WORKING PAPER 2020:2

Teacher career opportunities and school quality

Erik Grönqvist
Lena Hensvik
Anna Thoresson

IFAU
INSTITUTE FOR EVALUATION OF LABOUR MARKET AND EDUCATION POLICY

The Institute for Evaluation of Labour Market and Education Policy (IFAU) is a research institute under the Swedish Ministry of Employment, situated in Uppsala.

IFAU's objective is to promote, support and carry out scientific evaluations. The assignment includes: the effects of labour market and educational policies, studies of the functioning of the labour market and the labour market effects of social insurance policies. IFAU shall also disseminate its results so that they become accessible to different interested parties in Sweden and abroad.

Papers published in the Working Paper Series should, according to the IFAU policy, have been discussed at seminars held at IFAU and at least one other academic forum, and have been read by one external and one internal referee. They need not, however, have undergone the standard scrutiny for publication in a scientific journal. The purpose of the Working Paper Series is to provide a factual basis for public policy and the public policy discussion.

More information about IFAU and the institute's publications can be found on the website www.ifau.se

ISSN 1651-1166

Teacher career opportunities and school quality [a]

Erik Grönqvist[b] Lena Hensvik[c] Anna Thoresson[d]

December 16, 2019

Abstract

We study the effects of introducing a performance-based promotion program for teachers in Sweden. The program intended to make the teaching profession more attractive by raising wages for skilled teachers and taking advantage of teachers' professional competence. Our results show that: (i) high-wage, high-ability teachers are more likely to be promoted; (ii) the stipulated wage increase has full pass-through onto wages for promoted teachers; (iii) schools with promotions have lower teacher separations and an improved pool of teachers; (iv) the promotion program improved student performance. These results suggest 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

[a]We are grateful for comments from Peter Fredriksson, David Figlio, Claudia Goldin, Nils Gottfries, Lisa Höckel, Jesse Rothstein, Rune Vejlin and seminar participants at IFAU, UCLS, Uppsala University, Harvard University, IZA Summer School in Labor Economics as well as for helpful research assistance by Kristina Sibbmark.

[b]IFAU, PO Box 513, SE-751 20 Uppsala, Sweden. erik.gronqvist@ifau.uu.se

[c]IFAU and Uppsala center for labor studies (UCLS), Uppsala University, Sweden. lena.hensvik@ifau.uu.se.

[d]IFAU, Department of Economics and UCLS, Uppsala University, Sweden. anna.thoresson@ifau.uu.se

Contents

1 Introduction

Good teachers are an important input to schooling.[1] Still, most teacher labor markets are characterized by problems to recruit and retain talented teachers (Corcoran, Evans, and Schwab 2004; Bacolod 2007; Fredriksson and Öckert 2007; Grönqvist and Vlachos 2016; Leigh and Ryan 2008). The compressed wage distribution—relative to other occupations—is often put forth as a primary driving force behind these problems, pointing to a greater need for policy-makers to find ways to tie the pay structure more closely to teacher quality.

There are several ways to make teacher compensation more responsive to teacher skills (see Jackson 2012 for a discussion). In this paper we study how the teacher labor market is affected by improved career opportunities, 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 (550 USD) wage increase (about 15-20 percent of mean pre-reform wages) 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).

The intention of 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 also exist in England, New Zealand, Australia, Scotland and Poland (Regeringen 2013c), we know little about 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? Fourth, is there an effect on the composition of teachers? Last, is there an impact on student performance?

[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).

The number of career teacher positions increased gradually from 2013 to 2016. The allocation of positions to school districts was rule based, and 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 principals to identify and recruit skilled teachers to the new position.[2]

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, conditional on observable teacher characteristics. If higher wages are paid to more able individuals, this suggests that school principals complied with the intentions of the policy-makers and 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.[3]

Our finding that the allocation of career teacher positions at the school level was largely unrelated to observable characteristics apart from school size 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

[2]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), and that detailed screening measures used in recruitment (e.g. written assessments, interviews, and sample lessons) strongly predict teacher job performance (Jacob et al. 2018).

[3]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.

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. Based on tournament theory we would also expect the chance of becoming a career teacher to motivate marginal—not yet promoted—teachers to exert more effort (Lazear and Rosen 1981).[4] It is less clear how motivation is affected by being promoted.

We find that schools with career teacher promotions have lower teacher turnover, 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. Finally, we find non-negligible positive effects on student test scores in Math, English and Swedish in grades 3 and 6.

Our findings contribute to the policy-debate about how to improve school quality by tightening the link between teacher pay and performance. To the best of our knowledge, it is the first assessment of the effectiveness of performance-based promotions. Most of the previous literature has focused either on smaller bonus programs (e.g. Clotfelter et al. 2008) or general salary increases (e.g. Figlio 1997; Gilpin 2012; Leigh 2012; Falch 2011; Hendricks 2014). More related studies consider the impact of changes from fixed to more flexible pay schemes. For example, 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 (2019) finds no support for changes in teacher composition or student outcomes when individualized wage setting was introduced to teachers in Sweden in the 1990s.

Besides the mixed results, these studies also highlight difficulties for policy-makers to achieve the intended widening of the wage distribution through more local autonomy over teacher pay. In Wisconsin, around half of the school districts chose to maintain the fixed salary-scheme despite their new autonomy (Biasi 2018). Similarly, the flexible pay reform in Sweden led to a disproportionate increase in entry wages and a flattening of the age-wage profile, and only a modest increase in wage dispersion among teachers

[4]However, for promotions perceived as unfair in Chinese schools, Li (2019) finds an erosion of work moral and higher quitting probability among non-promoted teachers.

(Willén 2019).[5]

The promotion program we study is different from these flexible pay reforms in the sense that the salary increase aimed for talented teachers are coupled with new pedagogical development tasks. Therefore, they are possibly easier to motivate from a "fairness" perspective. Consistent with this notion, we find that nearly all school districts chose to participate in the promotion program and that the reform had the intended first-stage impact on the actual wage distribution. An important contribution of our study is also that we are able to go beyond the impact on teacher quality and also consider the impact on student performance. The direct evidence on the link between teacher pay and student outcomes is mixed with a focus on general pay raises rather than on increased wage dispersion. [6] Our findings 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 improve educational performance.

The paper proceeds as follows. It begins by describing the Swedish education system, the career teacher reform, and the data in Section 2. In Section 3 we show how the career teacher promotions were allocated across schools and teachers, and in Section 4 we analyze the pass-through of the stipulated wage increase onto wages. Section 5 contains analyses of teacher turnover, teacher composition, and student performance. Finally, Section 6 concludes.

[5]Consistent with this, Söderström (2010) finds that the switch from centralized to individualized wage setting increased entry wages, and wage dispersion late in the career.

[6]Several studies from the last two decades also find a positive relationship between general teacher wages and student outcomes (see for example, Loeb and Page 2000; Dolton and Marcenaro-Gutierrez 2011; Britton and Popper 2016; Alva et al. 2017). 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. These studies focus general pay raises rather than on performance-based promotions or increased wage dispersion. For performance-related pay schemes, surveys by Jackson, Rockoff, and Staiger (2014) and Neal (2011) find the earlier literature to be inconclusive. More recently, Sojourner, Mykerezi, and West (2014) study teacher bonuses based on classroom observations, student test scores, and students' non-test achievements, and find improved student achievements in school districts adopting the program. Dee and Wyckoff (2015) study a program where teachers are rated on a composite measure of teacher performance (value added in test scores and detailed classroom observations), and find that low performing teachers with the risk of dismissal and high performing teachers with the chance of financial rewards improved their performance.

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. 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.[7] We restrict our attention to public compulsory schools.

To work as a teacher at a Swedish school, the teacher needs to be certified.[8] Only certified teachers can 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.[9]

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

[8] There are uncertified teachers in Swedish schools but only on short term contracts and they cannot work independently and set grades, with some exceptions for vocational teachers and "mother tongue" teachers for immigrant students. For a teacher to be certified, 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 teacher occupational license ("lärarlegitimation") in 2011. To obtain the license, 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.*

[9] See Hensvik (2012) and Willén (2019) for more details.

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.[10] It was implemented in July 2013 and is financed by ear-marked government funding.[11]

The reform, akin to a performance-based promotion (Jackson 2012), targets 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 better 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. 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.[12] 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.[13] This increased to around 14,000 by 2014 (Skolverket 2014). By

[10]The reform is regulated in Regulation 2013:70, see Regeringen (2013a). Formally, it introduces two career steps: lead teachers ("förstelärare") and lecturers ("lektor"). Lead teachers is a position for highly skilled teaching practitioners whereas lecturers is a position for teachers with an academic degree (licentiate or PhD) and has a partly different job description. Since only around 1% of the career teachers are lecturers, we exclude teachers that are ever lecturers from our sample.

[11]The Swedish government also introduced other policy initiatives at about the same time as the career teacher reform. Two further education programs for teachers, the Boost for Mathematics and the Boost for Reading, were initiated 2013 and 2015, and a more general program to increase teacher pay, the Teachers' Salary Boost, was initiated in 2016. The Salary Boost also aimed at increasing wage dispersion, and implied a smaller unconditional wage increase to about half of the teaching pool financed by ear-marked money from the state. In sensitivity analyses (see Panel F of Tables C.1 and C.2) we add controls for the three boost reforms. For these reforms to invalidate our results their implementation needs to interact with the career teacher reform. The conclusions regarding the effect of the career teacher reform do not change when we control for the boost reforms.

[12]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.

[13]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

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.[14] 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.

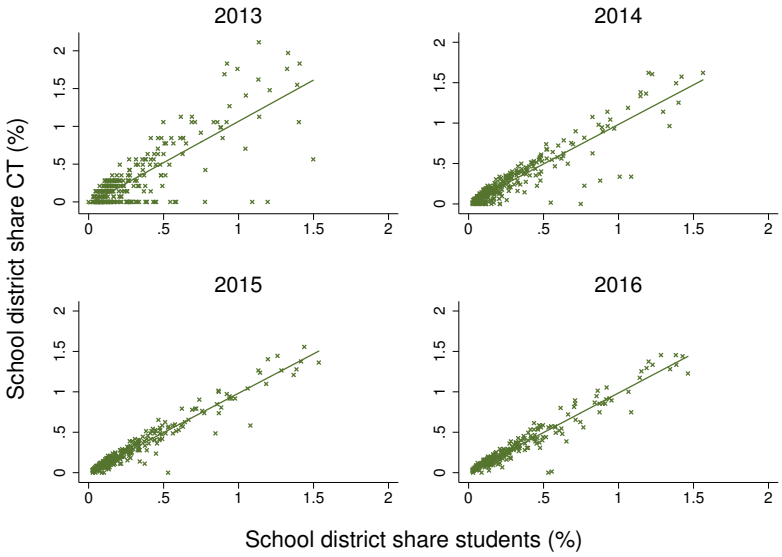


Figure 1: Allocation of promotions across school districts

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.

main sample, we include municipal compulsory schools only.

[14]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.

