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The Influence of Student Achievement on Teacher Turnover

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ABSTRACT *Evidence on teacher behavior is essential for the understanding of the performance of school systems. In this paper we utilize rich data to study the teachers' quit decision in Norway. We distinguish between decisions to move between public schools within school districts, to another school district in the same labor market region, across labor market regions, and whether to leave public schools. The results indicate that the quit propensity to all four destinations is negatively related to student performance. The result is qualitatively independent of whether student performance is measured by examination results or teacher graduation.*

KEY WORDS: Teacher turnover; student achievement; family status; non-pecuniary factors

Introduction

The recent literature clearly confirms the commonly held view that teachers are important for student achievement (see Hanushek, 2002; Rockoff, 2004). Evidence on teacher behavior and the functioning of the teacher labor market is therefore essential for the understanding of school performance. Both the choices of talented people on whether to go into teaching or not, the decisions of staying within or leaving teaching, and the allocation of teachers across schools are important for students' outcome. The occupational choices are important for the overall efficiency of the school system, while the allocation of teachers across schools is merely a distributional question. If the best teachers are matched with high-performing students and the poorest teachers are matched with low-performing students, the school system may boost the inequalities in society instead of contributing to equal opportunities as intended.

The outcome in the teacher labor market depends on the behavior of several actors. The decision-making of both political institutions and the schools (school boards and school principals), the power of teacher unions, and the behavior of teachers and students contribute to the final outcome. At the most basic level, teacher quality is determined by teacher supply and teacher demand as highlighted by Bonesrønning *et al.* (2005). Under reasonable assumptions they are able to

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separately identify teacher supply and demand. However, the measure of teacher quality that follows from their approach is only one aspect of a multi-dimensional concept. Because the overall outcome is a result of complex interactions, confining empirical analyses to specific aspects of the teacher labor market is useful to the extent that the results from such restricted studies reflect general mechanisms.

The decision of teachers to stay or leave teaching at a particular school is perhaps the most studied aspect of the teacher labor market. It is attractive from an econometric point of view because at least voluntary quits must be seen as an outcome merely of decisions of individual teachers. In addition, it is reasonable to believe that schools for which teachers tend to quit are in general unattractive for some reason. Determinants of quit decisions are therefore likely to indicate which factors influence the general attractiveness of schools.

The effect of student achievement on teacher behavior is of particular importance because it has implications for the equity-enhancing possibilities of the school system. If teachers flee low-performing schools, teacher quality is likely to be lowest for the students most in need of a good school. Hanushek *et al.* (2004) find that school districts serving academically disadvantaged students have difficulties retaining teachers, while Scafidi *et al.* (2006) find no effects of student achievement on the teachers' quit decision. In the present paper we study how student achievement affects the teachers' quit decisions at lower secondary schools in Norway. The main achievement data used are the results on an external examination that each student has to undertake at the end of the lower secondary school (10th grade). This is a high-stake test because the results influence the choice set for upper secondary education, undertaken by above 95% of the students. In addition, we also investigate the effect of the teacher-grading of the students, which covers several subjects, but may be due to different assessments across teachers and schools.

Existing studies of teacher moves can be divided into three groups. The first group is based on survey data and consists of papers concerned with teachers leaving teaching that focus mainly on the effects of wages and family status (e.g., Murnane and Olsen, 1989; Dolton and van der Klaauw, 1995; Stinebrickner, 2001). The second group of studies focuses on teachers leaving the school district (e.g., Gritz and Theobald, 1996; Mont and Rees, 1996; Imazeki, 2002; Hanushek *et al.*, 2004). This research indicates that school district characteristics such as class load and student composition influence the teachers' decisions. But because such studies typically are based on register data, they typically do not condition on the family status of the teachers. A small number of papers are able to distinguish between transitions within and between school districts (Greenberg and McCall, 1974; Falch and Strøm, 2005; Scafidi *et al.*, 2006). This may be an important aspect because recent evidence indicates that the variation in teacher quality across schools within school districts may be larger than the variation between districts (Lankford *et al.*, 2002; Bonesrønning *et al.*, 2005).

In this paper we consider all of these different kinds of moves and distinguish between moves between public schools within school districts, to a public school in another school district in the same labor market region, across labor market regions, and whether to leave public schools. The different types of moves are likely to be affected by different factors. Separating out moves within school districts, which may react stronger to student composition and student performance than other types of moves, may be more appealing in the Norwegian institutional setting than in the US institutional setting. In the United

States the teachers are formally linked to the school districts and can to some extent be instructed to switch schools within the school district, while in Norway the teachers are linked to the schools. The transition observed in the United States may be a result of both teacher preferences and the preferences of the school district. In Norway, the teachers can only be replaced against their will if there is a serious drop in the number of students at their particular schools (as a closure of the school). Thus, the transitions observed are voluntary quits with only very few exceptions.

Further, we are able to utilize extremely rich data on teachers and schools. The employer data on teachers include information on their wage, experience, and appointment status. These data are merged with register data on family structure, as marital status and fertility, and school data including a variety of information of the schools and the students. The combination of very rich description of the teachers and the schools makes this data-set unique. The sample is restricted to the school years 1998–99 to 2001–02 due to data availability, and we further restrict the sample to teachers with a permanent appointment to focus on voluntary quits.

The next section sets out a simple framework to think about how determinants of teacher quits are likely to be related to determinants of teacher quality. The data used are presented in the third section, and the empirical results are subsequently provided. The final section contains concluding remarks.

Theoretical Approach

Teacher quality must at some level be related to teacher supply. If no teachers are willing to work at a school, thinking about teacher quality is meaningless. On the other hand, schools faced with an extremely high supply should obviously be able to obtain a high teacher quality. Thus, our starting point is that teacher quality is positively related to teacher supply. There exist very few empirical analyses of the labor supply faced by individual schools or firms.[1] The main problem with studies of this kind is that one typically does not have good instruments for wages. Thus, it is attractive to study individual behavior because wages can more reasonably considered as exogenous at the individual level.

For a school, changes in individual's ranking of the school compared with other potential employers may be seen as a change in the teacher supply directed towards the school. To formalize, decompose the supply S faced by a school into the current incumbent teachers T, new hires H, and teachers who want to work at the school but who are not offered a post M. Then $S = T + H + M$. The change in teacher supply, say from the start of the previous school year $t - 1$ to the start of the present school year t can then be defined as

$$\Delta S = \Delta T - H_{t-1} + \Delta M + H_t = -q + m + h, \tag{1}$$

where Δ is a differential operator. The number of quits $q = \Delta T + H_{t-1}$ is defined as the number of incumbent teachers the previous school year ($T_{t-1} + H_{t-1}$) minus the number of incumbent teachers at the start of the present school year (T_t). $m = \Delta M$ is the change in the potential and unrealized school-teacher matches, and $h = H_t$ is simply the number of new matches. From equation (1) it follows that both analyses of the matching of teachers and schools and the quit behavior of existing

teachers may be seen as analyses related to the change in teacher supply. If the quit rate increases for some reason, hires must increase correspondingly, presumably reducing the average quality of the new matches, but certainly reducing the number of potential but unrealized matches.

School characteristics may of course have different quantitative effects on turnover decisions and matching processes. In particular, features of the first match for a newly educated teacher will influence their later turnover decisions. If attractive schools prefer teachers with high experience and good references, young teachers must start their career in less appealing schools and work their way up to more appealing schools. Then quit decisions will be more sensitive to school characteristics than the initial match. On the other hand, if all matches are based on perfect information about the teachers and the present situation at the schools, turnover will only be related to changes in school characteristics.

