The effects of School Accountability on Teacher Mobility and Teacher Sorting

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The effects of School Accountability on Teacher Mobility and Teacher Sorting *

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Abstract

Does school accountability change the teacher composition in schools? We exploit a nested school accountability reform to estimate the causal effect of accountability on teacher mobility and teacher sorting. In 2003, lower secondary schools in Oslo became formally accountable to the school district authority. In 2005, a value added measure of student achievement in lower secondary schools also became public information. Both when using a double and a triple difference estimator, we find significantly increased teacher mobility. Almost all teachers that moved left the teaching sector entirely. Non-stayers were largely replaced by high-ability teachers, yielding a positive sorting effect after the second part of the reform.

JEL-classifications: I2, J2

Keywords: school accountability, teacher turnover, teacher sorting, difference-in-difference-in-difference

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1 Introduction

School accountability is intended to reduce the principal-agent problem in education by providing incentives for teachers to boost student achievement and thereby school performance. However, school accountability may also induce teacher mobility and work as a sorting mechanism. For instance, student achievement is not directly attributable to teacher behavior. In fact, many elements influencing student achievement are out of the teachers' control.[1] Making teachers accountable might therefore induce negative pressure and more risk on teachers, and hence trigger teacher mobility. In addition, school accountability may increase the administrative workload for teachers and may crowd out their intrinsic motivation.[2] Moreover, it may cause a shift in focus, from student learning to student testing. This may induce disutility for some teachers. Teacher mobility might further affect the composition of teachers within schools. Differences in the turnover decisions made by high- and low-ability teachers may induce teacher sorting. If low-quality teachers move and are replaced by high-quality teachers, the sorting effect could be intentional, and could increase overall teacher quality.

In this paper, we study if school accountability has an impact on teacher turnover and teacher composition, and whether it works as a sorting mechanism. We exploit a management reform from 2003 that made schools *internally* accountable to the school district authority for student achievement, and the fact that a market-element was added in 2005: Information on school performance, a measure of conditional student achievement, became public, making schools also *externally* accountable.

[1] See Kane and Stagier (2002) and Koretz (2002) for the pitfalls of imprecise school accountability measures.

[2] Extensive work by Deci and Ryan (e.g., 1985, 2000) indicates that too much control or distrust might negatively influence an individual's intrinsic motivation. Whereas school accountability is meant to give teachers more autonomy in the classroom, school quality measures might be perceived as a signal of distrust. See Fehr and Falk (2002) concerning the psychology of incentives in general.

When studying turnover and recruitment, economists have traditionally emphasized pecuniary variables and to a lesser extent organizational and social structures. However, there is a growing interest in such topics. For example, Boyd et al. (2011) find that teachers with better pre-service qualifications are more likely to apply for a transfer, while teachers whose students demonstrate higher achievements are less so. Jackson (2009) studies the causal effect of changes in student characteristics on teacher sorting. He finds a decline in teacher quality in schools with increased black enrollment share due to these schools losing experienced and effective teachers.

Although there exists a vast literature on teacher mobility and sorting, their effects have largely been overlooked in the school accountability literature. Numerous studies have found that school accountability has a positive effect on student test scores (e.g., Rouse et al., 2013), however there is no real consensus on the mechanism through which the impact of accountability takes place.[3]

Confounding sorting effects play an important role in other settings. Lazear (2000) finds that introducing performance pay in the auto glass sector increased productivity by 44 %. Half of the increase was attributed to sorting, the other half to incentives. In a field experiment, Leuven et al. (2011) find that more able students tend to select themselves into tournaments with the higher prizes, and find no effect of tournament participation on study effort and exam results. Their results indicate that the non-experimental results are completely due to sorting, not incentives.

[3]Hanushek and Raymond (2004)) find that just reporting results has minimal impact and that the force of accountability comes from attaching sanctions and rewards. Bishop et al. (2001) find that the "stick is more effective than the carrot". Harri and Herrington (2006) argue that the positive effects of accountability should mainly be attributed to the existence of exit exams. Rouse et al. (2013) show that improvement in student achievement can be attributed to changes in teaching practices.

The literature on school accountability focuses mainly on channels through which school rankings can induce gaming responses: Teachers increase the use of special education placements (Jacob, 2005; Figlio and Getzler, 2006), substitute away from low-stakes subjects (Figlio, 2006), teach for the test (Jacob, 2005), cheat (Jacob and Levitt, 2003), and shift more attention to students in the middle of the achievement distribution in order to inflate accountability scores (Neal and Schanzenbach, 2010).

Feng et al. (2011) are one of few to study the effect of school accountability on teacher mobility.[4] They exploit a change in Florida's school accountability system that exogenously shocked some schools to higher accountability scores and others to lower accountability scores. They find that teachers are more likely to leave schools that have been downwardly shocked and less likely to leave schools that have been upwardly shocked. Dizon-Ross (2014) goes one step further and also study joining teachers' quality. She finds that a lower accountability grade among schools at the bottom end of the school grade distribution decreases teacher turnover among high-quality teachers and increases joining teachers' quality, whereas a lower accountability grade among schools at the top end of the school grade distribution has no turnover effect, but decreases joining teachers' quality.

We follow up the analysis of Feng et al. (2011) and Dizon-Ross (2014) by studying the effect of accountability on teacher composition. More specifically, we study if the ability distribution of the teachers changes as a consequence of the reform. Teacher ability is in the following based on teachers' academic performance in higher education. Several scholars provide evidence of

[4]There are some papers on school accountability and the mobility of school principals. E.g., Li (2012) finds that No Child Left Behind induced more able principals to move to schools less likely to face sanctions, thereby decreasing the average principal quality at schools serving disadvantage students. In addition, there are a few papers on school accountability and pupil sorting. E.g., Burgess et al. (2013) find indications of student sorting when school accountability was combined with school choice.

a positive influence of teacher' academic achievement on student achievement, and hence that teachers' own grades from higher education is a proxy for teacher quality (e.g., Hanushek et al., 2014; Hanushek and Rivkin, 2006; Clotfelter et al., 2006 and 2007). In addition, teachers' own academic achievement is a good indicator regarding teachers' outside options as teachers own grades are salient for potential future employers. In contrast to Feng et. al. (2010) and Dizon-Ross (2014), we study the reactions to the introduction of an accountability system instead of reactions within an already existing one. Furthermore, we disentangle teacher responses to two accountability regimes, one internal and one external, and study how they trigger teacher turnover and sorting. Although not able to make causal inference, we also discuss if a potential gain in student achievement is related to changed behavior of the incumbent workforce or to changes in the ability composition of teachers.

