0.175***	0.022***	-0.240***	-0.078***
	(0.007)	(0.001)	(0.026)	(0.017)
R^2	0.936	0.577	0.311	0.214
N	17,684	17,628	17,684	17,684
Panel D: Weighted regressions				
Share CT at school	0.174***	0.022***	-0.230***	-0.067***
	(0.007)	(0.001)	(0.021)	(0.014)
R^2	0.942	0.653	0.383	0.250
N	17,689	17,689	17,689	17,689
Panel E: Dropping never participating schools				
Share CT at school	0.161***	0.022***	-0.234***	-0.059***
	(0.006)	(0.002)	(0.025)	(0.016)
R^2	0.929	0.603	0.350	0.242
N	15,808	15,808	15,808	15,808

Note: In the table, we relate the change in the presence of career teachers within a school in year t to the change in mean wages (col. 1), wage dispersion (col. 2), school separations (col 3) and exits (col 4). Share CT at school is defined as the number of CT in t divided by the number of teachers in $t-1$. The school controls included are the number of students in year t as share of the number of teachers in $t-1$ (i.e. the student to teacher ratio) as well as log number of students. We include year and school FE in all regressions. Standard errors are clustered by school district.

(a) Log wages



(b) Wage dispersion

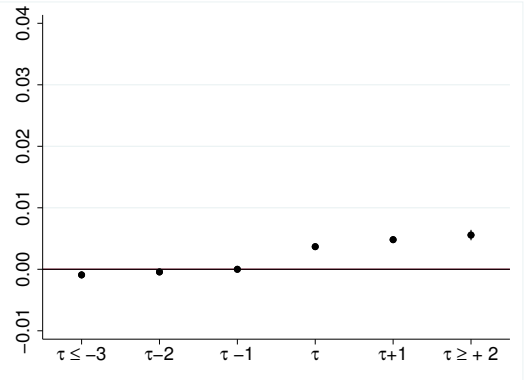


Figure C.1: Dynamic responses – excluding 2016

Notes: The figure plots the γ-coefficients from eq. 7 when 2016 (the last year in our observation period) is excluded. $\tau - 1$ omitted.

Table C.3: Sensitivity checks – Student performance

	Grade 3		Grade 6			Grade 9		
	Maths	Swedish	Maths	English	Swedish	Maths	English	Swedish
Panel A: Lead subject CT								
Subject CT as share of subject teachers	0.091**	0.088***	0.110***	0.055**	0.080***	0.003	0.033	0.040
	(0.040)	(0.028)	(0.029)	(0.025)	(0.029)	(0.032)	(0.026)	(0.031)
Subject CT as share of subject teachers t+1	0.020	0.047	0.013	0.009	0.022	-0.008	0.043**	0.052**
	(0.044)	(0.033)	(0.022)	(0.017)	(0.028)	(0.024)	(0.019)	(0.023)
R^2	0.465	0.489	0.597	0.585	0.583	0.680	0.727	0.697
N	12,596	12,607	10,560	10,552	10,565	5,259	5,266	5,265
Panel B: Share all teachers								
Subject CT as share of all teachers	0.166*	0.165***	0.422***	0.296**	0.234*	0.040	0.188	0.326*
	(0.092)	(0.061)	(0.115)	(0.122)	(0.120)	(0.204)	(0.186)	(0.195)
R^2	0.465	0.489	0.597	0.585	0.583	0.681	0.727	0.697
N	12,599	12,608	10,566	10,564	10,572	5,263	5,267	5,270
Panel C: Participating schools								
At least one CT at school	0.005	0.002	0.028**	0.010	0.025**	-0.010	-0.007	0.026
	(0.017)	(0.010)	(0.014)	(0.011)	(0.012)	(0.014)	(0.017)	(0.016)
R^2	0.465	0.489	0.596	0.585	0.583	0.681	0.727	0.697
N	12,599	12,608	10,566	10,564	10,572	5,263	5,267	5,270

Note: In the table we regress the standardised result from the national exams on subject & teaching level-specific reform variables. In Panel A we use the number of subject (Maths, English, Swedish) & teaching level (grade 1-3, grade 4-6, grade 7-9) career teachers at the school in year t as a share of subject and teaching-level specific teachers in $t-1$, as well as the lead of that share. In Panel B we use the number of subject (Maths, English, Swedish) & teaching level (grade 1-3, grade 4-6, grade 7-9) career teachers at the school in year t as a share of all teachers in $t-1$. In Panel C we use the presence of at least one career teacher at the school. All regressions include year and school FE and school controls. School controls are log number of students as well as the number of students in t over the number of teachers in $t-1$. Standard errors are clustered at school district level.