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. In a survey, where career teachers were asked about additional tasks that came with the promotion, about 70 percent answered that they lead projects for pedagogical development and that they support colleagues in their teaching practices (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 testimonials from the principal; 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 positions 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 to 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 among teachers, Figure 2 shows that mean teacher wages as well as wage dispersion 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) 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 after introducing the promotion program.[15] The gradual increase in mean wages is consistent with the roll-out of the reform.

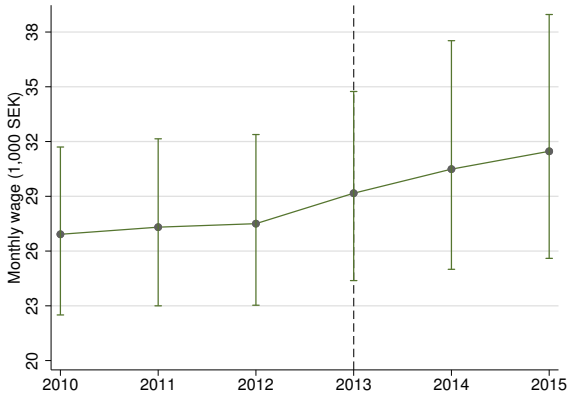


Figure 2: Teacher wages over time

Note: This 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.[16] The teacher register can be linked to a school register that contains school level characteristics, such as number of students and school district.[17] 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

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

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

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

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.[18] 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 Swedish only), grade 6 and grade 9 and are typically graded by the students' own teachers using centrally provided guidelines.[19] 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 in the full student population.[20]

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

[18]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.

[19]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 in Section 5.6 that use student test scores only use data until 2015.

[20]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.

in the same year, only the teacher's main school is included in the sample, defined as the school with the 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 promoted 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 Allocation of career teacher positions across schools and teachers

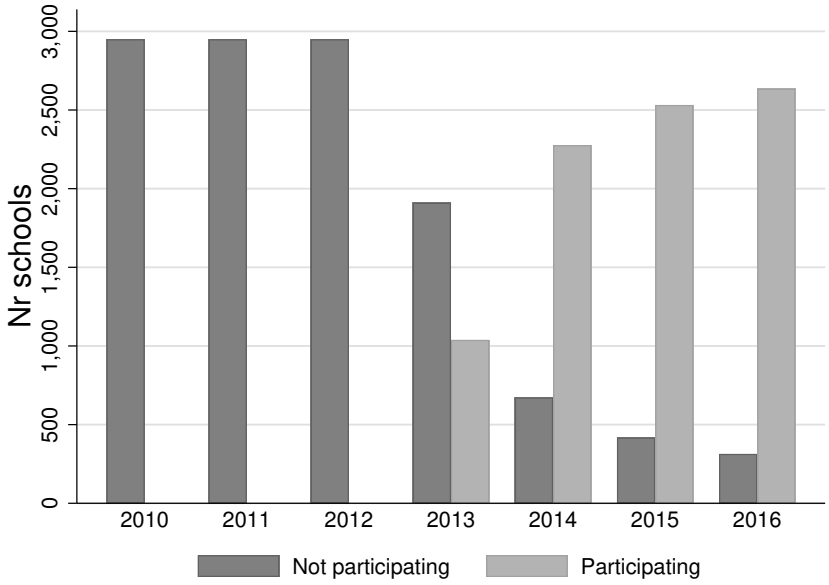
3.1 Allocation across schools

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 3 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 65 to under 25 percent between 2013 and 2014. In 2016, on average 15 percent of teachers were promoted at a school that employed a career teacher, while 16 percent of schools lacked a career teacher.

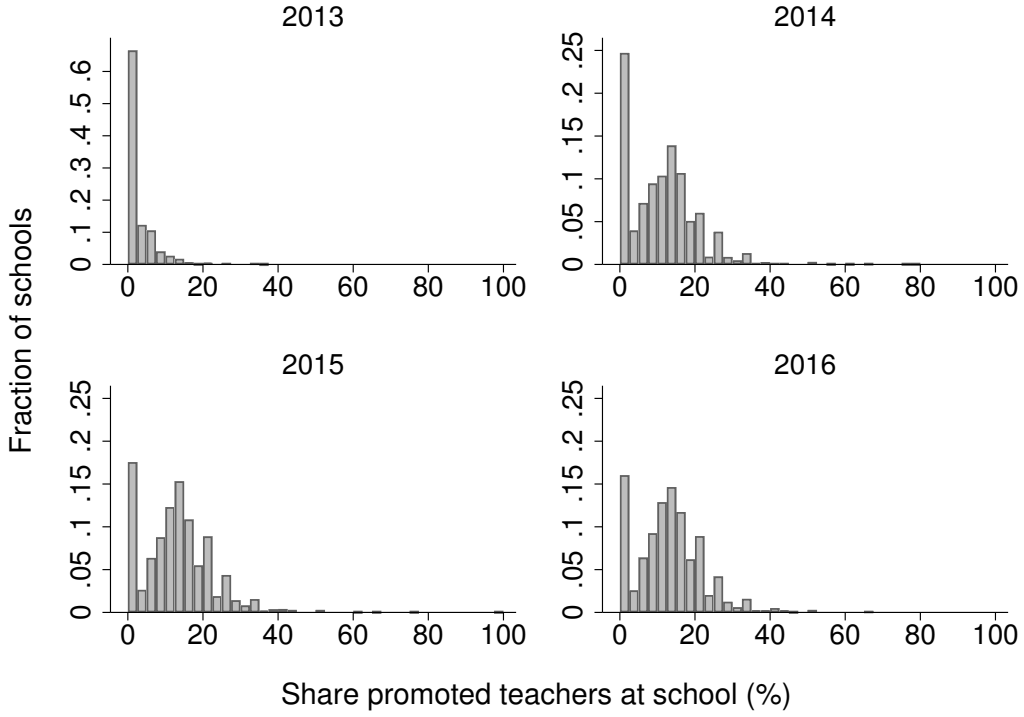
To descriptively consider how the career teacher positions were allocated across schools, Table 2 relates the presence of career teachers to lagged school characteristics. In particular, it presents the results of the regression:

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

where CT_{sdt} is a dummy equal to 1 if school s in school district d has a career teacher in year t, ϕ_{dt} are school district fixed effects and X_{sdt-1} are lagged school characteristics. In Appendix Table B.1 we estimate equation 1 instead using the fraction of of career teachers out of all teachers at the school in year t as dependent variable. 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



(a) Participating schools



(b) Share career teachers at schools

Figure 3: Variation in reform participation at school level

Note: Panel A shows the number of non-participating and participating 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.

only include schools that have no (never or not yet) career teachers in $t-1$.

The results suggest that the probability of having 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.[21]

[21]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.

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.

3.2 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 using OLS by regressing 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):

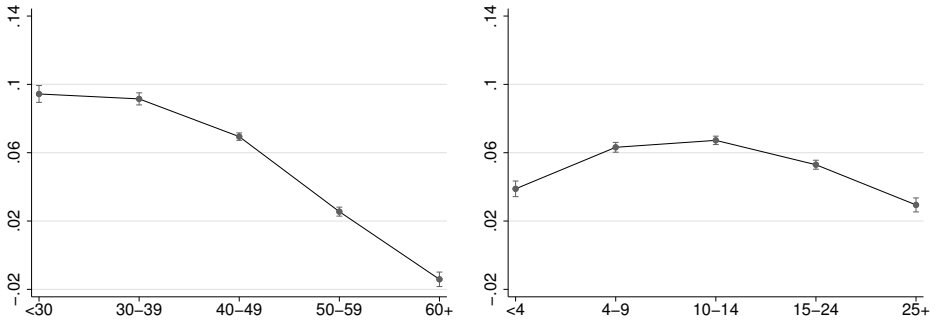
$$CT_{ist} = \beta X_{ist-1} + \delta_s \times \lambda_t + \epsilon_{ist} \tag{2}$$

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 4 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 in the previous year, 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 increases slightly with teachers' compulsory school GPA. 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.

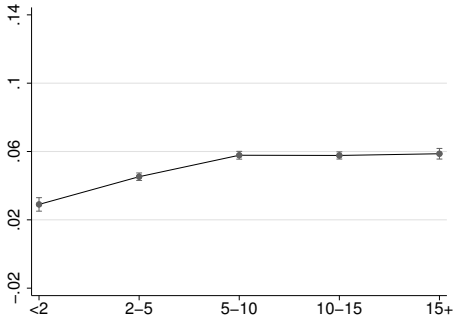
Table 3: Teacher summary statistics, 2012

	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	

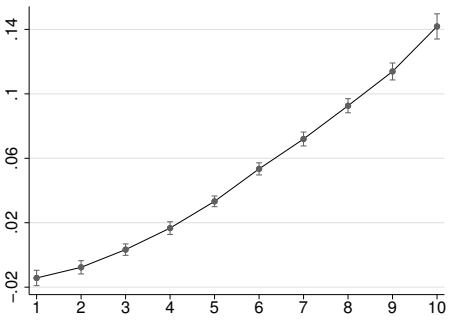


(a) Lagged age band

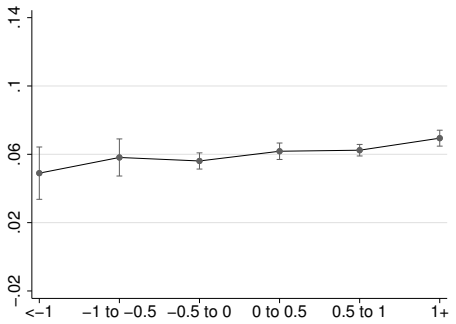
(b) Lagged experience band



(c) Lagged tenure band



(d) Lagged wage decile



(e) Standardised 9th grade GPA

Figure 4: 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 in Panel (e) we include 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.

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

A central component of the reform was to give promoted teachers a wage increase. Figure 5 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.

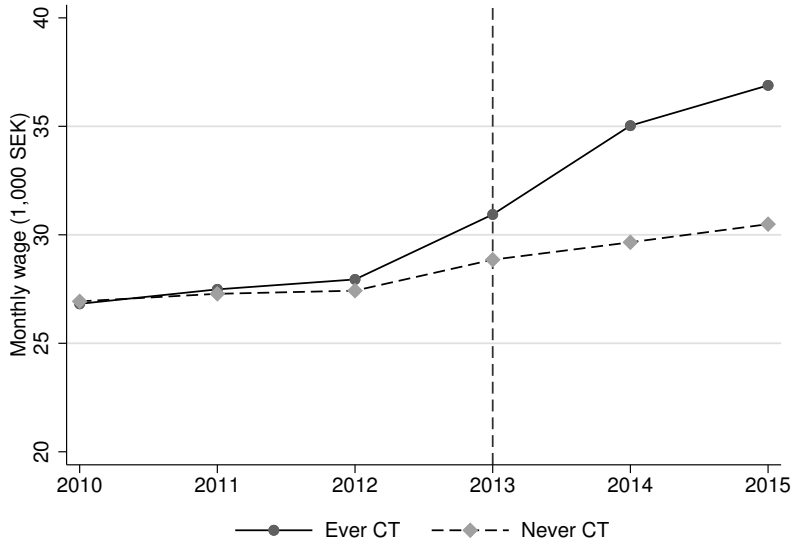


Figure 5: Ever career teacher vs. never career teacher mean wages

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:

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

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.[22] We include year fixed effects λ_t to control for time effects common to all individuals and teacher fixed effects, 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. Column (1) uses the full sample of teachers while column (2) only includes non-promoted teachers as well as career teachers in their first year of promotion. They suggest that the wage increase associated with a promotion is approximately 15%.[23] 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, particularly if we consider the wage increase associated with the first time a teacher is promoted, shown in column 2.[24]

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 the schools that they work. As a more formal complement to Figure 5, 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):

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

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.