Analyzing the matching process is complicated by the fact that one only observes actual matches and not potential matches.[2] Determinants of the quit decisions of existing teachers are therefore easier to analyze since all quits can in principle be observed. In the following, we will argue that the matching and quitting processes are likely to be influenced by the same factors. If a school turns less attractive, it will both increase the quit propensity of its initial teachers and make the school less appealing for new teachers. Teachers, like other workers, prefer more pleasant working conditions to less pleasant ones.

Let the utility of working in a particular school depend on the wage W and school characteristics N. School characteristics may be important because they may influence the effort the teachers need to provide, and thereby their nonpecuniary rewards. Then the lifetime utility from time t on for teacher i working in school j can be written as

$$U^i_{jt} = u^i\left(W_{jt}, N_{jt}\right) + \delta\, E\left(U^i_{jt+1}\right), \tag{2}$$

where δ is a discount factor and E is an expectational operator. School j is in the choice set J, where J includes schools, other jobs, and being out of the labor force. Then the teacher will prefer another state if

$$u^i\left(W_{jt}, N_{jt}\right) + \delta E\left(U^i_{jt+1}\right) < \max_{k\in J, k\neq j}\left\{u^i\left(W_{ikt}, N_{kt}\right) + \delta\, E\left(U^i_{kt+1}\right) - c^i\right\}, \tag{3}$$

where c^i is the moving cost. Teacher i will prefer to quit school j if she is offered a job in k, and if k is not a public school the wage in k will vary across seemingly identical individuals. Assuming that $E\left(U^i_{jt+1}\right) = E\left(U^i_{kt+1}\right)$ (i.e., the job today does not affect the opportunities in the future), equation (3) can be written

$$u^i\left(W_{jt}, N_{jt}\right) < \max_{k\in J, k\neq j}\left\{u^i\left(W_{ikt}, N_{kt}\right) - c^i\right\}, \tag{4}$$

If W_{jt} or N_{jt} increases, there will be fewer alternatives that yield a higher utility level than staying at school j, which decreases the probability of being offered a job preferable to staying at school j. When the probability that teachers at school j have a better alternative decreases, fewer teachers quit and q decreases. For teachers not working at school j, the rise in W_j or N_j increases the probability that school j is preferable compared with their present position, which increases m in

equation (1).[3] Within this set-up, each factor that makes a school more attractive will both reduce the quit propensities of incumbent teachers and increase the number of applicants to vacant teacher posts.

In the dynamic framework of Burdett (1978), with incomplete information and costly job search, the search intensity depends on the present utility level. Burdett (1978) shows that higher wages reduce the quit propensity of workers, both because the probability of being offered a higher wage than the present wage is reduced and because it is optimal to reduce the search intensity in this case. At the same time, a vacant position is more likely to be matched with a worker preferring this job over her alternatives when the wage increases because fewer will reject a job offer. Thus, a rise in the wage will both decrease the quit propensity of existing workers and increase the match propensity of new workers.

The teacher labor market is characterized by a rigid wage. In the United States the wages vary very little within school districts, while in many European countries, such as the United Kingdom, Germany, France and Norway, there are almost no national variations in the wage. In the framework above, non-pecuniary rewards N then have an important impact on teachers' preference ranking of the schools. In the analysis below, we will include a range of different measures that can influence the attractiveness of the work environment at different schools. For example, it is expected to be more pleasant to teach well-performing students than poor-performing students.

Family status, for example the presence of school-aged children, is likely to be important for the moving costs; in particular, for moves that require a residential change. In addition, the valuation of non-pecuniary aspects may depend on teacher characteristics as indicated by the formulation above.

Besley and Ghatak (2003, 2005) argue that the effort agents provide in public organizations depend on their valuation of the output produced. Thus, the mission of the teachers relative to the mission of the schools, deciding teachers' valuation of the output, affects the degree of effort teachers are willing to provide, and quit decisions observed are related to mismatch of teachers and schools. Within a relatively centralized public school system, we do not believe the missions of the schools vary nearly as much as the motivation of the teachers. The schools operate under the same relatively detailed school law. The dedication to serve low-performing students is likely to vary across teachers to a larger extent than across schools. However, teachers leaving a school must be replaced, and systematically high hiring rates are likely to make it hard to achieve high teacher quality because, within the framework above, m is likely to be low. Nevertheless, when attempting to single out the quits that are important for teacher quality, it may be important to include in the model a detailed set of teacher characteristics that may account for differences in mission.

Data and Econometric Specification

The utilization of several data sources makes the data rich on information about the individual teachers and schools. We use employer register data, collected by the Ministry of Labor and Government Administration, covering all Norwegian teachers in public schools until the school year 2002–03.[4] The data include, for example, information on wages, experience and appointment status. These data are merged with individual information from Statistics *Norway*, including family characteristics such as fertility and marital status, and region of

birth. Further, this sample is combined with school data collected by the Ministry of Education (*Grunnskolens Informasjonssystem*) as well as recently available student test scores from the Norwegian Board of Education. The achievement data are the results at the end of the lower secondary school (10th grade), which are available from the school year 1999–2000. Finally, as remaining controls, we use regional data from the Norwegian Social Science Data Services.

Because we focus on the effect of student achievement at the end of the 10th grade, the sample is reduced to teachers working at schools including this grade level. About one-half of these schools are combined primary and lower secondary schools (1st–10th grade), the rest is pure lower secondary schools (8th–10th grade). Since only voluntary quits are of interest, only teachers with permanent appointments are included in the sample, excluding teachers on short-term contracts.[5] In addition, in order to avoid retirement decisions, teachers over 60 years of age are excluded from the sample.

Data on teacher turnover is measured as moves the next school year (i.e., a teacher is defined to be a mover if he or she is not in the same school the next school year). Mobility both to primary, lower secondary and upper secondary schools (11th–13th grade) are identified. In the baseline empirical model we will distinguish between four types of teacher mobility: moves to another public school in the same school district;[6] moves to another public school in another school district in the same labor market region; moves to another public school in another labor market region; and moves out of the public school sector.[7] The comparison group is teachers that are in the same school both in the current and the next school year. The local labor market regions used are defined by Statistics Norway. Based on commuting statistics, they identify 90 labor markets, covering on average 4.8 school districts. Table 1 presents a brief summary of the teachers' moving pattern.

On average, over the school years 1998–99 to 2001–02, about 90% of the teachers do not quit at all. Most of the teachers that quit leave the public school sector, while moves to another school district within the same labor market region only include 0.6% of the teachers. The quit propensity increased slightly from 1998–99 to 1999–2000, and decreased markedly thereafter to 8.8% in the school year 2001–02.

We expect the effect of school characteristics, for example student achievement, to be strongest for moves within school districts and smallest for moves to another school district in the same local labor market. The latter type of moves are expected to be mainly motivated by reduced commuting time, while the former

Table 1. Teacher turnover (%) 1998–99 to 2001–02

	1998–99	1999–2000	2000–01	2001–02	1998–2002
Does not quit at all	89.33	88.95	90.06	91.16	89.88
Moves to a school in the same school district	3.12	3.18	2.66	2.41	2.84
Moves to a school in another school district in the same labor market region	0.67	0.78	0.56	0.39	0.60
Moves to a school in another labor market region	1.56	1.58	1.36	1.09	1.40
Moves out of public schools	5.31	5.50	5.36	4.95	5.28
Total mobility	10.66	11.04	9.94	8.84	10.12
Number of observations	20 918	21 175	20 719	20 707	83 519

types of moves to a greater extent may be due to searches for the 'best' school within a reasonable commuting space.

