

ISSN 1503-299X


WORKING PAPER SERIES

No. 1/2004

TEACHER TURNOVER AND NON- PECUNIARY FACTORS

Torberg Falch
Bjarne Strøm

Department of Economics

 Norwegian University of Science and Technology

N-7491 Trondheim, Norway

www.svt.ntnu.no/iso/wp/wp.htm

Teacher turnover and non-pecuniary factors^{*}

Torberg Falch[◇] and Bjarne Strøm

Norwegian University of Science and Technology, Dragvoll

October 2003

Abstract

This paper studies teacher mobility using matched employee-employer panel data from Norwegian primary and lower secondary schools. The Norwegian institutional set-up with completely centralized wage setting for teachers is ideal to analyze the effect of non-pecuniary job attributes on quit decisions. We find that teachers tend to leave schools with high share of minority students and high share of students with special needs. In addition, the composition of teachers and the school size affect the propensity to quit. These results are robust across different econometric specifications and sub-samples.

JEL classification: I29; J44; J45; J63

Keywords: Teacher turnover; non-pecuniary factors; centralized wage setting; student composition

^{*} This paper is part of a project funded by the Norwegian Research Council. Comments from seminar participants at the Norwegian University of Science and Technology, the Conference of the European Association of Labour Economists in Paris, The Nordic Econometric Meeting in Bergen, the Nordic Conference on Local Public Finance in Trondheim, and the European Meeting of the Econometric Society in Stockholm are gratefully acknowledged. Statistics Norway and The Ministry of Education and Research are acknowledged for kindly making the teacher and school level data, respectively, available for this research. The rest of the data are obtained from the Norwegian Social Science Data Service. The authors bear the responsibility for the analysis and the conclusions that are drawn.

[◇] Corresponding author: Torberg Falch, Department of Economics, Norwegian University of Science and Technology, Dragvoll, N-7491 Trondheim, Norway. E-mail: torberg.falch@svt.ntnu.no .

1. Introduction.

This paper studies the effect of non-pecuniary job attributes on individual teacher quit behavior. While sociologists, psychologists and industrial researchers all stress the importance of non-pecuniary job characteristics for worker turnover, economists have paid more attention to pay as the main motivation for worker quit decisions.¹ According to search models, workers quit a job when the discounted utility stream in the current job falls short of the discounted utility stream associated with alternative job offers (Burdett, 1978). Empirical models analyzing individual quit behavior in this tradition typically assume that the wage is the key variable describing utility levels in different jobs. However, in several countries with centralized pay bargaining, important segments of the labor market exhibit little or no variation at all in wages across jobs. In such environments, only a limited part of worker job to job mobility would be motivated by wage differences, while non-wage job attributes should be important determinants of individual turnover.

The labor market for teachers in most European countries is a prominent example of such an environment, with teacher pay almost exclusively determined by the amount of formal education and teaching experience. While wage differences between teaching and non-teaching is clearly relevant to understand why teachers move from teaching to non-teaching jobs, the national teacher wage system suggests that teachers also search across schools in order to find a match which satisfies their preferences with regard to non-wage job characteristics. Within such a setting it is important to identify what type of schools teachers like and dislike. If non-pecuniary attributes differ between schools, it is likely that teacher quality can differ substantially between schools even within areas with similar costs of living. For example, if teachers tend to leave schools with many minority students, serious problems with low teacher quality may arise in these schools. Further, cost of living varies across geographical areas. Hence, equal teacher nominal pay across areas suggests that teacher quality may suffer in areas where living costs are high and thereby the *real* teacher wage is low.

The extreme wage rigidity described above has been one of the cornerstones in teacher union wage policy in many European countries and the unions have claimed that teacher pay equality prevent large regional differences in teacher quality. However, the arguments presented above

¹ Clark (2001) provides a short overview of the literature on job quits and job satisfaction in psychology, sociology and management and presents evidence showing that job satisfaction measures are important predictors of worker quits even after controlling for wages.

suggest that equality in teacher quality across schools is implausible in a rigid teacher wage system. As schools are prevented from using wage policy to retain and attract teachers, while teachers sort themselves between school according to preferences for non-wage school characteristics, non-attractive schools from the teachers point of view are likely to be left with lower quality teachers. Taken together with the strong evidence for teacher quality as the most important factor in education production (Rivkin, Hanushek & Kain, 2001), this suggests that teacher mobility is an important research issue. As a first step towards an assessment of the costs of a rigid pay system, the purpose of this paper is to quantify empirically the effect of non-pecuniary school and district variables on teacher exit decisions. To our knowledge, the present paper appears to be the first study of this kind in Europe.²