[22] 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.

[23] Appendix Table B.4 shows results from alternative specifications including models without teacher fixed effects.

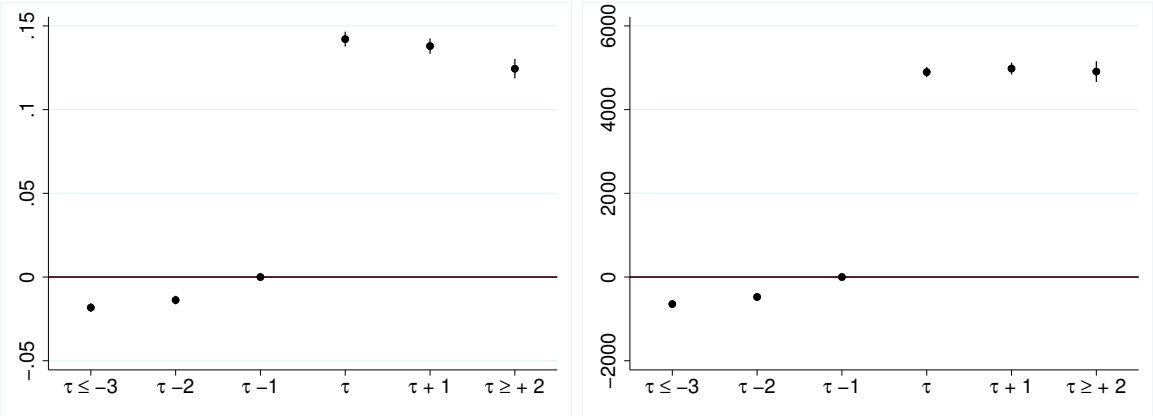
[24] The fact that the estimate in column (1) of Panel B is slightly larger probably reflects the outcome in subsequent wage negotiations, where pay raises are based on the current wage.

Table 4: Wage effects of promotion

	(1)	(2)
Sample	Full	First time CT
Panel A: ln*(wage)*		
Promoted	0.149***	0.141***
	(0.002)	(0.002)
R^2	0.958	0.904
N	374,108	260,619
Panel B: Monthly wage (SEK)		
Promoted	5329.2***	4744.3***
	(65.4)	(58.6)
R^2	0.954	0.900
N	374,108	260,619
Year FE	Yes	
Individual FE	Yes	
Controls	Yes	Yes incl. lag wage

Note: The table provides results of the regressions of $y_{ist} = \alpha_i + \lambda_t + \theta CT_{ist} + \beta X_{ist} + \epsilon_{ist}$. 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.

From Figure 6, which plots the parameters γ_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 6: Dynamic effects in wage outcomes

Note: Figure 6 displays the coefficients γ_τ from the regression $\ln(w_{ist}) = \alpha_i + \lambda_t + \sum_{\tau \leq -3}^{\geq 2} \gamma_\tau D_i \mathbb{1}[\tau] + \beta X_{ist} + \epsilon_{ist}$. 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.

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

The results from section 4 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 5.1. Section 5.2 presents results on teacher turnover while Section 5.3 tests the robustness of our results. Section 5.4 provides a heterogeneity analysis. Section 5.5 focuses on teacher composition and 5.6 finally looks at student performance.

5.1 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 exploit that treatment intensity may vary across schools, thus gaining more variation.[25] Furthermore, we control for the student to teacher ratio (defined as the

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

number of students in year t as the share of teachers in $t-1$) 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 appointing a career teacher, 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.

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 following regression separately by year for schools that do not yet participate:

$$Year_{sdt} = \phi_{dt} + \beta_t X_{sdt-1} + \epsilon_{sdt} \tag{6}$$

where $Year_{sdt}$ is equal to the year that the school first participates (i.e. a year in the interval 2013 to 2016), ϕ_{dt} are school district fixed effects and X_{sdt-1} are lagged school characteristics.[26] The results, included in Appendix Table B.5 and B.6, 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):

reform.

[26]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.

$$y_{st} = \sum_{\tau \leq -3}^{\geq 2} \gamma_{\tau} D_s \mathbb{1}[\tau] + \delta_s + \lambda_t + \beta X_{st} + \epsilon_{st} \quad (7)$$

The results of this analysis, which suggest parallel trends pre-treatment, are included in Figure 7. The year before treatment is omitted.

5.2 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 4.[27] In line with the intentions of the reform we also see increased wage dispersion in schools with career teachers (see column 2). Wage dispersion is defined as the variance in log wages at the school-level. 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 fraction of teachers exiting the teaching occupation. This effect is also negative, but smaller in magnitude and does not reach statistical significance.

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 and provide estimates that are easier to interpret, it also requires that the "share of promoted teachers" at the school level is exogenous. In Appendix Table B.1 we do not find that any (lagged) observable school characteristic, except school size, predict the fraction of career teachers in a given year. 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, and a reduction in exits from the profession with 0.6 percentage points, or five percent. Hence, separations in general and from the occupation is reduced and the effects are significant in size. Moreover, a 10 percent increase in the share of career teachers increases the variance of log wages by 0.0024 units, or 25 percent.

In Figure 7 we plot γ_{τ} from equation 7 to further investigate if the timing of exposure to the reform is exogenous. Reassuringly, outcomes evolve very similarly in

[27] We infer this from column (1) of Panel B.

promoting and non-promoting schools prior to the implementation of the new career step. This analysis also shows 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.

In summary, we find that schools promoting teachers to 'career teachers' have higher average wages, a larger wage distribution, and lower teacher turnover both in terms of general separations and exits from the teacher profession. The impact of the reform tends to grow over time, and there appear to be no pre-reform effects.

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
Control mean	10.231	0.009	0.222	0.114

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.

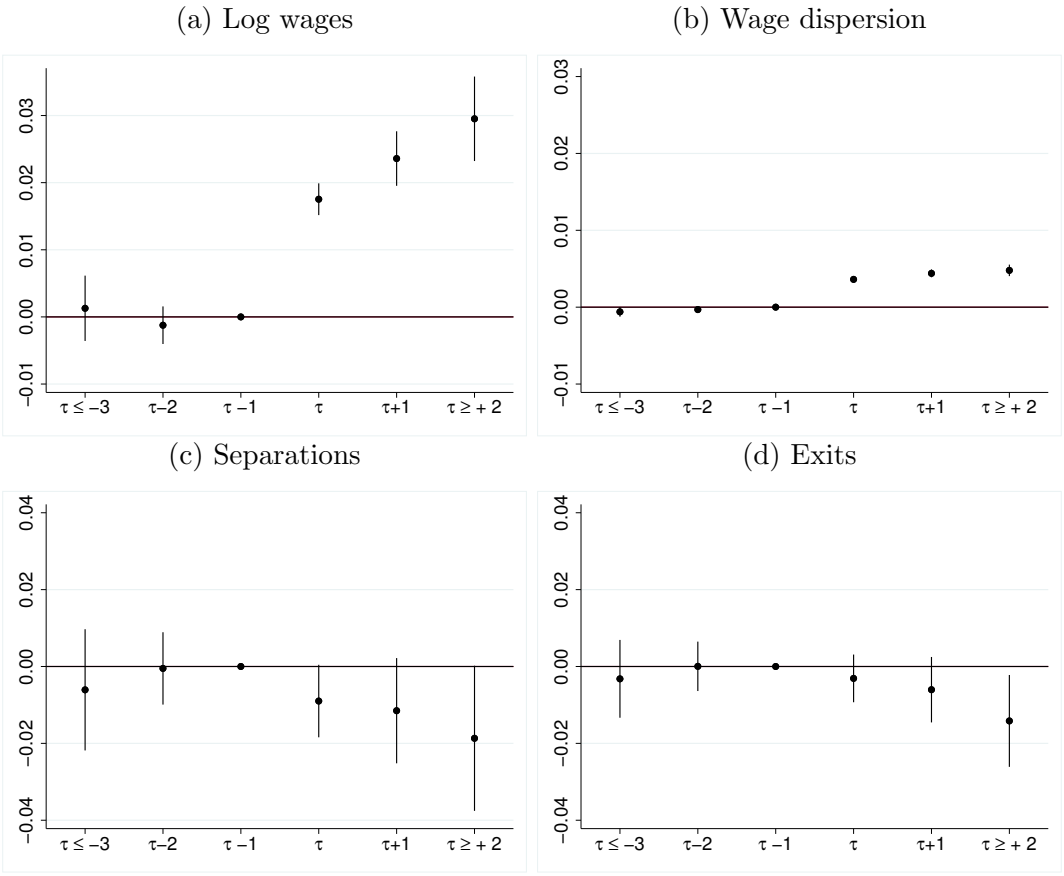


Figure 7: Dynamic responses

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.

5.3 Sensitivity analysis

Next we consider whether our results are robust to alterations of the empirical model. Appendix Table C.1 shows the results when the treatment is defined as hiring at least one career teacher, whereas Table C.2 considers treatment as the share of teachers at the school that have been promoted. Panel A of Tables C.1 and C.2 first report the baseline results from Table 5. Panels B to F include sensitivity analyses.

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 $t-1$; in Panel E we restrict the comparison to schools that had at least one career teacher during 2013–2016; and in Panel F we

control for whether the school participated in the Boost for Mathematics, the Boost for Reading, or the Teachers' Salary Boost, three other policy initiatives implemented 2013, 2015 and 2016 respectively. We conclude that the results are very stable across different empirical models and samples for both treatment variables.

5.4 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.[28] 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. 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 areas are of a magnitude 1.5 times higher than those in rural areas. These results are in line with teachers in urban areas having more outside options.

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 differs by school district. To identify school districts that seem to 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 displayed in Figure B.1. We then estimate equation 5 for schools that are above the 50th and 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 this rule or not.

To understand how the results differ for different types of teachers, we perform two

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

additional types of heterogeneity analysis. First, we calculate the four outcomes (log wages, wage dispersion, share separate and share exit) separately for junior and senior teachers.[29] 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 exclusively. 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.

Second, we consider the response among non-promoted teachers. While the career teacher promotions are expected to reduce turnover among promoted teachers it is, as previously discussed, not clear how they will impact turnover in the pool of non-promoted teachers. Since the reform entailed both higher pay and increased responsibilities for planning the pedagogical work and coaching other teachers, it is possible that part of the overall impact on turnover rates reflects reduced separations among non-promoted teachers, due to for example positive effects on work environment and support. At the same time, promotions could also *increase* teacher turnover among teachers *not* selected for a career teacher promotion, via the kind of "discouragement effects" documented by Card et al. (2012).