Baseline Model

The econometric specification relates school and teacher characteristics to the teacher moving pattern. The empirical analysis is based on the traditional multinomial logistic regression model.

$$\Pr\left(move_{i,s,r,t+1} = j \middle| Y\right) = \frac{e^{Y\beta_j}}{\sum_{h=0}^{4} e^{Y\beta_k}} \tag{5}$$

where the dependent variable *move* includes the five destinations described above for teacher i in school s in region r at time $t + 1$. The vector of independent variables Y includes variables at the individual, school, and regional levels.

Test scores Student achievement is expected to influence the teachers' required effort and their general well-being positively. Increased student achievement may make the work more pleasant, improving the teachers' non-pecuniary rewards. We use average achievement at the school level in the empirical analysis. Data are not available at the classroom level.

At Grades 8–10, the students are graded by their teachers. At the end of the 10th grade, the students must undertake an external examination. Both the examination results and the grading of the teachers matter for further schooling possibilities. Although all students have the right to continue at upper secondary schools (see Falch, 2002), and above 95% do continue, their choice set among different schools and different study tracks depends on their achievement in lower secondary schools. In this regard, the examination is clearly a high-stake test for the students. In this paper we mainly focus on the examination results because they are set by external examiners. Grading by teachers may be biased due to relative grading and grading inflation.

The curriculum consists of a lot of different subjects, some of them compulsory while others are elective. Written examination is only undertaken in the three main subjects; mathematics, English and Norwegian.[8] However, each student only participates in one of these examinations, decided centrally shortly before the examination. Often all students at a school have their examination in the same subject. Thus, in our analysis we will use the mean performance across these subjects.

In the grading, six is the top score while one is a fail. The distribution of the grades in mathematics in one particular school year is presented in Figure 1. The grading is reasonable normally distributed. For the other subjects, the distribution is very similar.[9] Nevertheless, when calculating weighted average achievement at the schools, we use standardized results for each subject in each year (mean equal to zero and standard deviation equal to unity).[10] In sensitivity analyses, we replace this achievement measure by the grading of the teachers in the same subjects. One advantage of using teacher grading is that all students are graded in all three subjects. In addition, we test the effect of the share of low-performing students, defined as the share of students with grade one or two.[11]

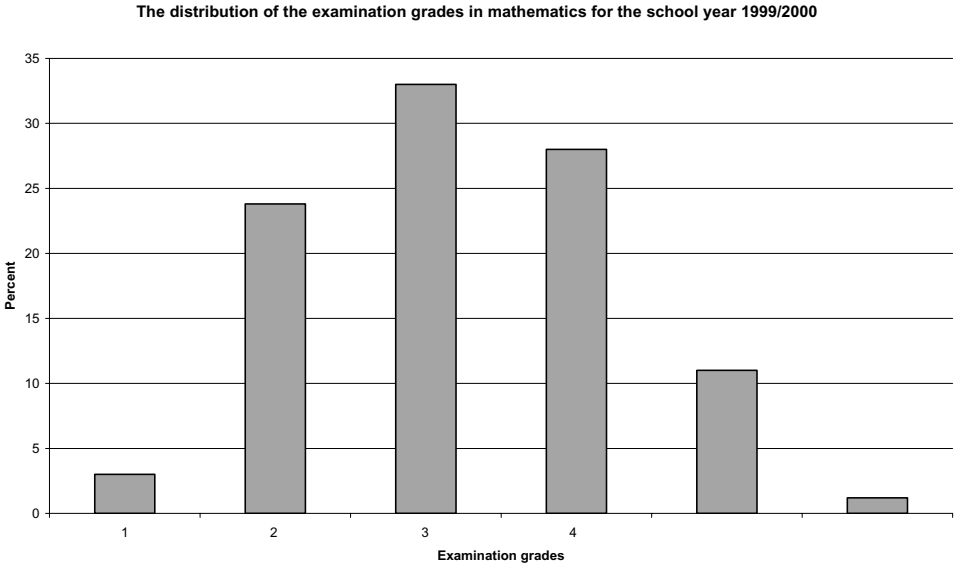

Figure 1. The distribution of examination grades in mathematics in 1999–2000

The test score used in the baseline model is related to the students finishing their lower secondary education. But if teachers are forward looking, they should be interested in the ability of students at school over the next school year(s). Current achievement of the 10th-graders may be an imprecise measure of the ability of interest for the teacher decisions, which should bias the estimate towards zero as with classical measurement error.

Empirically this does not need to be important if the test scores are reasonably constant over time. Table 2 shows that the within-school correlations between the examination results for the students at 10th grade in various years are in the range 0.30–0.35. This implies that there are important changes in student achievement at a particular school over time. Using leaded achievement of the 10th graders in the empirical model may then be attractive because this characterizes the students that will be at the school the next school year. On the other hand, leaded achievement may depend on whether specific teachers choose to stay or leave the school today. If it is expected that poor students will be at the school the next year, and the most qualified teachers react strongest to this expectation because they have more alternatives than other teachers, the estimated effect using leaded achievement will be biased away from zero compared with the true effect. By using a lagged value this mechanism is less relevant, but lagged achievement may include even more measurement error than present achievement. In order to shed

Table 2. Correlation across school years in average standardized examination results, weighted by the number of observations

	1999–2000	2000–01	2001–02
1999–2000	1		
2000–01	0.35	1	
2001–02	0.30	0.30	1

some light on these issues, we will also estimate models using leaded and lagged achievement.

Other school characteristics To control for other conditions with the particular school that might influence teacher turnover we include several additional school characteristics. The main role of the school district is to decide the budgets of the schools. As a measure of the resource use we include *total teacher education hours per student*, which is a slightly more detailed measure than the teacher–student ratio. Teacher education hours is the amount of time teachers interact with students, and is not perfectly correlated with teacher man-years because the work load varies between subjects and depends on the amount of non-teaching tasks. The common assumption is that increased resource use improves the working conditions and reduces teacher quits, although the findings in the literature are mixed (Hanushek *et al*., 2004, Falch and Strøm, 2005).

Student composition is characterized by measures of students with special needs and minority students. There has been increasing interest in the role of such characteristics for teachers' decision on which school to attend (see, e.g., Gritz and Theobald, 1996; Hanushek *et al*., 2004; Falch and Strøm, 2005; Scafidi *et al*., 2006). Our detailed school data make it possible to separate between the number of specific student types and the amount of specific attention they receive. As measures on quantity we include the *share of students with special needs* and *the share of minority students*. The extent of extra education directed towards these students is measured by utilizing the accounting of resource use at schools. The total teaching education hours at each school consist of a baseline nationally determined minimum plus additional hours to specific purposes.[12] The additional hours at least partly reflect the needs of the student population, and both the variables *additional teacher education hours for student with special needs per student with special needs* and *additional teacher education hour for minority students per minority student* are included in the analysis. Information on family background of the 10th-graders is available from the school year 2001–02 only, and we utilize this information in some robustness checks.