The performance indicator is salient in an accountability system. The performance indicator embedded in the nested school accountability reform was based on student grades. The lack of grading in primary education created a higher reform intensity in lower secondary than in primary education. We exploit this difference in reform intensity in a differences-in-differences (DD)-approach. For the general policy environment and the composition of students to be similar in the treatment and comparison groups, we compare lower secondary school teachers to primary school teachers in Oslo, before and after the reform was introduced. To ensure that any results are not driven by systematic differences between lower secondary and primary school teachers, we add a third difference: We compare the difference between treated teachers in lower secondary education and untreated teachers in primary education in the reform district to the difference between lower secondary and primary school teachers in school districts not affected by the reform in a difference-in-difference-in-differences (DDD)-

approach. We use rich Norwegian data on public school teachers to study causal effects of school accountability on teacher turnover and sorting.

We find significantly increased teacher mobility after the internal part of the reform. The external part of the reform also triggers teacher turnover in lower secondary education, but not to a larger extent than the internal part. Almost all non-stayers leave the teaching sector entirely. High-ability teachers respond more strongly in terms of teacher mobility than low-ability teachers. Nevertheless, we identify a positive sorting effect after the external part of the reform, indicating that high-ability teachers who quit are being replaced by other high-ability teachers. We find a small positive relationship between student achievement and school accountability after the external part of the reform, which is coherent with the pattern of teacher sorting.

The paper proceeds as follows: Section 2 presents the institutional setting and the reform details. The empirical strategy is outlined in section 3. Section 4 presents the data, defines important variables in the analysis, and presents some descriptive statistics. Section 5 presents the empirical results and robustness tests regarding teacher mobility and sorting. Section 6 offers a discussion on how sorting and incentive effects may contribute to student achievement. Section 7 offers some concluding remarks.

2 Institutional setting and the accountability reform

2.1 The Norwegian educational system

The educational system in Norway is based on public schools, in which more than 95% of the students are enrolled. Public schools have a common curriculum and the same number of teaching hours in each subject. They are organized in school districts and each district is in charge of their own school policies. Oslo, the reform district, has proved to be an active policy maker. For instance, teachers in Oslo are hired by the school they work at, which is not the case for all school districts in Norway. Whereas the governance structure can vary across districts, it is similar for primary and lower secondary school teachers within school districts.

The desirability of retaining and firing teachers may change as schools become more responsible for their performance. In Norway, the teacher labor market is strictly regulated, making it difficult to lay off teachers who have permanent positions. In addition, wage bargaining is centralized. There is little variation in wages across teaching jobs, and wages are difficult to use as a means of retaining teachers. In such an environment, mobility within the school sector will primarily be motivated by non-wage job attributes, as found by Falch and Strøm (2005).

Alternative wages are important in explaining out of sector mobility (Dolton and van der Klaauw, 1995, 1999; Hoxby and Leigh, 2004). Chingos and West (2012) find that teachers with high value added have higher earnings compared to other teachers after leaving the teaching sector. In Norway, the wage structure is compressed and the returns to education are generally low, particular in the public sector (Barth and Moene, 2000). In terms of wages, teachers' external labor market is similar to the teacher labor market at least within the public sector.

As regards the student body, schools take in students based on their catchment areas. The compulsory education track, composed of primary and lower secondary education, starts at age 6 and continues until the age of 16. In contrast to many other countries, students in Norway are not graded before entering lower secondary education at the age of 13. In primary education, the evaluation of students is based on low-stakes tests only. There is no objective measure of school performance in primary education in the time period analyzed. Students in lower secondary education, on the other hand, are graded by their teachers in a total of ten subjects. In addition, students sit for one central exit exam.[5] Grades from the last year of compulsory education are used to compete for study seats in upper secondary education, making them high stakes for the students.

2.2 The nested accountability reform

An emphasis on school performance was gradually implemented in Oslo. In 2002, there was a major reorganization in which school principals were granted substantive impact on school policies and hence assigned an important role in the process of generating educational success.

In 2003 (i.e., the internal part of the reform), school principals became accountable to the school district authority for student achievement. Individual meetings at which school performance was discussed were arranged annually between the authority and each school principal. School performance was based on student achievement. In lower secondary education, student grades (both teacher-awarded grades and central exam scores) were salient in this respect. Student grades are easily interpretable to both teachers, principals, and the

[5]Students are randomly assigned to one examination among four subjects: Norwegian I and II, English and mathematics.

school district authority. In the case of low performance, school principals had to commit to changes in order to increase performance later on.

In 2005 (i.e., the external part of the reform), a market element was added to the accountability regime. First, a new adjusted school quality indicator was calculated for schools in lower secondary education, which aimed at indicating each school's contribution to student achievement, i.e., the value added. The indicator was based on mean grade points from both teacher-awarded grades and central exams, and it was adjusted for individual student and parental characteristics (Hægeland et al., 2004). By relaying on student grades that are high stakes for students in contrast to accountability tests, the scope for gaming by teachers was reduced. Adjusting the school quality indicator and including centrally graded exam scores also made artificially inflating student achievement more difficult.

Second, the school quality indicator was publicly disclosed for the first and only time on November 18th. The aim was to inform parents and other stakeholders, and to further induce teachers to focus on school performance. At the time of the publication, both school principals and the public were told that there would not be any further public disclosures of school quality indicators. After the 2005 general election, the new government strongly opposed public disclosure of school performance. Hence, the threat of further exposure for teachers in lower secondary education in Oslo was no longer imminent.

In 2006, a national reform implemented accountability mechanisms in all school districts, thereby aligning the system in Oslo with other school districts. In addition, a new performance measure with written assessments was implemented in primary schools in Oslo from 2006.

2.3 What to expect of the nested accountability reform?

Neither the internal nor the external part of the reform were so-called high-stakes accountability regimes. Both were low-powered as no rewards or sanctions - such as threats of firing teachers, replacement of principals, or reconstitution of schools - were attached. Whereas these elements are often regarded as necessary to change teacher behavior, Figlio and Loeb (2011) suggest that even accountability systems absent of strong sanctions or rewards will affect the teaching environment and impact student achievement. In fact, increased focus on school performance and creating a new focal point can in itself be effort enhancing[6]

The internal part of the reform initiated a new way for school principals and teachers to govern and conduct schools. School principals were made responsible for student achievement towards the school district authority, and teachers were the main channel through which they could fuel student achievement. School principals were therefore induced to inform and motivate teachers in parallel with delegating more responsibility and making teachers more accountable for student achievement. Furthermore, the incentive embedded in the external part of the reform was more high-powered. The ranking of schools based on adjusted student grades, which could be interpreted as school value added, was made public. This external mechanism was added to the internal part of the reform and could have provided enhanced incentives for teacher to increase student achievement.[7]

School accountability may, however, not function as an incentive for incumbent teachers

[6] In a theoretical setting, Dewatripont et al. (1999), by extending the one-task career concerns model of Holmström (1982), find that total effort goes up when the number of tasks an individual has to perform decreases. The rationale behind this result is that accountability increases with the "clarity" of an organization's mission. In contrast, when an organization practices a "fuzzy mission" the market is uncertain about which mission an individual is actually pursuing, inducing lower career concerns, effort and performance.