We explore this aspect by comparing non-promoted teachers in schools that have and have not introduced promotions. A concern is that the pool of non-promoted teachers is likely different in schools with and without promotions (due to the selection of teachers for promotions documented in Section 3). To make the comparison as credible as possible, we therefore also account for the teacher's observable lagged characteristics, akin to the analysis in equation (2), with the purpose of comparing non-promoted teachers with similar chances of being promoted (based on observables). The analysis is based on the following model:

$$y_{ist}^{notCT} = \gamma CT_{st} + \alpha X_{ist-1} + \delta_s + \lambda_t + \beta X_{st} + \epsilon_{ist} \tag{8}$$

where y_{ist} is a dummy variable equal to 1 if a non-promoted teacher separates or exist, and CT_{st} is either a dummy for having at least one career teacher or the fraction of career teachers at the school in year t. The observable teacher characteristics are included in X_{ist-1}. In addition to the teacher characteristics we, as before, account for the student to teacher ratio and the log number of students as well as school and year fixed effects.

Results are presented in Table 6. Interestingly, these suggest that non-promoted

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

teachers also decrease their separation rate when promotions are introduced at the school. The magnitudes are smaller than the overall effects documented in Table 5, suggesting that the lower turnover rates in schools with promotions are partly driven by the pool of non-promoted teachers.[30]

5.5 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 7 shows the γ-estimates from equation 5 for each of our 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 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 teachers by 0.5 percentage points; an increase in the fraction of experienced teachers by 1 percentage point or about two years of experience; and a 1.5 percent of a standard deviation increase in average teacher grades. The corresponding event study results in Appendix Figure B.2 do not show significant pre-effects.

[30]In Table B.10 we use the wage of non-promoted teachers as outcome when we estimate equation 8. The results suggest a slight tendency for non-promoted teachers in schools having implemented the reform to be compensated relative to non-promoted teachers in schools without career teachers. However, the magnitudes are small and only statistically significant when we use the share of career teachers as treatment.

Table 6: Separations for non-promoted teachers in participating vs. non-participating schools

	(1)	(2)	(3)	(4)
	Separations	Separations	Exits	Exits
Panel A:				
At least one CT at school	-0.008**	-0.008*	-0.002	-0.002
	(0.004)	(0.004)	(0.003)	(0.003)
R^2	0.033	0.075	0.016	0.061
N	322,011	321,279	322,011	321,279
Panel B:				
Share CT at school	-0.078***	-0.079***	-0.005	-0.004
	(0.021)	(0.021)	(0.015)	(0.014)
R^2	0.033	0.075	0.016	0.061
N	322,011	321,279	322,011	321,279
Year FE:s	Yes	Yes	Yes	Yes
School FE:s	Yes	Yes	Yes	Yes
School controls	Yes	Yes	Yes	Yes
Teacher controls		Yes		Yes
Control mean	0.223	0.223	0.118	0.118

Note: In the table, we relate the change in the presence of career teachers within a school in year t to an indicator for if the teacher leaves the school or occupation between $t-1$ and t. 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. Lagged teacher controls are gender, age band, experience band, tenure band, level of education, educational specialization, wage decile and whether the teacher is certified.

Table 7: Teacher composition

	(1)	(2)	(3)	(4)
	Certified	Experienced	Median 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
Control mean	0.930	0.888	13.66	0.587

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 median level of experience at the school (col. 3), and the average grades among teachers (col. 4). School controls are 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.

5.6 Student performance

Finally, we look at the impact of promotions on student performance. The fact that the reform had a substantial impact on teacher wages and wage dispersion, a negative effect on teacher separations and led to a small improvement in the composition of teachers implies that the career teacher reform may also affect student outcomes via teacher quality; either through teacher sorting or effort. As career teachers were tasked with improving teaching practices, to be a mentor, and to lead pedagogical development projects at their schools, the general work environment may also have improved. The reduced separations among non-promoted teachers in participating schools indicates

that the reform may have had a positive impact on the motivation of non-promoted teachers. This is in line with the findings by Jackson and Bruegmann (2009) and Papay et al. (2016) that the quality of teacher peers has a positive influence on student outcomes.

As described in Section 2.3, we measure student performance using standardized test scores on national exams in Math, English and Swedish at different grade levels.[31] While 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 use information about the teachers' subject and level of teaching in order to associate the standardized result from the subject-specific national exams in grade 3, 6 and 9 to subject and teaching level-specific career teacher reform variables.

First, we pool the data over level l (grade 1–3, grade 4–6, grade 7–9) and subject b (Maths, English, Swedish). In Figure 8, we plot θ_τ from the following dynamic model:

$$y_{stbl} = \sum_{\tau \leq -3}^{2} \theta_\tau D_{sbl} \mathbb{1}[\tau] + \delta_{sbl} + \lambda_{tbl} + \beta X_{st} + \epsilon_{stbl} \tag{9}$$

where y_{stbl} is the standardised national exam result at school s in year t in subject b at level l. τ denotes the time relative to when a teacher at school s in subject b at level l is first promoted, which occurs when τ equals 0. Observations three or more event years before treatment ($\tau \leq 3$) are grouped.[32] The effect of the career teacher, captured in θ_τ, is pooled over grades and subjects. Controls included in X_{st} are log number of students and student to teacher ratio (which both vary by school and year). School by subject by level fixed effects, δ_{sbl}, as well as year by subject by level fixed effects, λ_{tbl}, are also included.[33]

When a school first hires a career teacher in a specific subject and level, the test scores in that subject and level increases with almost 2 percent of a standard deviation in comparison to the reference point the year prior to the career step. The effect is stable over time but only significant in τ. We also see that the effect two years prior to participation ($\tau - 2$) is close to zero, which supports the notion that the timing of participation is not related to lagged school characteristics, including student performance. This is also in line with the results in Sections 3.1 and 5.1. The pre-

[31] Note that Chetty, Friedman, and Rockoff (2014) show that teachers who improve test scores improve students' high school completion, college attendance, and earnings, which supports that teachers' impact on students' test scores is a relevant outcome in this case.

[32] Because the reform was introduced in 2013 and we only have student test scores until the school year 2015/2016, τ can at most take value 2.

[33] See Appendix Figures B.3 and B.4 for the corresponding event graphs by subject and by level.

effects three or more years before a school introduces the career step is negative but not statistically significant at the 5% level.

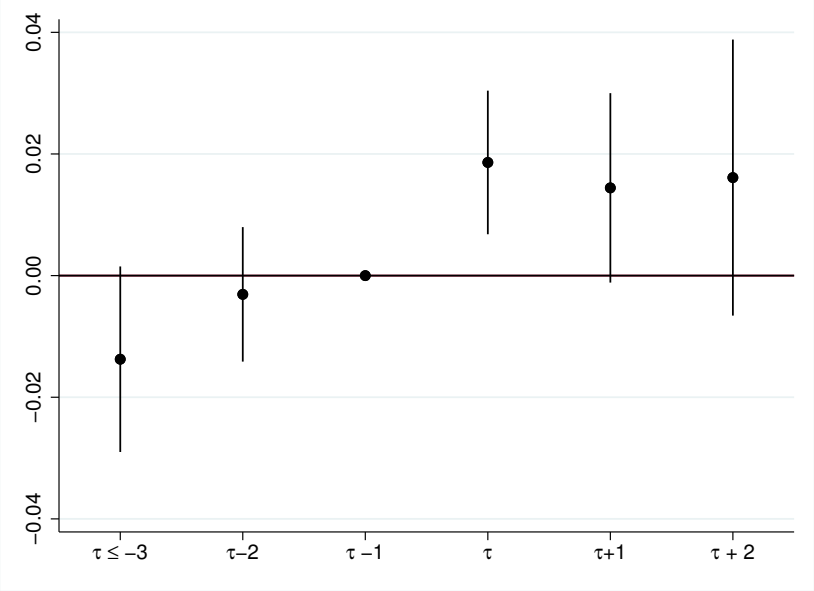


Figure 8: Dynamic response: Student performance

Notes: The figure plots the θ-coefficients from eq. 9.

Next we break out the results by level or by subject. In Table 8 we pool the estimates by either level l or subject b and report θ_q, for $q = b, l$, from the following equation:

$$y_{stbl} = \theta_q CT_{stbl} + \delta_{sbl} + \lambda_{tbl} + \beta X_{st} + \epsilon_{stbl} \tag{10}$$

CT_{stbl} is the treatment variable. This is either an indicator for having at least one career teacher in year t at school s in specific subject b and level l, or the share of career teachers in a specific subject and level in year t among all the teachers in the same subject and level in $t-1$ at the same school.[34]

In Panel A we present the results by teaching level. We see that participating in the reform improves test scores in grades 3 and 6 but not grade 9. In particular, having a career teacher in a specific subject in grade 3 (6) improves test scores with 1.9 (2.5) percent of a standard deviation. When exploiting the treatment intensity, we find that a ten percentage point increase in the share of career teachers in either math or Swedish in the lowest level of education increases test scores with on average 0.97 percent of a standard deviation. The corresponding number for the middle tier is 0.75 percent of a

[34]See Appendix B Table B.11 for the corresponding results for each subject and level separately. In Appendix C Table C.4 we show estimates obtained when we relate student performance to (i) the share and lead share of promoted teachers, (ii) the number of promoted teachers as a fraction of all teachers, or (iii) the presence of at least one career teacher, irrespective of subject and level.

standard deviation. In Panel B, we instead present results by subject. When pooling over tiers, we find positive effects for all subjects. The point estimates suggest slightly larger effects in math and Swedish than English. In Appendix C Table C.3 we find that these results are robust to including controls for the Boosts for Mathematics and Boost for Reading reforms.[35]

A contributing factor to the lack of effect in the highest tier of compulsory schooling (grade 7–9) could be that students have subject teachers rather than classroom teacher in the highest tier of education, such that exposure to career teachers becomes more fragmented than at the low or middle tiers. Pedagogical development projects may also become more specialized at higher tiers. Moreover, larger effects on student outcomes for younger children is consistent with that human capital interventions have higher returns in younger ages (Cunha and Heckman 2007; Heckman 2006).

To appreciate the size of these effects, consider a school with three parallel classes in the lowest 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.[36] 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; and Fredriksson, Öckert, and Oosterbeek (2012) find that a reduction in class size with 5 pupils increase test scores with 0.10 standard deviations.[37] In this respect, our results suggest a non-negligible impact of career teachers on student performance. At the same time, these effects are relatively small for example compared with that girls in the lowest tier had 0.10 standard deviations higher test scores in 2015 than boys did.

[35]Since we only have student test scores until the school year 2015/2016, the Teachers' Salary Boost is not relevant as it was only introduced in 2016.

[36]In 2016, the share of career teachers teaching Swedish or Math in the lower tier at participating schools was 24 or 25 percent, respectively.

[37]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.