In addition to the student body composition, we also include the *share of non-certified teachers at school* as a measure of the composition of the teachers.[13] We expect a positive effect of this variable because teachers may prefer to work with colleagues with the same education background, but this variable may also pick up the effect of some missing variables on school attractiveness.

A teacher may also regard the school size when he or she considers the quit decision. Because of large variation in the Norwegian settlement pattern there is a huge difference between the smallest and largest schools. We include the logarithm of the number of pupils at a level and squared form in the model to capture nonlinear effects. In addition, whether there are students at the primary level at school (*combined schools*) is included as a control variable in the model.

Average student achievement on school level typically depends on the student composition. Table 3 presents correlation coefficients between average student achievement and some of the school characteristics. The correlations between the test scores and the share of minority students and the share of students with special needs are negative. The variables capturing the extent of extra education directed towards these students, school size and whether there exist classes at the primary level at the school seems to be uncorrelated with student achievement

Table 3. Correlation coefficients between standardized examination results and different school characteristics

Share of students with special needs	–0.13
Additional teacher education hours for special needs students per student with special needs	0.02
Share of minority students	–0.14
Additional teacher education hours for minority students per minority student	–0.02
Log of number of pupils	0.03
Combined schools	–0.01

Individual teacher characteristics As discussed in the second section, teacher turnover is likely to depend on individual mobility costs, and the valuation of different school properties might differ between teachers. Hence it seems important to include relevant teacher characteristics in the model to reveal truthful estimates of the variable of interest. A general hypothesis is that the more settled a teacher, the higher is the mobility cost. To capture this notion, we include several teacher characteristics.

The number of school-aged children (6–18 years of age) are expected to increase mobility costs, while the number of children below six years of age may hasten mobility because the mobility costs increases when the children starts at school. Married teachers are likely to have higher mobility costs than divorced and never-married teachers, and mobility costs probably increase with age. In addition, proximity to place of childhood may be important for the quit behavior. The evidence in Boyd *et al*. (2005) strongly suggests that teachers prefer to work close to where they grew up. We have information on which school district teachers are born in and where they lived at age 10. Since the local labor market regions typically cover several school districts, we construct a dummy variable for whether the teacher is born in the same local labor market as he/she is working. Since there are some missing observations for this variable, we also include a dummy variable for whether the birth region is unknown.[14]

Stinebrickner (1998) finds that women are more likely to leave teaching than men. To control for the possibility that female teachers might have a different quit behavior than male teachers we include a dummy variable for gender in the empirical model. In addition, we include a dummy variable for whether the teacher is on leave with pay, mostly maternity leaves,[15] and a dummy variable for whether the teacher is working part-time. Teachers have three to six years of higher education (colleges and universities). Dummy variables for educational level are included.

In standard utility theory, increased salary has a negative effect on turnover. However, up to the school year 2000–01 the Norwegian teacher wage was completely determined by national bargains between the teacher union and the central government, and was solely determined by the amount of formal education (included in the model) and experience (in a non-linear way). Because there has been some limited local flexibility in the later years, we include the *log of salary* (corrected for working time) in the model, but with the caution that this variable may pick up other aspects of the quitting behavior as long as the factors determining the wage level are not fully controlled for. Anyway, the prediction is a negative effect in accordance with the findings of, for example, Murnane and Olsen (1989), Dolton and van der Klaauw (1995, 1999), and Imazeki (2002).

Regional characteristics Finally we utilize regional data to create variables at the school district level that may influence the teacher behavior: the unemployment rate, the share of immigrants, the share of divorced people, population size, and a measure of the settlement pattern. In particular, high unemployment rates are expected to have a negative effect on the probability of leaving teaching, and population size is expected to have a positive effect on moves within school districts because the choice set of schools for the teachers increases. In addition, a full set of dummy variables for labor market region is included. Among other things, this control for different choice sets for teachers in different regions. In essence, the analysis then allows for different behaviors of teachers currently working in schools with similar student achievement, but where the schools are located in regions where the student achievement in the neighboring schools differs.

Descriptive statistics for the variables used in the analysis are presented in Appendix 1. A total of 2116 observations are dropped due to missing information on individual teacher characteristics. For the baseline model, covering the school years 1999–2000 to 2001–02, we are therefore left with 60 485 observations of 25 363 teachers in 1062 schools. The average age of the teachers is 45 years, 70% are married, they have on average 0.66 school-aged children, and only 37% is working in the same labor market region as they were born.

Estimation Results

The estimation results for the school characteristics are reported in Table 4, while the effects of the other variables in the model are reported in Appendix 2. The effects of teacher characteristics are mainly as expected. For example, the quit propensity is generally negatively related to age, the number of school-aged children and whether the teacher lives in her birth region. For the latter two variables, there are strong effects on leaving the local labor market and none effects on moves within school districts. Divorced teachers have in general a higher quit propensity than single teachers who have never been married, while married teachers and female teachers have a lower propensity to quit for a school in another labor market as well as out of the education sector. Regarding moves out of the education sector, there is a positive effect of working part-time, and negative effects of having higher education of medium length (four or five years) and the salary.[16] Regarding the variables at the school district level, all effects of unemployment and population size are negative except for moves within school district.

Student performance seems to have a negative effect on teacher turnover. The effect is negative and significant at least at the 10% level for all types of moves identified. Evaluated at predicted quitting probabilities for mean values of the independent variables, an increase of one unit in student achievement (about 1.5 standard deviations) decreases the probability to move to another school in the same school district, to another school district in the same labor market region, across labor market regions, and to leave public schools by 0.31, 0.17, 0.28 and 0.26 percentage points, respectively. In total, the marginal reduction in quitting propensity is 1.02 percentage points, which is a significant amount compared with the mean quitting propensity of about 10%. The results are in line with Hanushek *et al.* (2004) but contradict the findings of Scafidi *et al*. (2006), who conclude that students' test scores do not play an important role in the teachers' decision whether or not to leave the initial school.

Table 4. The baseline model

	Moving to a school in the same school district	Moving to a school in another school district in the same labor market region	Moving to a school in another labor market region	Moving out of public schools
Student performance				
Average student achievement (present value)	–0.09 (1.77)*	–0.19 (2.20)**	–0.13 (2.26)**	–0.06 (1.94)*
	[–0.31]	[–0.17]	[–0.28]	[–0.26]
Other school characteristics				
Share of students with special needs	–0.23 (0.16)	–1.08 (0.57)	–0.27 (0.18)	–0.79 (0.99)
	[–0.52]	[–0.61]	[–0.28]	[–3.67]
Additional teacher education hours for special needs students per student with special needs/100	–0.01 (0.13)	–0.07 (1.05)	–0.07 (1.47)	0.001 (0.02)
	[–0.03]	[–0.04]	[–0.10]	[0.002]
Share of minority students	0.22 (0.35)	–1.36 (0.88)	–0.83 (1.37)	–1.21 (3.42)**
	[0.88]	[–0.77]	[–0.98]	[–5.69]
Additional teacher education hours for minority students per minority student/100	0.08 (2.04)**	–0.03 (0.50)	0.02 (0.43)	0.02 (0.82)
	[0.30]	[–0.02]	[1.08]	[6.07]
Log of number of pupils	–1.32 (2.04)**	–0.84 (0.98)	–0.61 (1.15)	–0.39 (1.03)
	[–3.79]	[–0.47]	[–0.72]	[–1.67]
Log of pupils squared	0.11 (1.66)*	0.08 (0.98)	0.06 (1.24)	0.04 (1.19)
	[0.31]	[0.04]	[0.10]	[0.17]
Logarithm to total number of teacher education hours per student	0.38 (0.82)	–0.50 (0.64)	0.49 (1.22)	0.40 (1.35)
	[1.04]	[–0.32]	[0.60]	[1.83]
The share of uncertified teachers employed at school	–0.04 (0.08)	0.61 (0.77)	1.20 (2.55)**	0.88 (3.10)**
	[–0.31]	[0.33]	[1.48]	[4.09]
Combined schools	0.08 (0.79)	0.04 (0.30)	–0.02 (–0.16)	0.01 (0.11)
	[0.23]	[0.03]	[–0.03]	[0.04]
Predicted probability	0.03	0.006	0.013	0.05