[7] Carnoy and Loeb (2002) find a positive and significant relationship between the strength of states' accountability systems and achievement gains.

to increase their effort. As mentioned in the introduction, teachers might find the conditions under which they operate inadequate: Many elements influencing student achievement are out of their control. Accountability may also crowd out teachers' intrinsic motivation, and may lead to a shift in focus from student learning to testing. The performance-contract between schools and the school district authority is also likely to have induced a higher administrative workload for teachers in Oslo compared to in other parts of the country. Hence, the nested school accountability reform may trigger teacher mobility.

Different teacher types may react differently to school accountability. Whereas high-quality teachers are considered to embody the necessary skills in order to respond to the new regime and therefore are more likely to stay than low ability teachers, they might find it hard to increase the overall school performance and may become demotivated, and hence leave. In addition, high-quality teachers, as measured in terms of teachers' academic achievement, may have better outside options compared to low quality teachers as potential future employers value applicants with strong academic records.

Dohmen and Falk (2010) find that introducing performance pay for teachers may crowd in teachers who are less trusting and more negatively reciprocal, at the cost of the current profile. As a consequence, the composition of teachers might negatively change and have an adverse effect on students' educational progress. A low-stakes accountability system is likely to yield different results. The incentives inherent in the accountability regime studied in this paper might be more suitable for teachers than the individualized and explicit incentive studied by Dohmen and Falk (*ibid.*).[8]

[8]Individual performance pay can be an adequate incentive for teachers (e.g., Lavy, 2009). Lavy (2015) even finds that teachers' pay for performance has positive long run effects on students' educational and labor market outcomes. Barley and Neal (2012) propose an incentive scheme for educators that rely on ordinal information contained in assessment results. They claim that such a scheme will reduce the gaming behavior of teachers

3 Empirical strategy

3.1 Teacher mobility

To estimate what we can interpret as a causal effect on teacher mobility by the reform, we need to control for two kinds of potentially confounding trends: Changes in teacher mobility over time that have nothing to do with the nested reform, and differences in teacher mobility between teachers at the different school levels. We employ a DD-framework to estimate the effect of the accountability reform on teacher mobility.

The existence of grading in lower secondary in contrast to in primary schools result in lower secondary being affected and primary schools not affected by the reform. We exploit this difference in accountability pressure by using lower secondary education as treatment group and primary education schools as comparison group.

The school districts are in charge of school policies, and Oslo has proved to be an active policy maker. For the general policy environment to be similar in the treatment and comparison groups, we only include schools from the same school district. Moreover, primary and lower secondary schools in Oslo share the same student population, which could be a factor impacting teacher turnover.

The following DD-equation is estimated:

$$y_{ist} = \beta_o + \beta_1 E_s + d_t + \gamma_1 (E_s d_t^T) + \beta_2 X_{it} + \varepsilon_{ist} \quad (1)$$

as these schemes are more adequate than those relying on cardinal rankings. In general though, output-based incentives for teachers are often suggested to be low-powered in order to avoid gaming as high-powered explicit incentives are best used when output is well defined, the effort-performance relation is well understood, the production is uni-dimensional, and the outcome is easily measured (Dixit, 2002; Lazear, 2003).

The outcome variable y_{ist} is a dummy for whether teacher i who works at school s quits the job in year t or not. β_o is a constant. E_s is a dummy variable that equals one if s is a lower secondary school and zero if a primary school, i.e., the comparison group. d_t is a set of year dummies covering the period before, during and after the nested accountability reform (i.e., 2000-2006). d_t^T is a dummy variable equal to one if a reform year (i.e., 2004-2005 or 2006) or zero otherwise. X_{it} is a vector of covariates that include gender, age, experience, controls for yearly local labor market conditions by educational background, a dummy for working in primary or lower secondary education, teacher education level, and dummies for having a teacher education at bachelor's and master's level. Age and experience are included as a quadratic functions. ε_{ist} is a random error term clustered on school level to safeguard against the possibility that the error term can be correlated within schools.[9] Our parameter of interest in Equation 1 is γ_1. This parameter, in which the reform year dummy is interacted with treatment group status, measures the change in teacher turnover in the reform years relative to the years before the reform.

Quit decisions are made each year, so we also estimate a more general equation than Equation 1. Instead of an average reform effect, pooled over all reform years we replace the DD-parameter, γ_1, with a vector of year specific parameters. Both specifications allow us to study the mobility responses to the internal (2004-2005) reform and the additional external element in 2006.

That the same reform leads to different accountability pressure in primary and lower secondary schools is a hypothesis that is important for identification. Grades in lower secondary

[9]To avoid a potential bias from too few clusters, we never have fewer than 42 clusters in any of our regressions. See Angrist and Pischke (2008).

education, salient to the difference in accountability pressure, are easily interpretable and the learning objectives for the them are clearly stated. Grades in lower secondary education are given for each grade level and in all subjects. In contrast, tests in primary education are low stakes, and evaluations of students are neither easily interpretable nor comparable across classrooms. If the hypothesis does not hold, and primary school teachers are affected in the same way in spite of the institutional differences, any effects must be a result of other factors influencing the difference between primary and lower secondary school in Oslo. On the other hand, if primary and lower secondary school teachers are similarly affected by the reform, but react opposite, we will overestimate the effect of the reform.

There are concerns with the DD-approach. Systematic differences in educational traits for primary and lower secondary school teachers could imply that common shocks in the labor market affect the two groups of teachers differently. If that is the case, the estimated effect using Equation 1 is not necessarily an effect of the reform, but could be an effect of different reactions to labor market conditions in primary and lower secondary education.

Systematic differences between primary and lower secondary school teachers should be similar across school districts. There might be a difference in how shocks affect primary and lower secondary school teachers, but the difference should be similar inside and outside the reform district. To safeguard that the estimated reform effect is not caused by different reactions to the same shocks, we compare the difference between lower secondary and primary school teachers in the reform district to the same difference in the rest of the country before and after the reform.

By adding a third difference between teachers inside and outside the reform school district, any within-school level differences, e.g., systematic differences in educational traits, are netted

out. Differences in the labor market situation across school districts are still accounted for by the fact that primary and lower secondary education teachers are situated in the same labor market area.

In the DDD-framework, the following equation is estimated:

$$y_{ist} = \beta_o + \beta_1 T_s + \beta_2 E_s + d_t + d_t E_s + d_t T_s + \gamma_1 (T_s E_s) + \gamma_2 (T_s E_s d_t^T) + \beta_3 X_{it} + \varepsilon_{ist} \qquad (2)$$

Our parameter of interest from Equation 2 is γ_2. This parameter measures the change in teacher turnover in the reform years in the difference between turnover for lower secondary school teachers and primary school teachers inside and outside the reform district. T_s is a dummy that equals one if school s is situated in the reform district and zero if situated outside of the reform district.