Most existing evidence on teacher moves across schools and school districts is based on US data. However, the US system with wage setting at the school district level makes studies of the relationship between teacher quit behavior and non-pecuniary school attributes complicated by the fact that school district wages themselves can easily respond to such factors. Thus, identification of the causal effect of non-pecuniary factors on teacher moves requires additional assumptions compared to the European institutional setting. Nevertheless, non-pecuniary factors and opportunity costs have been found to be important determinants of teacher sorting and hence the quality of teachers in recent studies by Loeb & Page (2000), Hanushek, Kain & Rivkin (2001), Lankford, Loeb & Wyckoff (2002) and Boyd, Lankford, Loeb & Wyckoff (2003).

A further limitation with the US research on teacher mobility is that most studies have used data for specific states. This implies that teachers moving to schools in other states are implicitly treated equal to teachers leaving the education sector completely, which may be a too restrictive assumption. Further, recent US evidence suggests that a large share of teacher sorting and teacher moves takes place within school districts, which may imply that studies focusing on inter-district teacher moves may only reveal a quite limited part of actual teacher mobility (Betts, Reuben & Danenberg. (2001) and Lankford et al. (2002)).³

² UK teachers' decision to quit teaching has been studied by Dolton & Mavromaras (1990) and Dolton & van der Klaauw (1995), but these studies do not consider the effect of school specific factors such as student composition and school size on the decision to quit.

³ An exception on inter-district-mobility is the study by Greenberg & McCall (1974).

The present study contributes to the research on teacher sorting by analyzing teacher transitions between schools and out of the school system using a complete matched individual teacher-school data set for all Norwegian primary and lower secondary public school teachers combined with detailed information of the schools during the period covering the school years 1992/93 to 1999/2000. Ironically, the completely centralized teacher wage setting system may be ideal for studies of non-wage determinants of mobility since identification problems due to compensating wage differentials do not arise. A possible objection to this argument is that non-pecuniary attributes of teacher positions are not fixed, but adjust endogenously in the absence of wage flexibility. As an example, schools may have incentives to decrease teacher workloads in areas with teacher shortages to compensate for the inflexibility of wages. However, such behavior is severely restricted in Norway by national regulations. The teacher workload, for instance, is completely determined in collective bargaining between the teacher union and the central government. In addition, the data enable us to distinguish completely between teachers leaving the education sector and teachers moving between schools within and between school districts. Bonesrønning, Falch & Strøm (2003) show that the supply of certified teachers varies a lot between Norwegian schools even within school districts, and that certified teachers seem to prefer large schools with few minority students.⁴

The paper is organized as follows: Section 2 reviews the existing literature on the association between teacher turnover and non-pecuniary school factors. In section 3 we present the theoretical and institutional background of the empirical analysis, section 4 contains a description of the data, while section 5 presents the empirical results. Section 6 concludes the paper.

2. Previous studies on teacher turnover

A number of studies suggests that higher wages reduce teacher quit propensity, for example Baugh & Stone (1982), Murnane & Olsen (1989), Theobald (1990), Gritz & Theobald (1996), Dolton & van der Klaauw (1995, 1999), Brewer (1996), Mont & Reese (1996), and Stinebrickner (1998, 2001). However, only a few studies provide systematic evidence on the role of non-pecuniary factors in teacher quit decisions. The investigations on this issue have used two types of data: Administrative data on teachers from certain US states or school districts, and national US survey data. The main advantages of studies using administrative data is large

⁴ While the effective supply of certified teachers to a school analyzed by Bonesrønning et al. (2003) is determined by both the entry and exit decisions of teachers, the present study focuses solely on the exit decision.

sample sizes and detailed information on school and student body characteristics. Their main weakness is that they rely on data from specific US states, which implies that teachers moving between states while continuing teaching is treated equal to those exiting the teaching profession. Studies using national surveys on US teachers are obviously more suited to give a complete picture of teacher mobility since they can make a distinction between those exiting the teaching profession and those migrating between states while continuing teaching. On the other hand, these studies use small samples of teachers and have to rely on rather crude self-reported information on school characteristics.