Note: The comparison group is staying teachers. 60 485 observations. The model is estimated by the multinomial logit method. Asymptotic *t* values in parentheses, calculated based on standard errors corrected to account for within-school clustering of errors; and marginal effects in percentage points in square brackets. *and **denote significance at 10% and 5% level respectively. In addition to the reported variables, the variables reported in Appendix 2, labor market region-specific effects and year-specific effects are included in the model.

The strong effect on mobility to schools in another labor market region indicates that teachers not only search for a good match for given residence, but residential change is also related to student performance. If one is dissatisfied with the current working conditions, and thereby wants to shift working place, the results indicate that both the willingness to change residence and the willingness to leave public schools increase. Notice that all effects are conditional on dummy variables for regional labor markets. The results must therefore be interpreted as the effect of relative achievement compared to other schools in the same labor market region.

The effects of the other school characteristics are insignificant. The student composition, the share of students with special needs and the share of minority students, and the amount of extra resources directed to these students all turn out to have small and insignificant effects. This contradicts the findings in, for example, Hanushek *et al.* (2004), Falch and Strøm (2005) and Scafidi *et al.* (2006), who all find that teachers tend to leave schools with a high share of minority or black students.[17] Regarding school size, the log of the number of pupils has a U-shaped effect on teacher turnover, although is only significant for within-district moves. Resource use has also in general small effects; see Falch and Strøm (2005) for a discussion of this result. Regarding the share of uncertified teachers at school, there are positive effects on moves to a school in another labor market region and out of public schools, which must be interpreted as the effect of the relative share of uncertified teachers employed compared with other schools in the same labor market region.

In the next sections we change the baseline model specification in different ways to investigate the robustness of the effect of student achievement.

Alternative Measures on Student Achievement

In this section we replace the measure of student achievement used in the baseline model above with several different alternative measures, including lagged and leaded values of the examination grades, grades given by teachers, and the share of low-performing students. The results for separate regressions are reported in Table 5. Regarding examination grades, there are negative effects on all types of moves for both leaded, present and lagged measures of student achievement. In all cases there is a significant effect on moves within school districts. Regarding the other types of moves, the effect varies to some extent across the specifications. There are no effects of lagged achievement, while the effect of leaded achievement is only significant for moves to another labor market region. Smaller effects of lagged achievement are as expected because this measure probably differs more from the true information used by the teachers than leaded and present achievement. The differences in the estimated coefficients must be related to the fact that the correlation over time in achievement is not overwhelming. In addition, there are also different samples used in the different specifications. When lagged achievement is used, the school year 2001–02 is excluded from the analysis (reducing the sample by one-third); while when leaded achievement is used, the sample consists of the school years 1998–99 through 2000–01.

Turning to the share of low-performing students, there are positive effects of this variable on the propensity for all types of quits of about the same order as for average achievement. For example, when the share of low-performing students decreases by 0.16 (about 1.5 standard deviations), the probability to move to another school in the same school districts and out of public schools increase with about 0.22 and 0.27 percentage points, respectively. The effect on moves within

Table 5. Effects of alternative measures on student performance

	Moving to a school in the same school district	Moving to a school in another school district in the same labor market region	Moving to a school in another labor market region	Moving out of public schools
Examination grades				
Average student achievement (leaded value)	–0.16 (3.07)**	–0.08 (0.87)	–0.19 (3.28)**	–0.04 (1.33)
	[–0.40]	[–0.04]	[–0.25]	[–0.13]
Average student achievement (present value)	–0.09 (1.77)*	–0.19 (2.20)**	–0.13 (2.26)**	–0.06 (1.94)*
	[–0.31]	[–0.17]	[–0.28]	[–0.26]
Average student achievement (lagged value)	–0.28 (2.96)**	–0.02 (0.14)	0.03 (0.36)	0.02 (0.41)
	[–0.82]	[–0.01]	[0.11]	[0.17]
Share of low-performing students (present value)	0.50 (1.66)*	0.62 (1.34)	0.36 (1.25)	0.38 (2.19)**
	[1.40]	[0.35]	[0.41]	[1.69]
Grades given by teachers				
Average student achievement (leaded value)	–0.38 (2.51)**	0.18 (0.78)	–0.29 (1.85)*	–0.10 (1.25)
	[–1.10]	[0.12]	[–0.38]	[–0.40]
Average student achievement (present value)	–0.27 (2.03)**	–0.23 (1.10)	–0.36 (2.55)**	–0.26 (2.01)**
	[–0.74]	[–0.13]	[–0.44]	[–0.69]
Average student achievement (lagged value)	–0.31 (1.45)	0.36 (1.07)	–0.28 (1.22)	–0.07 (0.52)
	[–0.89]	[0.19]	[–0.32]	[–0.28]
Share of low-performing students (present value)	1.17 (2.70)**	0.05 (0.08)	0.90 (1.84)*	0.62 (2.37)**
	[3.28]	[0.02]	[1.07]	[2.71]

Note: The comparison group is staying teachers. The models are estimated by the multinomial logit method. Asymptotic *t* values in parentheses, calculated based on standard errors corrected to account for within-school clustering of errors; and marginal effects in percentage pints in square brackets. *and **denote significance at 10% and 5% levels respectively. The specifications of all models are as in baseline model presented in Table 4 except as indicated.

school districts is only marginally significant at the 10% level, while the effects on quits out of public schools are significant at the 5% level.[18]

The results for grades given by teachers are very similar to the results above.[19] Out of 12 coefficients estimated for average achievement, five are significant at the 10% level compared with seven significant effects for examination grades. One of the differences is that there are no significant effects of lagged grades given by teachers.[20] On the other hand, the effect of the share of low-performing students is slightly stronger when teacher grades are used instead of examination grades.[21]

Overall, the results are almost qualitatively independent of whether leaded or non-leaded measures of student performance are used in the model. This indicates that neither a bias related to the simultaneity bias of the type indicated above or a measurement error of using grades that are not directly related to the student population the next year are large. On the other hand, the effects of lagged measures are smaller, which may indicate that this is a weaker measure of the student achievement relevant for teacher behavior.

Subsamples based on Teacher Characteristics

Referring to equation (4), different types of teachers may value non-pecuniary rewards differently. In the following we allow for different responses to all explanatory variables across teacher types by dividing the full sample into different subsamples based upon various characteristics of the particular teacher. The model specification is equal to the baseline model. Table 6 presents the results for student achievement.