There might still be concerns with the DDD-approach. If the reform led to strategic moving by parents, large changes in moving patterns could have led to changed student composition in schools, which again could affect teacher mobility. Fiva and Kirkebøen (2011) find an increase in housing prices near high-quality schools in Oslo as a consequence of the second part of the reform, indicating strategic movings. However, the effect was short-lived, and thus could not have led to large changes in the student composition. That our effect is driven by compositional changes due to the second part of the reform is therefore unlikely.

In general, there are indications of student composition influencing teachers' mobility decisions (e.g., Lankford et al., 2002; Hanushek et al., 1999; Falch and Strøm, 2005). We therefore perform robustness tests to test whether changes in school characteristics over time drive our

results by excluding small schools and schools with a high immigrant share.

The labor market for teachers could be systematically different in large cities and more rural areas. We test whether the results are robust to only including large cities in the comparison group. Another concern is that the treated school district is a different labor market district from also the other large cities. However, the surrounding municipalities share the same labor market, so we include municipalities surrounding the treated school district as a comparison group in another robustness test.

Changes in the accountability regime could lead to sorting within the school sector, i.e., that teachers move to schools with higher performance or outside the treated school district. To find out whether changes in the turnover is a result of within-sector sorting, we estimate Equation 2 with the outcome of leaving the teaching sector.

There could be heterogeneous responses to the accountability reform, which can induce teacher sorting effects. We estimate Equation 2 separately for teachers with academic achievement above and below mean separately. We also estimate Equation 2 separately according to gender, educational background, age and experience.

The main underlying assumption in a DD- and DDD-approach is the existence of a common trend before the reform. We check whether such an assumption holds both by graphical examination and a placebo test.

3.2 Teacher sorting

The overall effect on teacher composition depends not only on who leave, but also on the teachers replacing the ones who leave. To find out if there is a sorting effect of the nested

school accountability reform, we estimate the effect on the mean academic achievement of the teacher stock in schools. Systematic differences in teacher composition between primary and lower secondary education might be a larger concern when studying outcomes at the school level. We therefore use a similar empirical approach as in Equation 2, but with mean academic achievement within the school as the outcome:

$$y_{st} = \beta_o + \beta_1 T_s + \beta_2 E_s + d_t + d_t E_s + d_t T_s + \gamma_1 (T_s E_s) + \gamma_2 (T_s E_s d_t^T) + \beta_3 X_{st} + \varepsilon_{st} \quad (3)$$

The outcome y_{st} measures mean academic achievement of the teacher stock at time t for school s. All explanatory variables have the same interpretation as in Equation 2, with the exception of X_{st}, which now denotes a vector of control variables at the school level, including mean age, mean educational level, mean years experience, and male share. Our variable of interest is still γ_2.

Several authors provide evidence of a positive influence of teachers' academic achievement on student achievement and hence that teachers' own grades from higher education is a proxy for teacher quality (e.g., Hanushek et al., 2014; Hanushek and Rivkin, 2006; Clotfelter et al., 2006 and 2007). Teachers with strong academic records are not always the same as those who actually boost student achievement, but when analyzing teacher mobility, teachers' own academic achievement is a good indicator for teachers' outside options as teachers own grades signals ability to future employers. We also check how composition in terms of male share, experience, age and teacher educational background is affected by the reform.

4 Data and Descriptive Statistics

We use rich register data on public school teachers from Statistics Norway to study teacher turnover and sorting in Norway in the period between 2000 and 2006. Employment data on teachers includes information on gender, age, education, employment code, and experience (measured as years spent at the school). The employment data does not only cover a yearly reference week, but every 4 weeks during the year. The data source contains school identifiers and personal identification codes for each teacher. Since teacher mobility can be influenced by local labor market conditions we add yearly data on local unemployment by education level.

The sample is restricted to teachers eligible for permanent appointments. Non-certified teachers are not eligible for permanent positions, and are subject to involuntary moves. We therefore restrict the sample to teachers who either have a teacher education, or a teacher employment code. We also restrict the sample to those who work more than 50 percent of full-time. The pension age in Norway is 62 for most teachers, and we do not want to include those who leave the profession due to age. Therefore, only teachers between the ages of 20 and 60 are included in the sample for each year. Moreover, some schools in Norway are combined primary and lower secondary schools. We are not able to identify whether teachers at combined schools work in primary or lower secondary education, and combined schools are therefore excluded. Schools that were closed down during the period are also excluded from our sample, which is only relevant in the comparison group in the estimation period.

We add micro data on teacher academic achievement. To construct an ability index, we use teachers' own grades from higher education institutions (HEI), that is, all universities and university colleges in Norway. A range of different grading scales is used for grades included

in the sample.[10] We normalize every grade within each grading scale and year, and calculate the mean grade for each person, using all grades except for pass/fail.[11] The ability index is adjusted for institution- and field-specific effects. Even if it is a strength that HEI use external examiners from other institutions, grading practices can still vary across HEI and study fields. Also other teacher characteristics may contribute to student achievement, e.g., teacher effort, personal traits, and teaching practices. Nevertheless, our ability index is a good indicator for teachers' outside options as teachers' own grades signals ability to future employers. To control for teachers' academic achievement, we include a dummy for having academic achievement above average.

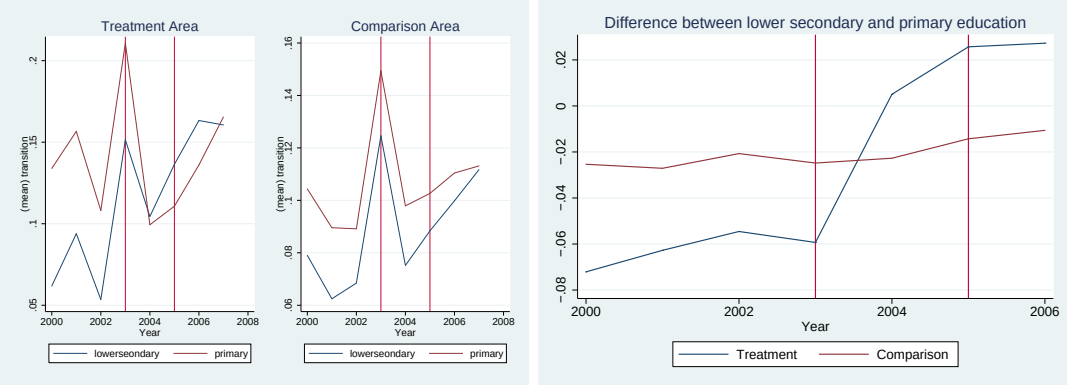
The sample includes 22 196 observations in Oslo, and 278 909 observations in total for 64 306 teachers for the years 2000-2006. Table A.1 in the Appendix gives a descriptive overview of the main variables used in the analysis, for the total sample and for the treatment and comparison groups separately. As regards data on teachers' performance in higher education, we have information about at least one grade for 48 792 teachers in the sample.