Table 8: Student performance

	(1)	(2)	(3)
Panel A: Pool across subject	Grade 3	Grade 6	Grade 9
Treat	0.019*	0.025***	0.005
	(0.010)	(0.008)	(0.008)
R^2	0.474	0.590	0.702
Share	0.097***	0.075***	0.027
	(0.028)	(0.018)	(0.020)
R^2	0.474	0.591	0.702
N	25,207	31,702	15,800
Year × subject FE:s	Yes	Yes	Yes
School × subject FE:s	Yes	Yes	Yes
School controls	Yes	Yes	Yes
Panel B: Pool across level	Maths	English	Swedish
Treat	0.018**	0.015*	0.021***
	(0.008)	(0.008)	(0.007)
R^2	0.532	0.627	0.561
Share	0.084***	0.039**	0.076***
	(0.017)	(0.018)	(0.017)
R^2	0.533	0.627	0.561
N	28,428	15,831	28,450
Year × level FE:s	Yes	Yes	Yes
School × level FE:s	Yes	Yes	Yes
School controls	Yes	Yes	Yes

Note: The table presents the results of estimating eq. 10. In Panel A we pool the results across subjects. In Panel B we pool the results across levels. Treatment variables are "treat" (a dummy equal to one if there is at least one subject & level career teacher at the school) or "share" (the number of subject & level career teachers at the school in year t divided by the number subject & level teachers in the school in $t-1$). School controls are log number of students and student to teacher ratio. The results of the national exams are standardised by year, subject and level to have mean 0 and st.d. 1. Each school obtains a mean standardised score. Standard errors are clustered at school district level.

6 Conclusions

Despite the widespread 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 the 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 led 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 non-negligible effects on student test scores in Math, English and Swedish in grades 3 and 6. Our results suggest that promoting one third of grade 1–3 teachers

increases test scores at the grade 3 national 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.

References

Alva, C., M. Bobba, G. Leon, C. Neilson, and M. Nieddu (2017). "Teacher Wages, Student Achievement and the Recruitment of Talent in Rural Peru". In: *mimeo*.

Bacolod, M.P. (2007). "Do Alternative Opportunities Matter? The Role of Female Labor Markets in the Decline of Teacher Quality". In: *The Review of Economics and Statistics* 89.4, pp. 737–751.

Biasi, B. (2018). "The Labor Market for Teachers Under Different Pay Schemes". In: *NBER Working Paper No. 24813*.

Britton, J. and C. Popper (2016). "Teacher Pay and School Productivity: Exploiting Wage Regulation". In: *Journal of Public Economics* 133, pp. 75–89.

Cabrera, J.M and D. Webbink (2018). "Do Higher Salaries Yield Better Teachers and Better Student Outcomes?" In: *MPRA Paper No. 86972*.

Cantrell, Steven, Jon Fullerton, Thomas J Kane, and Douglas O Staiger (2008). *National Board Certification and Teacher Effectiveness: Evidence from a Random Assignment Experiment*. Working Paper 14608. National Bureau of Economic Research.

Card, David, Alexandre Mas, Enrico Moretti, and Emmanuel Saez (2012). "Inequality at Work: The Effect of Peer Salaries on Job Satisfaction". In: *American Economic Review* 102.6, pp. 2981–3003.

Chetty, R., J.N. Friedman, and J.E. Rockoff (2014). "Measuring the Impacts of Teachers II: Teacher Value-Added and Student Outcomes in Adulthood". In: *American Economic Review* 104.9, pp. 2633–2679.

Clotfelter, C., E. Glennie, H. Ladd, and J. Vigdor (2008). "Would Higher Salaries Keep Teachers in High-Poverty Schools? Evidence From a Policy Intervention in North Carolina". In: *Journal of Public Economics* 92, pp. 1352–1370.

Corcoran, S.P., W.N. Evans, and R.M. Schwab (2004). "Changing Labor-Market Opportunities for Women and the Quality of Teachers, 1957-2000". In: *American Economic Review* 94.2, pp. 230–235.

Cunha, Flavio and James Heckman (2007). "The Technology of Skill Formation". In: *American Economic Review* 97.2, pp. 31–47.

Dee, Thomas S. and James Wyckoff (2015). "Incentives, Selection, and Teacher Performance: Evidence from IMPACT". In: *Journal of Policy Analysis and Management* 34.2, pp. 267–297.

Deshpande, M. and Y. Li (2018). "Who Is Screened Out? Application Costs and the Targeting of Disability Programs". In: *mimeo*.

Dolton, P. and O.D. Marcenaro-Gutierrez (2011). "If You Pay Peanuts Do You Get Monkeys? A Cross-Country Analysis of Teacher Pay and Pupil Performance". In: *Economic Policy* 26.65, pp. 5–55.

Dube, Arindrajit, Laura Giuliano, and Jonathan Leonard (2019). "Fairness and Frictions: The Impact of Unequal Raises on Quit Behavior". In: *American Economic Review* 109.2, pp. 620–63.

Falch, T. (2011). "Teacher Mobility Responses to Wage Changes: Evidence from a Quasi-natural Experiment". In: *American Economic Review: Papers & Proceedings* 101.3, pp. 460–465.

Figlio, D.N. (1997). "Teacher Salaries and Teacher Quality". In: *Economics Letters* 55.2, pp. 267–271.

Fredriksson, P. and B. Öckert (2007). "The Supply of Skills to the Teacher Profession". In: *mimeo*.

Fredriksson, Peter, Björn Öckert, and Hessel Oosterbeek (2012). " Long-Term Effects of Class Size *". In: *The Quarterly Journal of Economics* 128.1, pp. 249–285. ISSN: 0033-5533. DOI: 10.1093/qje/qjs048. eprint: http://oup.prod.sis.lan/qje/article-pdf/128/1/249/17092382/qjs048.pdf. URL: https://doi.org/10.1093/qje/qjs048.

Fryer, Roland G (2017). *Management and Student Achievement: Evidence from a Randomized Field Experiment*. Tech. rep. National Bureau of Economic Research.

Gilpin, G.A. (2012). "Teacher Salaries and Teacher Aptitude: An Analysis Using Quantile Regressions". In: *Economics of Education Review* 31.3, pp. 15–29.

Grönqvist, E. and J. Vlachos (2016). "One Size Fits All? The Effects of Teacher Cognitive and Non-cognitive Abilities on Student Achievement". In: *Labour Economics* 42, pp. 138–150.

Hanushek, E.A. and S.G. Rivkin (2006). "Teacher Quality". In: *Handbook of the Economics of Education* 2, pp. 1051–1078.

Heckman, James J. (2006). "Skill Formation and the Economics of Investing in Disadvantaged Children". In: *Science* 312.5782, pp. 1900–1902.

Hendricks, M. (2014). "Does It Pay to Pay Teachers More? Evidence from Texas". In: *Journal of Public Economics* 109, pp. 50–63.

Hensvik, L. (2012). "Competition, wages and teacher sorting: Lessons learned from a voucher reform". In: *The Economic Journal* 122.561, pp. 799–824.

Jackson, C. Kirabo (2010). "A Little Now for a Lot Later A Look at a Texas Advanced Placement Incentive Program". In: *Journal of Human Resources* 45.3, pp. 591–639.

Jackson, C. Kirabo and Elias Bruegmann (2009). "Teaching Students and Teaching Each Other: The Importance of Peer Learning for Teachers". In: *American Economic Journal: Applied Economics* 1.4, pp. 85–108.

Jackson, K. (2012). "Recruiting, Retaining and Creating Quality Teachers". In: *Nordic Economic Policy Review* 3.1, pp. 61–103.

Jackson, K., J. Rockoff, and D. Staiger (2014). "Teacher Effects and Teacher-Related Policies". In: *Annual Review of Economics* 6.1, pp. 801–825.

Jacob, Brian A., Jonah E. Rockoff, Eric S. Taylor, Benjamin Lindy, and Rachel Rosen (2018). "Teacher applicant hiring and teacher performance: Evidence from DC public schools". In: *Journal of Public Economics* 166, pp. 81–97. (Visited on 04/03/2019).

Jacobson, L.S., R.J. LaLonde, and D.G. Sullivan (1993). "Earnings Losses of Displaced Workers". In: *The American Economic Review* 83.4, pp. 685–709.

Lazear, Edward P. and Sherwin Rosen (1981). "Rank-Order Tournaments as Optimum Labor Contracts". In: *Journal of Political Economy* 89.5, pp. 841–864.

Lazear, E.P and K.L. Shaw (2007). "Personnel Economics: The Economist's View of Human Resources". In: *Journal of Economic Perspectives* 21.4, pp. 91–114.

Leigh, A. (2012). "Teacher Pay and Teacher Aptitude". In: *Economics of Education Review* 31.3, pp. 41–53.

Leigh, A. and C.A. Ryan (2008). "How and Why Has Teacher Quality Changed in Australia?" In: *The Australian Economic Review* 41.2, pp. 141–159.

Leigh, Andrew (2010). "Estimating teacher effectiveness from two-year changes in students' test scores". In: *Economics of Education Review* 29.3, pp. 480–488. ISSN: 0272-7757.

Li, Xuan (2019). "The Costs ofWorkplace Favoritism: Evidence from Promotions in Chinese High Schools". In: *mimeo*.

Loeb, S. and M.E. Page (2000). "Examining the Link Between Teacher Wages and Student Outcomes: The Importance of Alternative Labor Market Opportunities and Non-Pecuniary Variation". In: *The Review of Economics and Statistics* 82.3, pp. 393–408.

Neal, Derek (2011). "Chapter 6 - The Design of Performance Pay in Education". In: *Handbook of the Economics of Education*. Ed. by Eric A. Hanushek, Stephen Machin, and Ludger Woessmann. Vol. 4. Handbook of The Economics of Education. Elsevier, pp. 495–550.

Oyer, P and S. Schaefer (2011). "Personnel Economics: Hiring and Incentives". In: *Handbook of Labor Economics* 4.B, pp. 1769–1823.

Papay, John P, Eric S Taylor, John H Tyler, and Mary Laski (2016). *Learning Job Skills from Colleagues at Work: Evidence from a Field Experiment Using Teacher Performance Data*. Working Paper 21986. National Bureau of Economic Research.

Ree, J. de, M. Muralidharan, M. Pradhan, and H. Rogers (2018). "Double for Nothing? Experimental Evidence on an Unconditional Teacher Salary Increase in Indonesia". In: *The Quarterly Journal of Economics* 133.2, pp. 993–1039.

Regeringen (2013a). *Förordning (2013:70) om statsbidrag till skolhuvudmän som inrättar karriärsteg för lärare*.

— (2013b). *Karriärvägar för lärare i skolväsendet m.m.* Regeringens proposition 2012/13:136.

— (2013c). *Karriärvägar m.m. i fråga om lärare i skolväsendet*. Utbildningsdepartementets promemoria U2012/4904/S.

Rivkin, Steven G., Eric A. Hanushek, and John F. Kain (2005). "Teachers, Schools, and Academic Achievement". In: *Econometrica* 73.2, pp. 417–458.

Rockoff, Jonah E. (2004). "The Impact of Individual Teachers on Student Achievement: Evidence from Panel Data". In: *American Economic Review* 94.2, pp. 247–252.

Rockoff, Jonah E., Brian A. Jacob, Thomas J. Kane, and Douglas O. Staiger (2011). "Can You Recognize an Effective Teacher When You Recruit One?" In: *Education Finance and Policy* 6.1, pp. 43–74.