Out of the 48 estimated coefficients in Table 6, all but three are negative. Student achievement seems to have a negative effect on the quit propensity for all types of teachers, but there are important quantitative differences across teacher types. These differences should be interpreted as a result of different mobility costs. For example, there are stronger effects on young teachers (below 40 years of age) than old teachers for all types of quits. The same is true for non-married teachers versus married teachers, except that student achievement has a stronger effect on the propensity to leave the school sector for married teachers. Regarding subsamples based on other teacher characteristics, there are more heterogeneous effects across destinations. For example, teachers with school-aged children and teachers working in the same labor market region as they were born react stronger on student achievement on moves between schools within the labor market region than others, while teachers without school-aged children and not working in the same labor market region as they were born react strongest for moves out of schools in the labor market region. These results seem reasonable in light of differences in mobility costs. Both young teachers, non-married teachers, teachers without school-aged children and teachers born in a different labor market region are likely to have relatively small mobility costs for moves out of the local labor market. Part-time and full-time working teachers seem to react almost similar to student achievement, while male teachers are more responsive when it comes to leaving schools in the local labor market.

Model Specification

The multinomial logit model relies on some strong underlying assumptions; for example the assumption of independence of irrelevant alternatives. It may

Table 6. Effect of average student performance for different subsamples

Subsample	Moving to a school in the same school district	Moving to a school in another school district in the same labor market region	Moving to a school in another labor market region	Moving out of public schools	Number of observations
Aged above 40 years	–0.07 (1.03) [–0.20]	–0.22 (1.68)* [–0.09]	0.04 (0.44) [0.03]	–0.06 (1.40) [–0.22]	44 208
Aged below 40 years	–0.15 (2.01)** [–0.39]	–0.18 (1.47) [–0.14]	–0.24 (3.43)** [–0.66]	–0.07 (1.45) [–0.41]	16 277
Married	–0.06 (0.96) [–0.15]	–0.15 (1.34) [–0.70]	–0.11 (1.26) [–0.08]	–0.11 (2.75)** [–0.51]	41 784
Non-married	–0.18 (2.53)** [–0.51]	–0.25 (1.82)* [–0.15]	–0.15 (1.84)* [–0.28]	0.02 (0.33) [0.17]	18 701
School-aged children	–0.18 (2.74)** [–0.51]	–0.17 (1.29) [–0.10]	0.16 (1.76)* [0.15]	–0.08 (1.41) [–0.36]	24 108
No school-aged children	–0.02 (0.31) [–0.04]	–0.21 (1.78)* [–0.10]	–0.24 (3.25)** [–0.37]	–0.06 (1.38) [–0.26]	36 377
Working in the same labor market region as born	–0.20 (2.41)** [–0.60]	–0.24 (1.80)* [–0.16]	–0.15 (1.05) [–0.07]	–0.03 (0.64) [–0.10]	22 084
Not working in the same labor market region as born	–0.04 (0.74) [–0.10]	–0.18 (1.55) [–0.10]	–0.12 (1.92)* [–0.19]	–0.08 (1.93)* [–0.36]	38 401
Working part-time	–0.13 (1.44) [–0.35]	–0.17 (0.91) [–0.08]	–0.26 (2.08)** [–0.22]	–0.09 (1.73)* [–0.61]	13 847
Working full-time	–0.08 (1.38) [–0.19]	–0.19 (1.92)* [–0.10]	–0.11 (1.69)* [–0.13]	–0.04 –(1.05) [–0.10]	46 638
Female	–0.05 (0.67) [–0.13]	–0.31 (2.61)** [–0.18]	–0.09 (1.30) [–0.11]	–0.05 (1.22) [–0.22]	35 294
Male	–0.16 (2.34)** [–0.45]	–0.02 (0.17) [–0.01]	–0.20 (2.24)** [–0.23]	–0.08 (1.60) [–0.34]	25 191

Note: The comparison group is staying teachers. The model is estimated by the multinomial logit method. Asymptotic *t* values in parentheses, calculated based on standard errors corrected to account for within-school clustering of errors; and marginal effects in percentage points in square brackets. *and **denote significance at 10% and 5% levels respectively. The specifications of all models are as in baseline model presented in table 4.

therefore be useful to estimate a simpler logit model. In order to make an attempt to distinguish between different types of moves, Table 7 presents the result for two different specification of the dependent variable. The first model investigates determinants of quitting the present school, which is the sum of all quits considered above. The results are close to the sum of the effects across destinations presented in Table 3. For example, an increase in average student achievement by 1.5 standard deviations decreases the quit propensity by 0.8 percentage points. The second model investigates determinants of quitting public schools, focusing on one of the quit types discussed above. In this model there are few significant effects, and the effect of student achievement is only marginally significant at the 10% level.

So far teachers on leave without pay are regarded as quitters. About 18% of the observed quits are teachers returning to the same school after one year, mainly related to moves within school district and moves out of teaching.[22] However,

Table 7. Logit models for school quits and quits out of education

	Teacher is not at the same school the next school year	Teacher is not in public schools the next school year
Student performance		
Average student achievement	–0.09 (3.34)**	–0.06 (1.68)*
	[–0.81]	[–0.29]
Other school characteristics		
Share of students with special needs	–0.56 (0.80)	–0.75 –(0.95)
	[–5.04]	[–3.56]
Additional teacher education hours for special needs students per student with special needs/100	–0.01 (0.62)	0.003 (0.15)
	[–0.10]	[0.01]
Share of minority students	–0.70 (2.26)	–1.19 –(3.39)**
	[–6.3]	[–5.65]
Additional teacher education hours for minority students per minority student/100	0.04 (1.82)*	0.01 (0.67)
	[–0.36]	[–0.05]
Log of number of pupils	–0.81 (2.38)**	–0.26 (0.69)
	[–7.29]	[–1.24]
Log of pupils squared	0.08 (2.27)**	0.03 (0.86)
	[0.72]	[0.14]
Logarithm to total number of teacher education hours per student	0.34 (1.40)	0.34 (1.28)
	[3.06]	[1.62]
The share of uncertified teachers employed at school	0.74 (3.03)**	0.83 (2.95)**
	[6.66]	[3.94]
Combined schools	0.04 (0.88)	0.002 (0.04)
	[0.36]	[0.01]
Predicted probability	0.10	0.05
Fixed effects	No	No
Number of observations	60 485	60 485

Note: 60 485 observations. The model is estimated by the multinomial logit method. Asymptotic *t* values in parentheses, calculated based on standard errors corrected to account for within-school clustering of errors; and marginal effects in percentage points in brackets. *Significance at 10% level and **significance at 5% level. In addition to the reported variables, the same teacher and regional variables reported in Appendix 2, labor market region-specific effects and year-specific effects are included in the model.

redefining these kinds of moves as staying teachers has very small effects on the results.[23]

Even though the present analysis includes a large number of school characteristics that capture the student composition at school level, no direct measure of parental background of the students is included. Information of parental background such as highest level of obtained education and income is, however, available for the last year in our sample. Imposing these measures on all three years of the sample does not change the results much. For example, by including these variables in the first logit model of Table 7, the effect of student achievement is slightly reduced to –0.66, but is still significant at the 1% level.[24]

The present analysis also includes a large number of teacher characteristics, but still unobserved teacher characteristics, such as for example the teachers' mission to teach low-performing students, may bias the estimated effects. One way of taking this into account is to include fixed teacher effects. Including fixed teacher effects may be problematic, however, within a three-year panel because only teachers that move at least once during the empirical period can be included in the model. Teachers that do not move will not contribute to the log-likelihood. For this reason the sample is reduced by about 86%. The results for fixed effects logit models are sensitive to which achievement measure is included. For the measure used in our baseline model, there is basically no effect of achievement. Using leaded achievement, however, the effect is negatively significant at the 5% level.