The outcome variable in the mobility analysis is to leave the school, which is defined as not being registered as employed in the same school during the next calendar year. Persons who have an end to their employment spell in a specific school during a year will not be registered as employed in the next year, and are thus making a transition. The exception is if they quit the job, but return to the school so that they are registered as employed in the school the next year. In that case, they will not be registered as making a transition by our definition. Most teacher mobility takes place during summer. For teachers who are employed at several

[10] A national grading system in HEI was first implemented in 2003.

[11] 60 percent of all grades included in the sample are obtained by teachers with exams in educational science.

Figure 1: Teacher Turnover in Lower Secondary and Primary Education



schools at the same time, we chose what we define as the main employer (highest number of working hours and highest seniority). To leave the school thus includes changing jobs to other teaching jobs both inside and outside the treatment area, or leaving the sector entirely. Making schools accountable for student achievement to the school district authority in 2003, and publicly distributing new information about school quality in November 2005, are most likely to influence teacher turnover from 2004 and 2006, respectively.[12]

The critical assumption for both the DD- and DDD-approach is that in the absence of the nested reform, the difference between lower secondary and primary school teachers follow a similar trend. The first part in Figure 1 indicates a common pre-treatment trend in Oslo, the treatment area. The third part in Figure 1, which shows the difference in mobility responses between lower secondary and primary education teachers in the treatment and comparison areas, suggests that there is also a common trend in the difference between lower secondary and primary school teachers before the reform. In the pre-treatment period, teacher turnover in primary education is higher than teacher turnover in lower secondary education. That changes, however, in the treatment period. For the comparison group (see second part in

[12]Teachers were not informed long before the implementation of each reform, i.e., teachers could not adjust their mobility responses ex ante, only ex post.

Figure 1), there is no such shift. These figures thus provide the first indication that the nested school accountability reform impacts lower secondary and primary teachers in the reform district differently.

As suggested in Section 3.1, there are no parallel pre-trend when comparing lower secondary school teachers' mobility in Oslo to the rest of the country (see part one and two in Figure 1). This, however, is not a threat to our DD- and DDD-estimators as we exploit the differences between lower secondary and primary school teachers.

There is a spike in teacher mobility in 2003 for both teacher groups in both areas, as seen in Figure 1, indicating that national events affected both the treatment and comparison groups. Such events could be the surprisingly low performance on the PISA-test or business cycle conditions.[13] Teacher unemployment reached a peak in 2003, which is coherent with the peak we find in our data. Tighter budget constraints at the school district level are the main reason for the high teacher unemployment in 2003. Neither of these events should influence our DD- and DDD-estimates, since it is unlikely that they would influence the difference between teacher mobility in lower secondary schools and primary schools in Oslo, and unlikely that they would influence the same difference in other parts of the country.

Our main analysis ends in 2006 when the accountability regime in our comparison group changes. As a part of the robustness tests, long-term effects are also analyzed by adding data to 2008. With higher accountability intensity in primary education in Oslo, and the introduction of accountability regimes in the rest of the country, an increase in mobility in all parts of our comparison group could be expected after 2006.

[13]During the period studied, Norway participated in PISA in 2000, 2003, and 2006. Norway performed badly on the first PISA-test, and this is often referred to as the "PISA-shock".

The data used in the sorting analysis are aggregated to school level. We calculate mean academic achievement of teachers within schools, which is our primary outcome variable in the sorting analysis. Positive sorting in terms of mean teacher ability implies that schools are able to attract and/or replace their high-ability teachers. For this analysis, we have 13 495 observations from 2360 schools.

We use data on student achievement to discuss sorting and incentive effects on student achievement in Section 6. In Norway, data on teachers' evaluations and central exam scores for 10th grade have been collected from 2002. Included are student grades in all subjects for the last year of lower secondary education.[14] In total, we have information on grades and social background variables for 278 223 students for the years 2002-2008.

5 Results

5.1 Teacher mobility

Table 1 shows the results from the DD-analysis based on Equation 1. Column 1 shows the average effect pooled over reform years while column 2 and 3 show year specific effects. In column 3, control variables for teacher background are added.

Column 1 reveals a substantial effect of the reform on teacher mobility. We estimate a 7.7 percentage points increase in teacher mobility after the first part of the reform and a 8.9 percentage points increase after the second part, from a pre-reform level of around 10 percent (see Table A.1). Column 2 shows that the reform effect is the smallest in the first year, with an estimate of 6.7 percentage points, before it increases with about 2 percentage points

[14] Test scores on national tests for primary and lower secondary education are only available from 2007.

Table 1: The Effect of Accountability on Teacher Mobility, DD-specification

	Pooled reform effect		Reform effect by year		Reform effect by year with controls	
Lower Secondary	-0.062	(0.008)***	-0.062	(0.008)***	-0.037***	0.009)
Oslo*Lower Secondary*(2004-2005)	0.077	(0.013)***				
Oslo*Lower Secondary*2004			0.067	(0.015)***	0.045	(0.013)***
Oslo*Lower Secondary*2005			0.088	(0.017)***	0.064	(0.016)***
Oslo*Lower Secondary*2006	0.089	(0.022)***	0.089	(0.022)***	0.066	(0.019)***
R-squared	0.013		0.013		0.202	
Number of observations	22 196		22 196		22 196	

Note: All specifications are estimated by OLS and include a constant term, year dummies (ref. 2000), and the interaction terms ($E_s * d_t$). Standard errors are clustered on school level. */**/*** statistically significant at the 10/5/1 percent level.

from 2005. The external reform element added in 2005 does not lead to a further increase in the 2006-effect. Publicly disclosing school performance seems therefore, on average, not to alter the mobility response of lower secondary school teachers relative to the response already emanating from the internal part of the reform. Adding controls for teacher background decreases the magnitude of the effect, although the pattern is similar. Column 3 reveals a reform effect of 4.5 percentage points the first year, before it increases to about 6.5 percentage points in the subsequent years.

As lower secondary school teachers have different characteristics, and thus may be exposed to different shocks, we add a third difference; between the school district of Oslo and other school districts. Column 1 in Table 2 reports estimated results based on Equation 2, whereas Columns 2 and 3 report year specific effects. Control variables for teacher background are added in Column 3.