Rockoff, Jonah E. and Cecilia Speroni (2011). "Subjective and objective evaluations of teacher effectiveness: Evidence from New York City". In: *Labour Economics* 18.5, pp. 687–696.

Skolverket (2014). *Skolverkets årsredovisning 2014*.

— (2016). *Skolverkets årsredovisning 2016*.

— (2018). *Antal elever och skolenheter inkl fritidshem*. URL: `https://www.skolverket.se/skolutveckling/statistik/sok-statistik-om-forskola-skola-och-vuxenutbildning` (visited on 07/12/2018).

Söderström, Martin (2010). "Wage scales and centralized bargaining – a binding constraint on the wage-setting?" In: *Applied Economics Letters* 17.3, pp. 247–250.

Sojourner, Aaron J., Elton Mykerezi, and Kristine L. West (2014). "Teacher Pay Reform and Productivity Panel Data Evidence from Adoptions of Q-Comp in Minnesota". In: *Journal of Human Resources* 49.4, pp. 945–981.

Statskontoret (2015). *Uppföljning av karriärstegsreformen. Delrapport 1*. URL: `http://www.statskontoret.se/publicerat/publikationer/2015/uppfoljning-av-karriarstegsreformen.-delrapport-1/`.

Willén, A.L.P. (2019). "Decentralization of Wage Determination". In: *IFAU Working Paper 2019:17*.

Supplementary material

Appendix A: Supplementary description

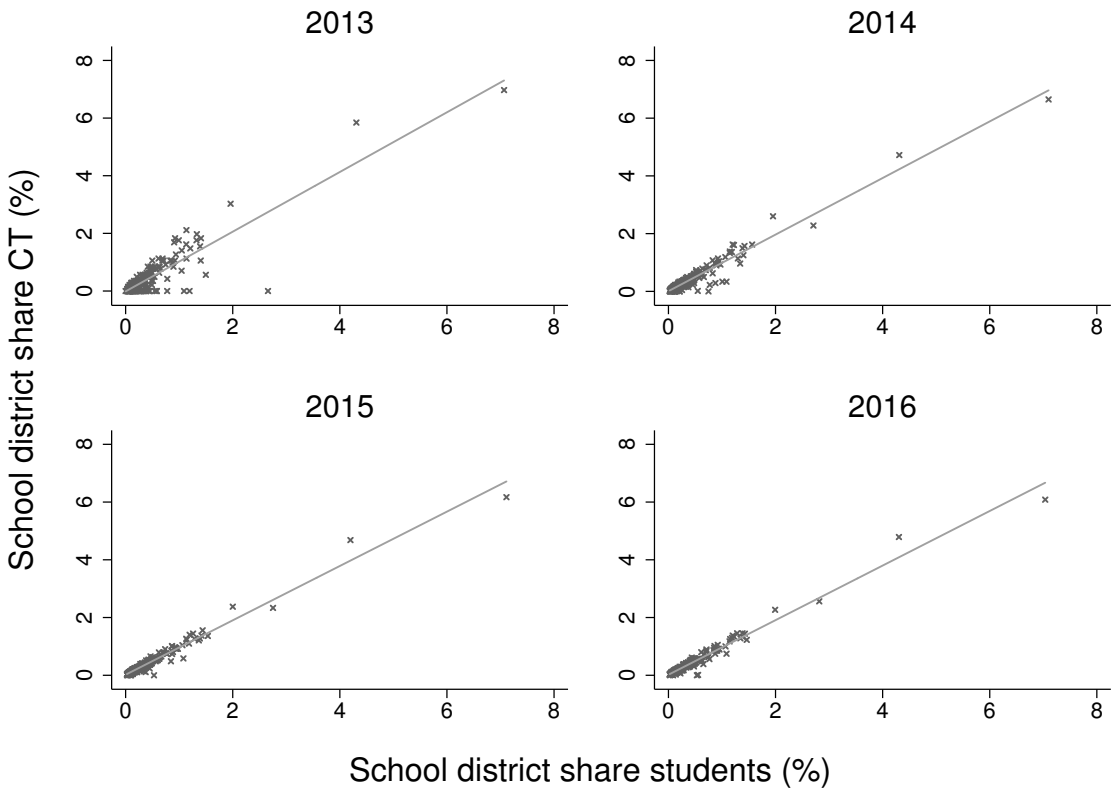


Figure A.1: Allocation of promotions across school districts - all school districts

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.

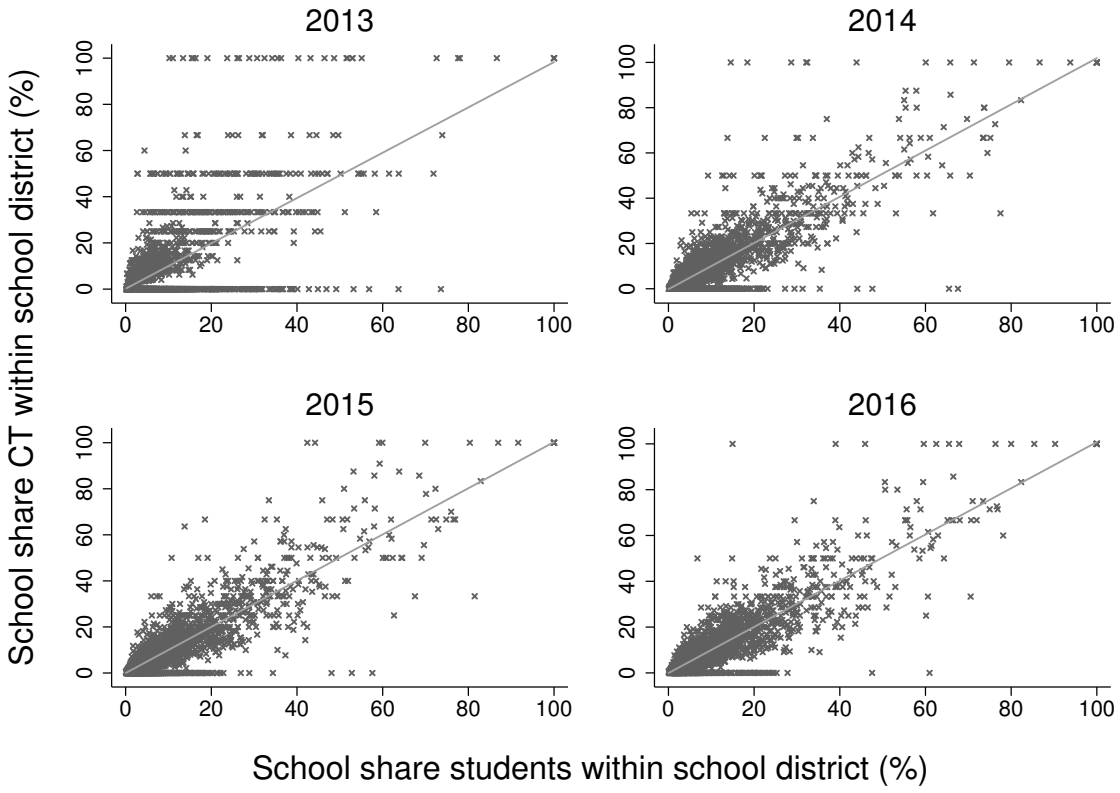


Figure A.2: Allocation of promotions within school districts

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

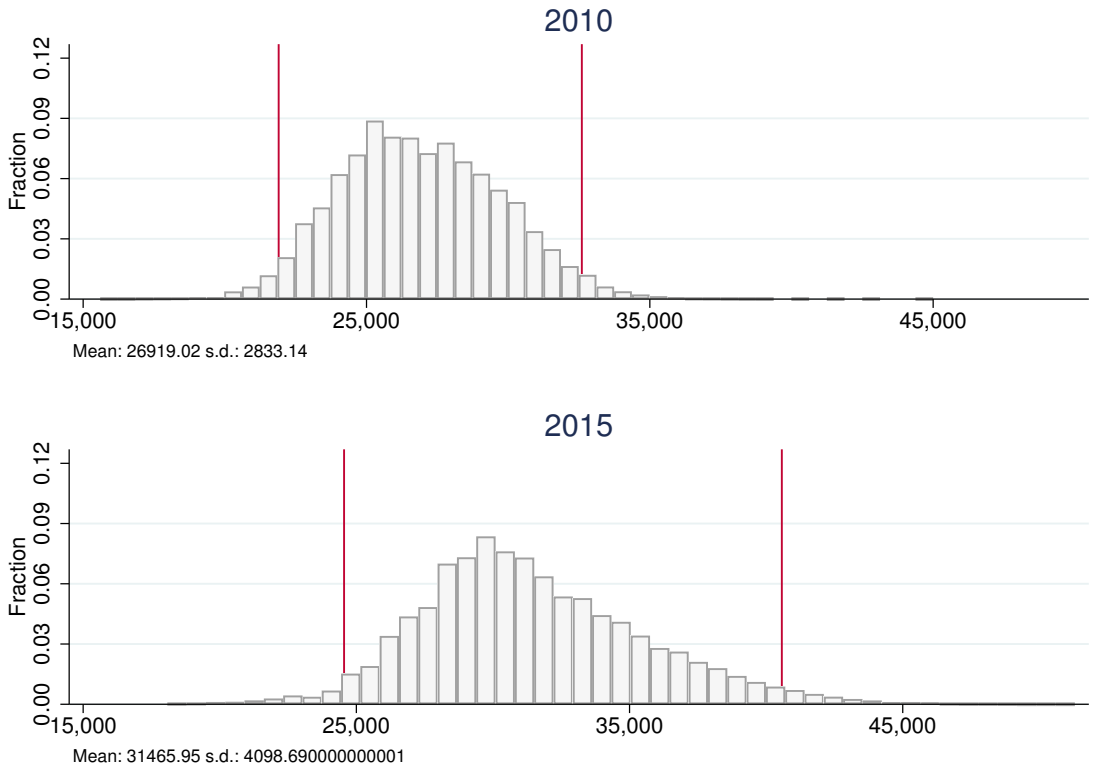


Figure A.3: Teacher wage distribution including 95% CI (2010 and 2015)

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.