We cannot rule out that some of the included explanatory variables may be affected by the quit propensity. At the teacher level, the indicator for working part-time and the salary are perhaps the most probable candidates, and both variables have relatively strong effect on moves out of public schools. However, excluding these variables from both the baseline model and the first logit model in Table 7 alter the estimated effects of student achievement only very marginally. Another issue is whether the results are sensitive to the choice of only excluding teachers older than 60 years from the analysis. Some teachers retire at a younger age. However, excluding people older than 55 years from the sample does not affect the results either.

Conclusions

This paper indicates that teachers tend to quit schools with low student performance. This result must be interpreted within a wage-setting regime that yields little variation in the wages across schools. When teachers are not compensated for working conditions, students most in need of good schools and high-quality teachers may be harmed. The effect of high teacher turnover on teacher quality, however, depends on the possibility of the schools to attract new and competent teachers. We have argued that systematic effects on the quit rate are likely to reflect the attractiveness of the schools. In this case, our results indicate that reduced student performance makes the school less attractive from the 'average' teachers' point of view, reducing the pool of teachers that want to teach at the school. Not only must the school hire more of the teachers in the applicant pool, the number of potential matches will also be reduced.[25]

This effect is likely to be critical mainly in situations with low teacher supply. When the overall supply of well-qualified teachers is relatively low compared with the demand for teachers, teachers leaving a school can be hard to replace; in

particular, when teacher mobility is related to factors making the school unattractive. Betts *et al.* (2000) and Jepsen and Rivkin (2002) show that the mandated class size reduction in California in 1996 increased the share of less-experienced teachers and teachers who lack a full credential. Most importantly, the evidence indicates a substantial teacher movement away from high-poverty schools to low-poverty schools and from schools serving mainly nonwhite students to schools serving white students. Jepsen and Rivkin (2002) argue that this movement in some cases fully offset the benefits from smaller classes.

The importance of a negative influence of student achievement on teacher turnover is therefore expected to be more severe in, for example, the United Kingdom experiencing teacher shortages (Dolton *et al*., 2002) than in, for example, Switzerland with a high teacher supply (Wolter and Denzler, 2003). In Norway, the importance of this effect may have been reduced in the twenty-first century as the teacher wage increased and teacher supply improved. An OECD working paper argues that there 'is a widespread belief that several countries in the OECD area suffer from shortages of teachers in particular subject areas, grade levels, or regions of the country' (Santiago, 2002, p. 11). To avoid unwanted distributional consequences of low teacher supply, one could think of wage-setting institutions that compensate teachers serving low-performing students. This is an intricate situation, however, because then teacher incentives with respect to student performance may become completely wrong. The most reasonable policy change given the evidence that rigid wages tends to sort teachers in a harmful way for disadvantage students is to let teacher wages respond to at least some extent to local supply of, and demand for, teachers.

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Notes

1. The exceptions are some studies of the labor market for nurses (Sullivan, 1989; Staiger *et al*., 1999) and some studies of teacher supply (Currie, 1991; Falch, 2003; Bonesrønning *et al*., 2005).
2. To the best of our knowledge, the only empirical study of two-sided match in the market for teachers is Boyd *et al*. (2003). By utilizing the method of simulated moments they model the interaction between schools and teachers in a game-like fashion.
3. In addition, m will increase because a lower quit rate reduces new hires.
4. In the school year 2000–01, 1.7% of the students at primary and lower secondary schools were enrolled in private (mostly religious) schools. Teachers at those schools are not included in our sample.
5. Teachers at schools that are not in the data the next school year (school closures) are removed from the sample. Due to increased overall teacher employment during the empirical period, there exists extremely few other cases where teachers are instructed to leave their initial school.
6. In Norway, primary and lower secondary education is the responsibility of the municipalities. The municipalities are multipurpose institutions with the responsibility for care for the elderly, daycare, infrastructure, and so on. Spending on primary and lower secondary education accounts for about 30% of total municipal spending.
7. Teachers who are not in the data the next school year are defined as movers out of public schools. Teachers on paid leave (mostly maternity leave) are considered stayers.
8. Norwegian includes two separate examinations in the two official written languages in Norway.

9. For example, in the school year 2001–02 the mean (standard deviation) result was 3.55 (0.53), 3.48 (0.60), 3.59 (0.59) and 3.39 (0.70) in mathematics, English and the two examinations in Norwegian, respectively.
10. The correlation coefficient between average standardized achievement and the average of the examination grading (non-standardized) is 0.92.
11. The correlation coefficient between the average of the standardized examination results and the grades given by teachers is 0.54. The correlation coefficient between the average of standardized examination results and the share of low-performing students at the examination is –0.78.
12. According to the school act, extra resources have to be allocated to students with special needs based on individual education plans to be designed in an interaction between teachers, parents, specialists on disabled students, and the local government. The amount of extra resources entitled to each student shall be determined by their needs. A similar rule is in place for minority students.
13. There is a national rule saying that non-certified teachers (i.e., teachers without formal teacher education) can only be appointed as a teacher if no certified teachers are willing to accept the job. Further, non-certified teachers can only be appointed on one-year contracts (see Bonesrønning *et al*., 2005, for details).
14. When the birth region is unknown, it is replaced by the region where the teacher lived at age 10. For about 10% of the observations, both the school district of birth and at age 10 are missing.
15. Being on a maternity leave is not regarded as a quit in the empirical analysis.
16. The salary is mainly decided by experience and education in a non-linear and interacting way. The salary is included instead of including these variables in a very flexible form, also recognizing that there is some local discretion on the salary from 2000–01 and onwards. The negative and significant effect on moves out of public schools is pretty strong. This may indicate that the least experienced and least educated teachers are most likely to leave public schools, but may also be a direct effect of the wage level.
17. The divergent results compared with earlier Norwegian studies (Falch and Strøm, 2005) seem mainly to be driven by different samples used. Our sample covers the years 1999–2000 to 2001–02, while Falch and Strøm investigated teacher moving pattern over a seven-year period from 1992–93 to 1998–99, including both primary and lower secondary schools. The effects of the share of minority students and students with special needs in our model are independent of whether student achievement is included in the model or not, or whether the different measures of teacher education hours are included in the model or not. However, excluding all family characteristics (which is not included in the Falch and Strøm study) increases the effects in expected direction somewhat.
18. In a 'horse race' competition between average achievement and the share of low-performing students (using present values), average achievement turns out as a 'winner'. In a simple logit model where both average achievement and the share of low-performing students are included, the effect of average achievement is significant at the 10% level (the marginal effect is –0.72), while the effect of the share of low-performing students becomes clearly insignificant.
19. The correlation over time for teacher grades is in the range 0.39–0.44.
20. In a 'horse-race' competition between average examination grades and average grades given by teachers using present values in a simple logit model, the effect of examination grades are significant at the 5% level (the marginal effect is –0.63) while the effect of grades given by teachers is clearly insignificant.
21. The effect of the other variables in the model are mainly unaffected by the changes in the model specifications presented in Table 5. However, when using leaded and lagged values there are some small changes compared with the baseline model, probably because of different samples used (the school years 1998–99 to 2000–01 and 2000–01 to 2001–02, respectively, instead of the school years 1999–2000 to 2001–02). This is in particular true for the effects of the different measures of student composition, indicating that these effects are not stable over time.
22. For teachers leaving a school for another school in the same school district, another school district in the same labor market region, another labor market region, or out of teaching, 12.2%, 5.5%, 4.7%, and 19.2%, respectively, return to the same school after one year.
23. The marginal effects of student achievement in the baseline model changes to –0.19, –0.11, –0.16 and –0.21 for the four different types of moves, respectively.
24. Parental education is measured as average parental education of the students in the 10th grade, and income is measured as average household income of the students in the 10th grade.
25. This indicates that there is a negative correlation between teacher turnover and student achievement. In our data, the correlation between the share of teachers in a permanent position that leave the school and average student achievement is –0.06