Column 1 shows an average treatment effect of 7 percentage points after the internal part of the reform, and the same effect is found for the external part of the reform. Decomposing the average treatment effect of the 2003 reform (calculated for the period 2004-2005) into

Table 2: The Effect of Accountability on Teacher Mobility, DDD-specification

	Pooled reform effect		Reform effect by year		Reform effect by year with controls	
Oslo	0.026	(0.004)***	0.026	(0.004)***	0.017	(0.004)***
Lower Secondary, Oslo	-0.037	(0.002)***	-0.037	(0.002)***	-0.020	(0.002)***
Lower Secondary	-0.011	(0.005)**	-0.011	(0.005)**	-0.015	(0.004)***
Oslo*Lower Secondary*(2004-2005)	0.071	(0.004)***				
Oslo*Lower Secondary*2004			0.065	(0.004)***	0.052	(0.004)***
Oslo*Lower Secondary*2005			0.077	(0.005)***	0.066	(0.005)***
Oslo*Lower Secondary*2006	0.075	(0.005)***	0.075	(0.005)***	0.063	(0.005)***
R-squared	0.006		0.006		0.179	
Number of observations	278 909		278 909		278 909	

Note: All specifications are estimated by OLS and include a constant term, year dummies (ref. 2000), and the interaction terms $(T_s * d_t)$ and $(E_s * d_t)$. The third specification is used in all subsequent tables. Standard errors are clustered on school level. */**/*** statistically significant at the 10/5/1 percent level.

year-specific effects in Column 2 and 3 reveal the same picture as before: The reform effect is the smallest in the first year, then increases in 2005, and remains the same in 2006.

The results in Table 1 and 2 are quantitatively the same. The estimates are somewhat higher in column 1 and 2 in the DDD-analysis than for the DD-analysis, but when adding controls for teachers' educational background in column 3, the results from the two models are aligned. The similarity of the results in the two models leads to the conclusion that primary and lower secondary school teachers are not exposed to different shocks. However, there are compositional effects that lead the results in column 2 and 3 to be different in the DD-analysis. The DDD-analysis are less sensitive to such a concern. In the following analysis, we thus keep the DDD-framework and the third specification with teacher controls.

Individuals may respond differently to incentives (e.g., Leuven et al., 2010; Bettinger, 2010; Angrist et al., 2009; Angrist and Lavy, 2009). Heterogeneity in terms of mobility may also have implications for teacher sorting, i.e., the net impact of teacher outflow and inflow. We therefore compliment the analysis by studying heterogeneous mobility effects, see Table

3. We find that high-ability teachers are more responsive to the reform than low-ability teachers. More precisely, teachers with strong academic records react stronger than those with academic achievement below average in 2004 and 2006. In 2005, there is no significant difference in the mobility response for the two groups.[15] The difference in the 2006-effect is substantial considering that the baseline mobility is similar for high- and low-ability teachers. Regarding the stronger reaction in the high-ability group, an important reason may be that those with higher academic achievements also have better labor market prospects as academic achievement serves as a signal of ability. The sample is reduced when estimating the effect by ability group as we do not have information on academic achievement for all teachers. However, the reduction of the sample does not change the results when estimating Equation 2. Other studies have also found that teachers with high academic achievements more often leave the teaching profession than teachers with lower scores, although not as a consequence of school accountability (Murnane and Olsen, 1990; Henke et al., 2000; Podgusrsky et al., 2004; Boyd et al., 2011).[16]

For other subgroups, the heterogeneous effects are as follows: Teachers with relatively short experience (less than 4 years at the same school) react stronger to the reform than their more experienced colleges. Younger teachers (below 40) respond more strongly to public exposure than their older counterparts as younger teachers change jobs to a significantly greater extent than older teachers after the external part of the reform. Mobility response is somewhat higher for men than women, although the difference between male and female teachers' responses is

[15] To check whether the differences between the subgroup pairs' DDD-estimates are statistically significant we test the linear combination of two estimates.

[16] We also analyze the effect of new information concerning school performance on teacher mobility. We compare the ranking of schools based on the adjusted and the non-adjusted performance indicator related to the external part of the reform. We find reduced mobility among low-ability teachers in schools receiving a negative information shock, while for high-ability teachers in the same schools the mobility increases.

Table 3: Heterogeneous Treatment Effects, Teacher Mobility

	male		female		young		old	
Oslo*Lower Secondary								
*2004	0.064	(0.005)***	0.048	(0.005)***	0.052	(0.007)***	0.050	(0.004)***
*2005	0.101	(0.007)***	0.050	(0.005)***	0.055	(0.008)***	0.069	(0.005)***
*2006	0.064	(0.007)***	0.053	(0.005)***	0.078	(0.008)***	0.046	(0.005)***
R-squared	0.220		0.204		0.234		0.160	
Number of observations	79 372		199 537		90 278		188 631	
Baseline mobility	10.83		11.52		15.75		7.88	
	long experience		short experience		Teacher Education		general education	
Oslo*Lower Secondary								
*2004	0.039	(0.004)***	0.114	(0.016)***	0.043	(0.004)***	0.003	(0.012)
*2005	0.058	(0.004)***	0.087	(0.016)***	0.050	(0.005)***	0.034	(0.012)***
*2006	0.042	(0.004)***	0.127	(0.017)***	0.037	(0.005)***	0.040	(0.013)***
R-squared	0.060		0.054		0.202		0.272	
Number of observations	232 036		46 873		250 316		28 593	
Baseline mobility	2.42		24.12		12.63		9.40	
	high academic achievement		low academic achievement					
Oslo*Lower Secondary								
*2004	0.074	(0.006)***	0.039	(0.006)***				
*2005	0.061	(0.007)***	0.057	(0.006)***				
*2006	0.097	(0.007)***	0.032	(0.006)***				
R-squared	0.197		0.235					
Number of observations	106 530		99 306					
Baseline mobility	11.04		12.72					

Note: See Table 2

only significant in 2005. Teachers with a designated teaching degree have a stronger mobility response than teachers with a general education in 2004.

5.1.1 Out of sector mobility

So far, we have studied whether lower secondary school teachers change workplaces or not. An alternative outcome is the extent to which lower secondary school teachers leave the sector entirely. That is, do lower secondary school teachers move into other teaching jobs, and strategically move in or out of the treatment group, or do they leave the school sector entirely? Table A.2 shows that most of those who change jobs actually leave the teaching profession.[17] The same mobility effects (results not shown) are found for out of sector mobility as for the main outcome variable, change in workplace. In contrast to previous studies, we do not find that those who leave the teaching profession often leave employment altogether (Stinebrickner, 2002; Fritjers et al., 2004). Few go to better paid jobs, which is coherent with non-wage attributes driving teacher mobility as discussed in Section 2.1.

5.2 Robustness checks

5.2.1 Placebo and alternative comparison groups

We conduct several robustness checks to investigate the sensitivity of our findings. First, we perform a placebo test. Based on Equation 2, we test for plausible reform effects in the years before the nested accountability reform. Reform effects should not be found before the implementation of the nested accountability reform if there exist a common trend. Table 4 shows the year-specific effects for lower secondary education in Oslo before, during and

[17] There are too few observations to study other transitions, such as mobility in or out of treatment.

after the implementation of the nested accountability reform. The DDD-estimates are indeed insignificant in the pre-treatment years 2001, 2002 and 2003. The difference between lower secondary and primary education teachers in Oslo and the rest of the country thus have a common trend before the implementation of the reform.