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	2016
Panel A: Includes 3rd grade test results								
Log nr students	0.228***	0.302***	0.234***	0.144***	0.001	0.008*	0.002	-0.009
	(0.021)	(0.018)	(0.046)	(0.046)	(0.002)	(0.004)	(0.007)	(0.009)
Student-to-teacher ratio	-0.009***	-0.010***	0.000	-0.005	0.000	-0.000	0.001	0.001
	(0.003)	(0.003)	(0.007)	(0.006)	(0.001)	(0.001)	(0.001)	(0.001)
Separation rate	0.009	-0.068	0.003	0.252	0.004	-0.024	0.005	0.022
	(0.088)	(0.095)	(0.217)	(0.222)	(0.010)	(0.023)	(0.044)	(0.054)
Exit rate	-0.084	0.213	0.051	-0.312	-0.008	0.054*	0.026	-0.059
	(0.110)	(0.133)	(0.232)	(0.230)	(0.015)	(0.029)	(0.048)	(0.052)
Certified (share)	-0.109	0.192	0.134	-0.308	0.003	0.019	0.076*	-0.039
	(0.172)	(0.159)	(0.249)	(0.214)	(0.017)	(0.041)	(0.046)	(0.042)
Female (share)	-0.029	0.270**	-0.129	0.047	0.009	0.047*	-0.028	-0.027
	(0.087)	(0.106)	(0.172)	(0.186)	(0.009)	(0.025)	(0.039)	(0.036)
Mean age (years)	-0.007	-0.006	-0.002	0.011	-0.001	-0.001	-0.001	0.001
	(0.005)	(0.005)	(0.007)	(0.008)	(0.001)	(0.001)	(0.001)	(0.002)
Mean experience (years)	0.003	0.001	0.002	-0.010	0.000	0.000	0.001	-0.002
	(0.005)	(0.005)	(0.008)	(0.008)	(0.001)	(0.001)	(0.002)	(0.002)
Maths/natural science (share)	0.068	-0.072	-0.244	-0.083	-0.007	0.003	-0.068**	0.003
	(0.081)	(0.115)	(0.153)	(0.170)	(0.011)	(0.029)	(0.033)	(0.034)
Swedish/social science (share)	0.133**	-0.009	-0.109	0.205	0.009	0.041*	-0.015	0.063*
	(0.066)	(0.091)	(0.145)	(0.161)	(0.010)	(0.021)	(0.036)	(0.032)
3rd grade maths score	-0.008	-0.047	0.020	0.081	-0.000	-0.002	0.012	0.009

Continued on next page

Table B.2 – continued from previous page

	At least one CT at school				Share CT at school			
	2013	2014	2015	2016	2013	2014	2015	2016
	(0.021)	(0.029)	(0.043)	(0.069)	(0.003)	(0.006)	(0.009)	(0.014)
3rd grade Swedish score	0.013	0.045	-0.039	-0.029	0.006	0.012*	-0.017	0.013
	(0.031)	(0.029)	(0.060)	(0.076)	(0.004)	(0.006)	(0.013)	(0.015)
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.360	0.415	0.481	0.586	0.194	0.272	0.417	0.489
N	2,509	1,635	543	307	2,509	1,635	543	307
Mean dep. var.	.34	.63	.37	.24	.02	.09	.05	.04
Panel B: Includes 6th grade test results								
Log nr students	0.210***	0.298***	0.255***	0.103*	-0.001	0.010**	0.007	-0.007
	(0.022)	(0.019)	(0.051)	(0.052)	(0.002)	(0.005)	(0.008)	(0.012)
Student-to-teacher ratio	-0.009**	-0.008***	-0.002	-0.008	0.000	0.000	0.000	0.000
	(0.004)	(0.003)	(0.008)	(0.008)	(0.001)	(0.001)	(0.001)	(0.001)
Separation rate	0.072	-0.197	0.329	0.551**	0.001	-0.044	0.070	0.066
	(0.081)	(0.120)	(0.241)	(0.233)	(0.011)	(0.029)	(0.046)	(0.052)
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)	(0.044)
Certified (share)	-0.031	0.181	0.020	-0.452*	0.003	0.030	0.034	-0.081
	(0.162)	(0.166)	(0.292)	(0.248)	(0.016)	(0.041)	(0.058)	(0.053)
Female (share)	-0.024	0.127	-0.207	0.093	0.002	0.042	-0.042	-0.007
	(0.087)	(0.120)	(0.189)	(0.202)	(0.010)	(0.028)	(0.040)	(0.037)
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)	(0.002)
Mean experience (years)	0.004	0.001	0.009	-0.007	0.000	0.001	0.002	-0.002

Continued on next page

Table B.2 – continued from previous page

	At least one CT at school				Share CT at school			
	2013	2014	2015	2016	2013	2014	2015	2016
	(0.005)	(0.006)	(0.009)	(0.010)	(0.001)	(0.001)	(0.002)	(0.002)
Maths/natural science (share)	-0.091	-0.142	-0.247	-0.182	-0.020	-0.023	-0.047	-0.019
	(0.101)	(0.132)	(0.197)	(0.260)	(0.015)	(0.034)	(0.040)	(0.046)
Swedish/social science (share)	0.140*	-0.055	0.333*	-0.054	0.006	0.029	0.096**	0.036
	(0.078)	(0.119)	(0.177)	(0.216)	(0.010)	(0.026)	(0.041)	(0.042)
6th grade maths score	-0.035	-0.001	0.122	-0.025	-0.005	0.009	0.011	0.002
	(0.033)	(0.047)	(0.074)	(0.068)	(0.004)	(0.010)	(0.013)	(0.015)
6th grade English score	0.007	0.006	-0.072	0.001	-0.002	-0.004	-0.008	-0.003
	(0.036)	(0.046)	(0.079)	(0.074)	(0.005)	(0.010)	(0.015)	(0.017)
6th grade Swedish score	0.015	-0.028	-0.117	0.046	0.006	-0.009	-0.006	0.001
	(0.029)	(0.047)	(0.084)	(0.085)	(0.004)	(0.010)	(0.015)	(0.019)
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.397	0.450	0.585	0.629	0.217	0.287	0.504	0.555
N	2,041	1,280	390	206	2,041	1,280	390	206
Mean dep. var.	.38	.65	.40	.23	.03	.09	.05	.03

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 in the first four columns, and a variable equal to the share of career teachers at the school in year t in the last four columns. 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.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**

Continued on next page

Table B.3 – continued from previous page

	(1)	(2)	(3)
		(0.045)	(0.052)
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)

Continued on next page

Table B.3 – continued from previous page

	(1)	(2)	(3)
0.5 to 1			0.013
			(0.008)
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: 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***	0.149***	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	0.958	0.904	
Panel B: Monthly wage (SEK)								
Promoted	7176.4***	7104.4***	6253.5***	6231.7***	6243.3***	5329.2***	4744.3***	5315.1***
	(90.5)	(84.9)	(73.2)	(74.4)	(73.9)	(65.4)	(58.6)	(56.6)
2012 mean wage	27501.3							
R^2	0.438	0.542	0.799	0.795	0.808	0.954	0.900	0.949
Year FE	Yes	Yes	Yes		Yes	Yes		Yes
School FE		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 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.5: 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 regressions of $Year_{sdt} = \phi_{dt} + \beta_t X_{sdt-1} + \epsilon_{sdt}$ where $Year_{sdt}$ 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.6: 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 regressions of $Year_{sdt} = \phi_{dt} + \beta_t X_{sdt-1} + \epsilon_{sdt}$ where $Year_{sdt}$ 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.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

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 student to teacher ratio and log number of students. We include year and school FE in all regressions. 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.

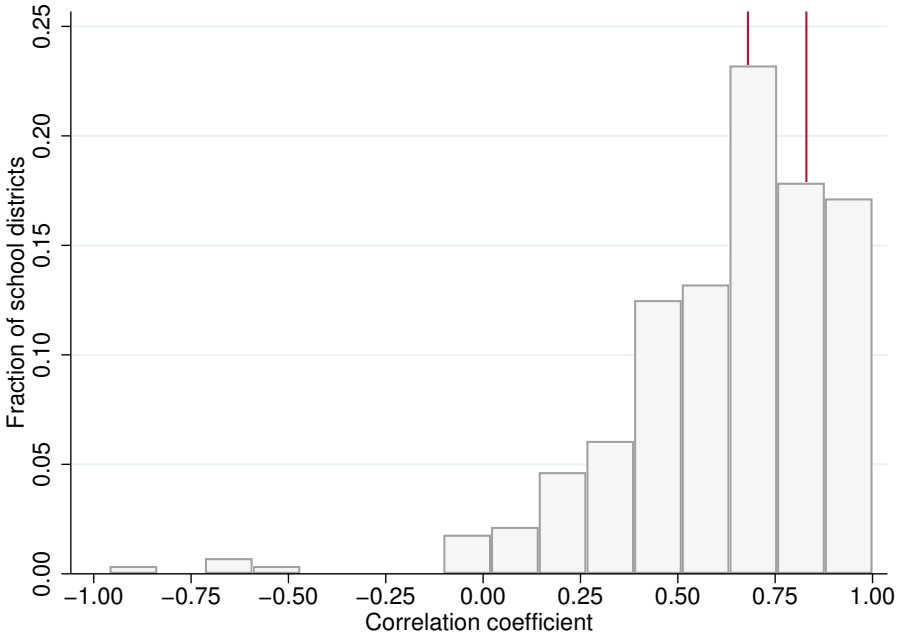


Figure B.1: Distribution of correlation coefficients between share career teachers and share students

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

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. We include year and school FE in all regressions. 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

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 student to teacher ratio and log number of students. We include year and school FE in all regressions. Senior status is defined by having at least five years of experience in teaching.

Table B.10: Log wages among non-promoted teachers in participating vs. non-participating schools

	(1)	(2)
Panel A:		
At least one CT at school	-0.002*	0.001
	(0.001)	(0.001)
R^2	0.366	0.869
N	316,290	252,083
Panel B:		
Share CT at school	-0.001	0.044***
	(0.008)	(0.007)
R^2	0.366	0.869
N	316,290	252,083
Year FE:s	Yes	Yes
School FE:s	Yes	Yes
School controls	Yes	Yes
Teacher controls		Yes
Control mean	10.231	10.243

Note: The table shows estimates from equation 8 where the dependent variable is the log monthly full-time non-CT teaching wage. That is, we relate the change in the presence of career teachers within a school in year t to the log wage in year t in the sample of non-CT teachers. School controls included are the student to teacher ratio and log number of students. Lagged teacher controls are gender, age band, experience band, tenure band, level of education, educational specialization, wage decile, and whether the teacher is certified. Standard errors are clustered at school district level.