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Appendix 1

Table A1. Descriptive statistics

	Mean	Standard deviation	Minimum	Maximum
Student performance				
Examination grades				
Average student achievement	−0.05	0.68	−4.77	5.18
Share of low-performing students	0.22	0.12	0	1
Grades given by teachers				
Average student achievement	3.64	0.27	1.75	5.5
Share of low-performing students	0.16	0.08	0	1
Other school characteristics				
Share of students with special needs	0.07	0.03	0	0.31
Additional teacher education hours for special needs students per student with special needs	197.12	114.58	0	1900
Share of minority students	0.06	0.10	0	0.87
Additional teacher education hours for minority students per minority student	85.69	105.26	0	1900
Log of number of teacher education hours per student	4.50	0.61	1.9	6.68
Number of pupils	271	129.77	3	798
Log of number of pupils				
Log of pupils squared	30.12	6.18	1.21	44.65
The share of uncertified teachers employed at school	0.05	0.07	0	1
Combined schools	0.50	0.50	0	1
Individual characteristics				
Married	0.70	0.46	0	1
Divorced	0.11	0.31	0	1
Single	0.20	0.40	0	1
Working in the same labor market region as born	0.37	0.48	0	1
Birth region unknown	0.12	0.32	0	1
Part-time working	0.25	0.43	0	1
On leave	0.027	0.16	0	1
Female	0.60	0.49	0	1
Number of school children (children between 6 and 18 years)	0.66	0.94	0	8
Number of children beyond 6 years	0.24	0.57	0	4
Age	45.20	9.83	23	60
Monthly salary measured in NOK	23 663	2583.28	13 976.92	35 794
Logarithm to salary				
3 years of higher education (unqualified)	0.03	0.19	0	1
4 years of higher education	0.75	0.44	0	1
5 years of higher education	0.17	0.37	0	1
6 years of higher education	0.05	0.22	0	1

Table A1. (*Continued*)

	Mean	Standard deviation	Minimum	Maximum
Regional characteristics				
Unemployment-rate in the local government	0.04	0.02	0.01	0.25
Population in local government	61 382.3	126 935.60	246	508 726
The share of people living in rural areas	0.30	0.26	0	1
The share of divorced people between 16 and 66 years	0.10	0.02	0.033	0.147
The share of immigrants	0.05	0.04	0.002	0.193

Note: The sample is the school years 1999–2000 to 2001–02, 60 485 observations.

Appendix 2

Table A2. The effects of individual and regional characteristics on teacher turnover

	Moving to a school in the same school district	Moving to a school in another school district in the same labor market region	Moving to a school in another labor market region	Moving out of public schools
Individual teacher characteristics				
Married	0.03 (0.36) [0.10]	0.25 (1.46) [0.20]	−0.19 (1.73)* [−0.24]	−0.12 (2.17)** [−0.57]
Divorced	0.27 (2.62)** [0.73]	0.42 (1.69)* [0.24]	0.52 (3.54)** [0.64]	0.18 (2.45)** [0.77]
Working in the same labor market region as born	0.03 (0.51) [0.11]	0.38 (2.81)** [0.23]	−1.15 (10.89)** [−1.49]	−0.16 (3.73)** [−0.77]
Birth region unknown	−0.15 (1.46) [−0.42]	0.68 (3.17)** [0.41]	−0.48 (2.36)** [−0.61]	−0.10 (1.34) [−0.44]
Working part time	0.21 (3.15)** [0.50]	0.02 (0.12) [0.01]	−0.10 (0.99) [−0.20]	0.76 (16.69)** [3.58]
On leave	0.18 (0.26) [1.73]	1.30 (1.21) [1.02]	−36.2 (167.2)** [−46.60]	1.22 (4.36)** [8.05]
Female	0.01 (0.23) [0.05]	−0.07 (0.55) [−0.04]	−0.17 (2.12)** [−0.21]	−0.11 (2.55)** [−0.51]
Number of children in school age	0.05 (1.96)** [0.17]	0.02 (0.24) [0.02]	−0.19 (3.59)** [−0.24]	−0.12 (5.37)** [−0.57]
Number of children beyond 6 years	0.06 (1.06) [0.17]	−0.08 (0.73) [−0.05]	−0.04 (0.59) [−0.06]	0.04 (1.02) [0.19]
Age	−0.03 (5.49)** [−0.08]	−0.09 (8.61)** [−0.05]	−0.08 (11.53)** [−0.10]	−0.02 (4.61)** [−0.08]
Logarithm of salary	0.72 (1.69)* [2.38]	1.97 (2.17)** [1.22]	0.05 (0.09) [0.16]	−2.18 (5.98)** [−10.53]
4 years of higher education	−0.32 (2.09)** [−0.90]	−0.15 (0.47) [−0.10]	0.24 (1.11) [0.35]	−0.42 (4.86)** [−1.96]
5 years of higher education	−0.28 (1.65)* [−0.76]	0.16 (0.46) [0.11]	0.25 (1.08) [0.36]	−0.39 (4.02)** [−1.83]

Table A2. *(Continued)*

	Moving to a school in the same school district	Moving to a school in another school district in the same labor market region	Moving to a school in another labor market region	Moving out of public schools
6 years of higher education	–0.29 (1.47) [–0.87]	0.11 (0.27) [0.06]	0.38 (1.38) [0.49]	0.12 (0.88) [0.59]
Region characteristics				
Unemployment rate	–0.68 (–0.14) [–0.78]	–10.00 (1.70)* [–5.75]	–7.29 (1.87)* [–8.90]	–4.88 (2.25)** [–22.4]
Log of population	0.14 (1.59) [0.43]	–0.39 (3.91)** [–0.23]	–0.22 (3.34)** [–0.28]	–0.04 (0.94) [–0.19]
The share of people living in rural areas	–1.37 (3.32)** [–3.90]	–0.62 (1.46) [–0.34]	–0.31 (1.03) [–0.33]	–0.11 (0.53) [–0.28]
The share of divorced people between 16 and 66 years	3.94 (0.90) [10.93]	–0.60 (0.11) [–0.54]	6.50 (1.67)* [8.07]	1.93 (0.76)* [8.17]
The share of immigrants	–5.96 (1.44) [–17.56]	–0.96 (0.20) [–0.50]	1.10 (0.34) [1.57]	1.25 (0.66) [6.79]
Predicted probability	0.03	0.006	0.013	0.05

Note: The comparison group is staying teachers; 60 485 observations. The model is estimated by the multinomial logit method. Asymptotic *t* values in parentheses, calculated based on standard errors corrected to account for within-school clustering of errors; and marginal effects in percentage points in square brackets. *Significance at 10% level and **significance at 5% level. In addition to the reported variables, the variables reported in Table 4, labor market region-specific effects and year-specific effects are included in the model.