Table 4: Placebo Test, Teacher Mobility

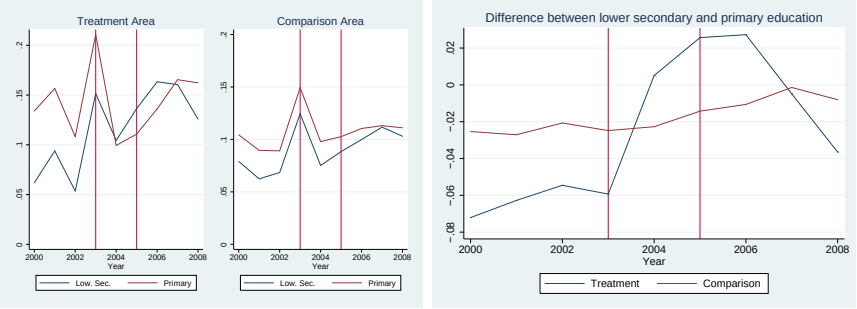
	Specification (3)	
Treatment Effect (ref. 2000)		
2001	0.003	(0.006)
2002	0.003	(0.006)
2003	-0.004	(0.006)
2004	0.052	(0.006)***
2005	0.063	(0.007)***
2006	0.059	(0.006)***
R-squared	0.207	
Number of observations	278 909	

Note: See Table 2

To investigate further whether the results are sensitive to the choice of comparison group, we first exclude small schools (less than 20 persons in full-time positions per school) as a robustness check as there are few small schools in the treatment group. This does not change our DDD-estimates. Neither does excluding schools with high immigrant share, which are concentrated in the treatment area.

It might still be a concern that the labor market for teachers in lower secondary education is different than for teachers in primary education, and that there are differences in labor market conditions in Oslo compared to the rest of the country. We therefore change the comparison group to first only include school districts around Oslo, which are part of the same labor market region, and then to only include the main cities in Norway, which might have similar and, on average, better pools of applicants. None of these changes in the comparison group

Figure 2: Long Term Transition Rates



influence our DDD-estimates (results not shown).

5.2.2 Long-term effects

No long-term effects (for the years 2007-2008) on teacher mobility of the nested accountability reform are found in lower secondary education in Oslo. The effect fades out in 2007 and is non-existent in 2008 (results not shown). Figure 2 shows that the transition rate for teachers in lower secondary education in the reform district decreases after 2006, while it rises for teachers in primary education in the reform district. Written performance assessments were introduced for primary schools in Oslo in 2006, thus increasing accountability intensity for these teachers. An increase in transition rates is also observed in the comparison area post 2006, which could be expected as a consequence of the national 2006 school reform. From 2006, there is an alignment of accountability systems across the country, which is coherent with the pattern for teacher turnover. In this case, the lack of long-term effects strengthens our argument that school accountability does in fact increase teacher mobility.

5.3 Teacher sorting

Which types of teachers sort into schools under school accountability? The previous analysis were concerned with the outflow of teachers, and notably teacher turnover among high-ability teachers. We now study changes in the ability distribution of the stock of teachers at the school level. By estimating the DDD-effect using Equation 3, we disclose if there are any sorting effects.

The mean teacher ability increases in the reform schools in 2005 (not statistically significant) and 2006 (statistically significant), as seen in Table 5. The positive 2006-effect on mean teacher ability amounts to 3.6 percent of a standard deviation within a school. This means that even though the nested school accountability reform does not encourage the right pattern of retention as seen in Section 5.1, lower secondary schools in Oslo are able to attract high-ability teachers.

Large cities face a different pool of potential applicants for available teacher positions than the rest of the country. Sorting may thus be different in the large cities than in the rest of the country, so we repeat the analysis only with the main cities including areas around these cities as comparison group. Reassuringly, we find similar results as when using the rest of the country as comparison group. When performing placebo tests, no significant effects are found for the pre-reform years (results not shown).

Also schools performing below average are able to attract high-quality teachers. Other studies find adverse effects on teacher turnover in low-performing schools (e.g., Clotfelter et al., 2004) and adverse effects on school principal mobility in low-performing schools (e.g., Li, 2012). Dizon-Ross (2014), on the other hand, finds that a lower accountability grade among

Table 5: The Effect of Accountability on Teacher Sorting, DDD-specification

	Rest of the country as comparison group		Large cities as comparison group	
Oslo	-0.041	(0.006)***	-0.029	(0.008)***
Lower Secondary, Oslo	-0.002	(0.010)	-0.011	(0.015)
Lower Secondary	-0.010	(0.012)	-0.001	(0.016)
Oslo*Lower Secondary*2004	-0.004	(0.009)	0.003	(0.010)
Oslo*Lower Secondary*2005	0.015	(0.009)	0.019	(0.011)
Oslo*Lower Secondary*2006	0.036	(0.010)***	0.027	(0.012)**
R-squared		0.017		0.029
Number of observations		13 495		4 268

Note: See Table 2

schools at the bottom end of the school grade distribution decreases teacher turnover among high-quality teachers and increases joining teachers' quality.

Even if we identify a positive sorting effect, it is not certain that the same result applies to all parts of the country. School districts facing difficulties with recruitment in the first place are constrained in recruiting high ability teachers, and negative sorting may thus be a concern. In Oslo, we find that the positive sorting effect is smaller for schools with the highest turnover in the reform period. Schools that need to hire a high number of new teachers struggle to attract enough teachers with high academic achievements.

Table 6 shows the compositional effects concerning other teacher characteristics than ability. Column 1 shows how the male share in the schools are affected by the reform. There are positive effects on the male share in 2005, but such a finding disappears in 2006. For all other characteristics (educational level, experience and age), the compositional effect is growing with exposure time to the reform: We find a slight negative effect on the share with a designated teacher degree, a decrease in experience as a teacher, and reduced mean age at the schools. In 2006, i.e., the third year after implementation, the mean experience is on

Table 6: Other Compositional Effects, DDD-specification

	Male share		Educational level		Experience		Age	
Reform effect								
2004	0.005	(0.007)	-0.015	(0.007)**	0.094	(0.137)	-0.300	(0.172)*
2005	0.028	(0.008)***	-0.016	(0.007)**	-0.171	(0.148)	-0.329	(0.183)*
2006	-0.001	(0.008)	-0.020	(0.007)***	-0.277	(0.163)***	-0.616	(0.192)***
R-squared	0.241		0.192		0.173		0.188	
Number of observations	13 495		13 495		13 495		13 495	

Note: See Table 2

average reduced by a third of a year. Table A.1 shows that mean experience in the sample is 10 years. This could explain why we do not find even larger compositional effects for age and experience.