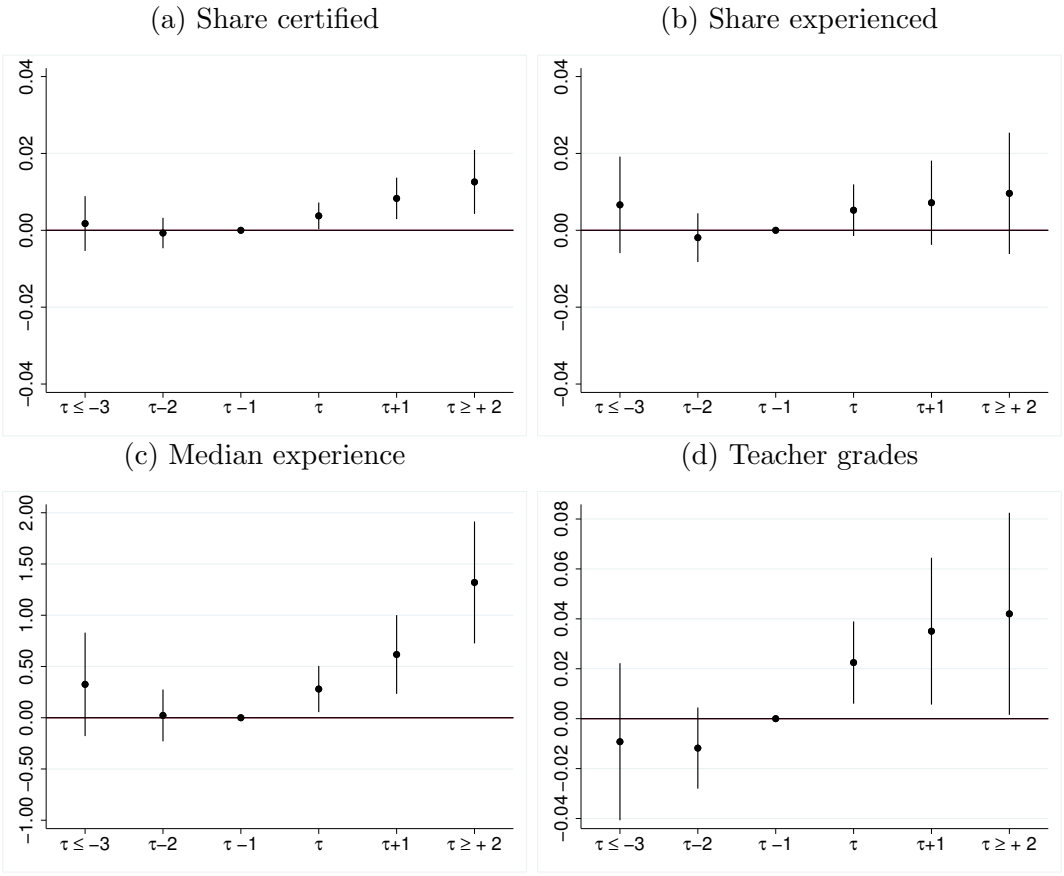
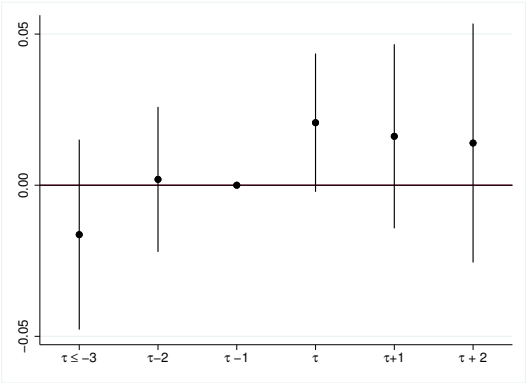


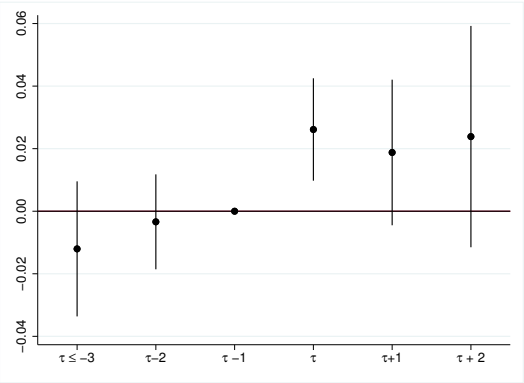
Figure B.2: Dynamic responses: teacher composition

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) Grade 3



(b) Grade 6



(c) Grade 9

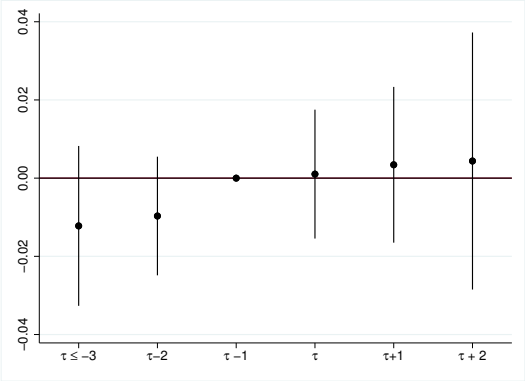
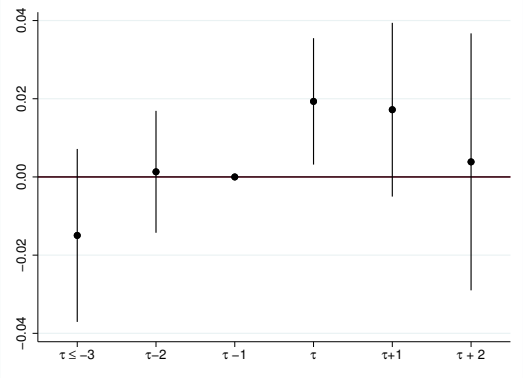


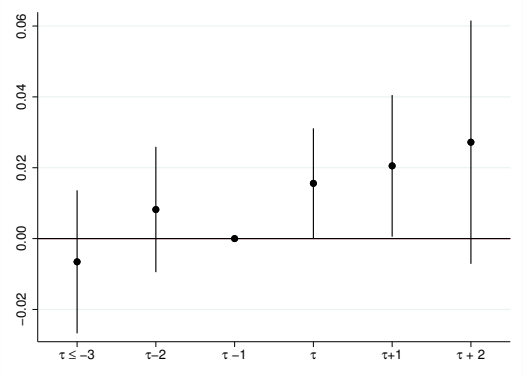
Figure B.3: Dynamic responses: Student performance – pool across subject

Notes: The figure plots the θ-coefficients from a eq. 9, where we only pool across subject.

(a) Mathematics



(b) English



(c) Swedish

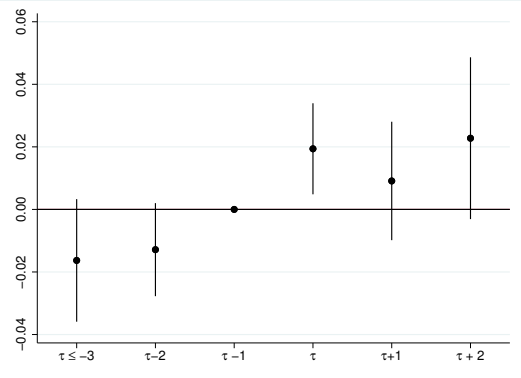


Figure B.4: Dynamic responses: Student performance – pool across level

Notes: The figure plots the θ-coefficients from a eq. 9, where we only pool across level.

Table B.11: Student performance – detailed

	Grade 3		Grade 6			Grade 9		
	Maths	Swedish	Maths	English	Swedish	Maths	English	Swedish
Panel A								
Treat	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								
Share	0.097***	0.097***	0.109***	0.044**	0.075***	0.005	0.025	0.051*
	(0.037)	(0.028)	(0.027)	(0.022)	(0.027)	(0.028)	(0.032)	(0.028)
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
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 national exam result on subject & level-specific reform variables. In Panel A we use the treatment variable "treat" (a dummy equal to one if there is at least one subject & level career teacher at the school). In Panel B we use the treatment variable "share" (the number of subject & level career teachers at the school in year t divided by the number subject & level teachers in the school in $t-1$). School controls are log number of students and student to teacher ratio (the number of students in t over the number of teachers in $t-1$). The results of the national exams are standardised by year, subject and level to have mean 0 and st.d. 1. Each school obtains a mean standardised score. Standard errors are clustered by school district.

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: Excl. 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
Panel F: With boost controls				
At least one CT at school	0.019***	0.004***	-0.009*	-0.004
	(0.001)	(0.000)	(0.005)	(0.003)
R^2	0.915	0.583	0.340	0.239
N	17,689	17,689	17,689	17,689

Continued on next page

Table C.1 – continued from previous page

	(1)	(2)	(3)	(4)

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 definitions). 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 regressions (apart from Panel B) also control for the number of students in year t divided by the number of teachers in $t-1$ (i.e. the student to teacher ratio) and the log number of students. In Panel F we also include controls for the boost reforms (mathematics boost, reading boost and teacher wage boost). 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: Excl. 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
Panel F: With boost controls				
Share CT at school	0.163***	0.024***	-0.203***	-0.054***
	(0.007)	(0.001)	(0.025)	(0.015)
R^2	0.922	0.596	0.346	0.240
N	17,689	17,689	17,689	17,689

Continued on next page

Table C.2 – continued from previous page

	(1)	(2)	(3)	(4)

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 definitions). Share CT at school is the number of CT in t divided by the number of teachers in $t-1$. The regressions (apart from Panel B) also control for the number of students in year t divided by the number of teachers in $t-1$ (i.e. the student to teacher ratio) and the log number of students. In Panel F we also include controls for the boost reforms (mathematics boost, reading boost and teacher wage boost). We include year and school FE in all regressions. Standard errors are clustered by school district.

Table C.3: Student performance – with boost controls

	(1)	(2)	(3)
Panel A: Pool across subject	Grade 3	Grade 6	Grade 9
Treat	0.018*	0.025***	0.005
	(0.010)	(0.008)	(0.008)
R^2	0.474	0.590	0.702
Share	0.095***	0.074***	0.025
	(0.028)	(0.018)	(0.020)
R^2	0.474	0.591	0.702
N	25,207	31,702	15,800
Year × subject FE:s	Yes	Yes	Yes
School × subject FE:s	Yes	Yes	Yes
School controls	Yes incl boost	Yes incl boost	Yes incl boost
Panel B: Pool across level	Maths	English	Swedish
Treat	0.018**	0.015*	0.020***
	(0.008)	(0.008)	(0.007)
R^2	0.533	0.627	0.561
Share	0.083***	0.039**	0.075***
	(0.017)	(0.018)	(0.017)
R^2	0.533	0.627	0.561
N	28,428	15,831	28,450
Year × level FE:s	Yes	Yes	Yes
School × level FE:s	Yes	Yes	Yes
School controls	Yes incl boost	Yes incl boost	Yes incl boost

Note: The table presents the results of estimating eq. 10, with additional controls for the Maths and Reading Boost reforms. In Panel A we pool the results across subjects. In Panel B we pool the results across levels. Treatment variables are "treat" (a dummy equal to one if there is at least one subject & level career teacher at the school) or "share" (the number of subject & level career teachers at the school in year t divided by the number subject & level teachers in the school in $t-1$). School controls are log number of students, student to teacher ratio, and dummies for participating in the boost reforms. The results of the national exams are standardised by year, subject and level to have mean 0 and st.d. 1. Each school obtains a mean standardised score. Standard errors are clustered at school district level.

Table C.4: Sensitivity checks – Student performance

	Grade 3		Grade 6			Grade 9		
	Maths	Swedish	Maths	English	Swedish	Maths	English	Swedish
Panel A: Lead subject CT								
Share	0.095**	0.089***	0.108***	0.044*	0.073***	0.006	0.020	0.045
	(0.038)	(0.028)	(0.027)	(0.022)	(0.027)	(0.028)	(0.031)	(0.028)
Lead share	0.019	0.047	0.014	0.009	0.022	-0.012	0.042**	0.051**
	(0.044)	(0.033)	(0.022)	(0.017)	(0.028)	(0.025)	(0.019)	(0.023)
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 B: Share all teachers								
Subject/level 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: We regress standardised test scores on subject & teaching level-specific reform variables. In Panel A we use the number of subject & teaching level career teachers in year t over the number of subject and teaching level teachers in $t-1$, and the lead of that share. In Panel B we use the number of subject & teaching-level career teachers in year t over 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 FE, school FE, log number of students and student to teacher ratio. Standard errors are clustered by school district.