The sorting effects are more subtle than the mobility effects. If estimating a similar model as Equation 3 only with number of teachers quitting as the outcome variable, on average between 2 and 2,5 more teachers quit in each school per year following the reform. The teacher workforce in each school consists of on average 30 persons. It thus takes time before there are any substantial compositional changes in the teacher workforce. Teacher composition effects, in contrast to teacher turnover, are not immediate responses, but are accumulated over time. That is, a sorting effect in year t does not only depend on changes in the teacher ability-composition in year t, but also the years in advance. We therefore cannot attribute a 2006 sorting effect only to the external part of the reform.

6 What about student achievement?

Ideally, we would like to measure the impact of school accountability on student achievement, and furthermore decompose a potential net effect into sorting and incentive effects. However,

we are not able to identify a causal effect on student achievement. No measure of student performance is available for primary education, thus we cannot use the same empirical approach as for the mobility and sorting analysis. A common trend assumption *across* school districts is a strong assumption when each school district is responsible for its own policies. In addition, the treated school district is different from other school districts in terms of teacher and student composition: Oslo has a higher share of immigrant students, more dispersed social background of the student body, and more teachers with a master's degree compared to the rest of the country.

There are only two years of observations pre-reform. We therefore do not compose a synthetic control group. For decomposing any effects on student achievement into incentive and sorting effects, it would be necessary to link teachers and students for a measure of teacher value added. Such data are not available to us.

Even though we cannot make causal inference with our DD-framework, comparing student achievement in Oslo to the rest of the country, it is interesting to check if there are any patterns in the data following the nested school accountability reform. To measure the influences on student achievement, we construct an index based on 10th grade performance. It includes grades obtained in Math, English and Norwegian, in addition to central exam scores, and corresponds to the unadjusted school quality indicator calculated for all schools in Oslo in 2005. The test scores are normalized with mean 0 and standard deviation 1.

We find a negative estimate of being in a lower secondary school in the reform district in both 2004 (significant) and 2005 (not significant). In 2006, it shifts to a small, but significantly positive estimate, which amounts to about 3 percent of a standard deviation.

Teacher-awarded grades are at least partially within the control of teachers and are there-

fore more manipulable than central exam scores. We find, however, no indication of teachers in Oslo inflating their students' grades as they do not seem to increase more relative to central exam scores. The use of student grades and exams scores as a performance indicator, that are high stakes for the students, and excluding sanctions and rewards may have facilitated a non-gaming behavior. The choice of performance indicator and the lack of gaming may also explain the low increase in student achievement that we find in Oslo relative to other studies.

We find a significantly positive placebo effect in 2003. We are thus not able to confirm a common trend before the reform.[18] Although not causal, our results on student achievement are coherent with the findings on teacher sorting, with a positive sorting effect in terms of teacher ability in 2006. Positive sorting accumulated over time may lead to improved student performance in 2006.

There are other compositional changes due to the reform. Teacher experience, which is considered relevant for student achievement (e.g., Wiswall, 2013), is slightly reduced. Positive sorting in terms of teacher ability and decreased experience level could pull in different directions, and impede the influence of positive sorting.

Teacher turnover may in itself have a negative effect on student achievement (e.g., Ronfeldt et. al., 2013), and could be linked to the decreased student achievement that we find in the first years of the reform.

We cannot rule out that the market element added in 2005 contributed to increasing student achievement through an incentive effect. Furthermore, there might be an additional incentive effect through teacher sorting: Joining teachers of high quality may work as an incen-

[18] We also construct a comparison group based on propensity score matching; matched on characteristics for parental education, migration characteristics (migration age and migration area), and teacher characteristics (gender and education). Using such a comparison group does not alter our results.

tive for incumbent teachers to increase their effort and performance (Jackson and Bruegmann, 2009).

When checking the effects on student achievement for the schools with the highest turnover in the treatment period, the effects on student achievement is smaller than the results from the whole sample. Schools with turnover above the mean also have smaller positive effects on teacher sorting, indicating that positive sorting could contribute positively to student achievement.

7 Concluding remarks

It is essential to understand teacher mobility and teacher sorting if we want to design adequate incentives for teachers and comprehend school performance. In this paper, we have studied two accountability regimes, one internal and one external, and evaluated their causal effects on teacher mobility and sorting. We have also discussed teacher sorting as a mechanism for increased student achievement under school accountability.

We find significantly increased teacher mobility in the years after the internal part of the reform. When using a DDD-estimator, we find that teacher mobility increases with about 6 percentage points after the reform from a baseline of 10 percent. The external part does not trigger teacher turnover to a higher extent than the internal part. The majority of teachers who change jobs leave the public school sector entirely.

Although the turnover rate increases substantially, the increase in the number of teachers leaving their job is still not dramatic. On average between 2 and 2,5 more teachers quit in each school per year following the reform, from an average teacher stock of 30 persons.

We find that high-ability teachers respond more strongly in terms of teacher mobility than low-ability teachers. Nonetheless, high-ability teachers are largely replaced by high-ability teachers: Despite adverse turnover effects, treated schools experience a positive sorting effect after the external reform, as measured in terms of teachers' own grades from higher education. In contrast to teacher turnover, teacher sorting effects are not likely to be immediate responses, but are accumulated over time. We therefore cannot attribute the positive sorting effect only to the external part of the reform.

In accordance with the findings for teacher sorting, we find a small positive relationship between student achievement and school accountability after the external part of the reform. With more suitable data, the causal impact on student achievement could be studied, and sorting and incentive effects could be better disentangled by linking teachers and students. Furthermore, comparing a value added measure to an indicator of teachers' own grades could be interesting in order to see how strongly these two measures of teacher quality are correlated.

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Appendix

Table A.1: Descriptive Statistics for the Estimated Sample (fractions unless otherwise noted)

	SAMPLE	OSLO		OTHER SCHOOL DISTRICTS	
		LOWER SECONDARY	PRIMARY	LOWER SECONDARY	PRIMARY
OUTCOME VARIABLE					
Transition (2000-2006)	10.24	10.99	13.71	8.60	10.61
Transition (2000-2003)	8.95	7.02	13.32	6.97	9.41
EXPLANATORY VARIABLES					
Male	28.46	38.41	18.92	42.36	23.01
Age (average)	42.78	42.51	40.55	43.32	42.76
Experience (average)	10.52	9.53	9.20	11.10	10.42
Unemployment (average)	0.014	0.020	0.020	0.013	0.013
Education at Master's level	10.25	39.32	6.78	21.36	4.85
Teacher Education at Bachelor's level	87.92	57.97	89.87	76.59	93.58
Teacher Education at Master's level	1.83	2.72	3.35	2.05	1.57
Number of observations	278909	5598	16598	77 601	179 112
Number of teachers	64306	1426	4413	19390	43270

Note: The number of teachers in the different subgroups does not add up to the total number in the sample due to mobility across groups.

Table A.2: Types of Teacher Transitions

	Transitions	Percent
Stay in the same school	250 349	89.76
New school, same school district	5 030	1.80
New school, new school district	4 070	1.46
Leave school sector	19 462	6.98