An early study by Greenberg & McCall (1974) on the mobility of teachers in the San Diego school district shows that experienced teachers tend to move from schools with high share of minority students and low average achievement. Hanushek et al. (2002), using a large administrative Texas data base, corroborate this finding by demonstrating that teachers currently working in schools with high minority share and low achievement students have a higher propensity to move from a school district. Their results also imply that non-pecuniary differences between schools related to student composition and quality is more important than wage differences for quit decisions. Lankford et al. (2002) use administrative data from New York State and shows that teacher quality differs systematically between schools both within and between school districts. Boyd et al. (2003) analyze the determinants of teacher choices and schools hiring decisions based on a two-sided matching model. Their results show that minority students have a negative effect on the utility of new teachers.

Authors studying the effect of working conditions on teacher wages and teacher turnover have included measures of class size or resource use per student as explanatory variables. The underlying argument is that required teacher effort per teaching hour is higher in large than in small classes, and hence teachers favor schools with small classes and large resource use per student, usually approximated by the student-teacher ratio measured at the school level or district level. If wage flexibility is limited, schools may reduce class size in an attempt to improve working conditions and hence reduce teacher turnover.⁵ A detailed investigation of this issue can be found in Mont and Rees (1996). Using administrative data from New York State, they find that lower class size has a significant positive, but numerically small effect on length of stay in

⁵ With flexible wages, teachers at schools with low resource use are expected to be compensated with higher wages. Analyses of the relationship between the teacher wage level and school resource use include Kenny & Denslow (1980), Eberts & Stone (1985) and Levinson (1988).

teaching. Recent studies by Stinebrickner (1998, 1999) using national US survey data find no statistically significant association between class size and duration of teaching jobs.⁶

3. Institutional and theoretical considerations

3.1. Institutions

Public primary and lower secondary education in Norway (first through tenth grade), free of user charges, is the responsibility of local governments. In contrast to school districts in the US, these local governments are multipurpose institutions that provide a large set of services in addition to education.⁷ Usually, there exists several public schools within each local government, and private schools are quite rare and do not provide a realistic alternative to public schools. Parental school choice between public schools for given residence is not allowed.

Two institutional features are important in the understanding of teacher quality and teacher sorting in this particular market. First, in the period covered in this paper, teacher wages and workload were completely determined in national bargains between the teacher union and the central government. This national contract effectively prevented schools and districts from using wage policy to attract and retain teachers as the teacher wage was solely determined by the amount of formal education and teaching experience.⁸ Secondly, although the local government is the formal employer of teachers, hiring decisions are made by the school principal at each school and the teachers apply for jobs at the separate schools. There are no formal rules on the principal's ranking of applicants except that non-certified teachers cannot be appointed if it is possible to appoint a certified teacher. In this respect, the system differs from that in the US, where school district authorities are directly involved in the allocation of teachers between schools within school districts. In the Norwegian setting, separations of teachers with permanent appointment are due to either voluntary quits or significantly reductions in the number of

⁶ Gritz & Theobald (1996) investigate the relationship between teacher turnover and spending on non-teacher items by the schools using administrative data from the state of Washington. The evidence suggests that higher school spending on central administration and instructional assistants decrease length of stay in teaching. Thus, their findings indicate that moving resources away from teachers to other school personnel increases teacher turnover.

⁷ Spending on primary and lower secondary education accounts for about 30% of total local government spending. Other important services are care for the elderly, preschool education, and infrastructure.

⁸ The wage received is independent of where the teaching experience is obtained.

students at the schools (including closing of schools). In the empirical period covered by this paper, the latter reason is of little relevance because the cohort sizes increased.

3.2. Teacher quality and teacher sorting.

We now present a simple model of teacher sorting and discuss the relationship between teacher mobility, teacher characteristics and school characteristics. Our approach to the sorting discussion builds on Bonesrønning et al. (2003) and is also inspired by Boyd et al. (2003). In a conventional flexible wage world, teacher wages would adjust to compensate for non-pecuniary characteristics of schools and regions, living costs and alternative job opportunities. This is formally illustrated in equation (1), where W_{is} is the equilibrium wage individual i receives in school s , X_s is a vector of non-pecuniary school and regional characteristics corresponding to school s , and Z_i is a vector of individual characteristics.

$$(1) \quad W_{is} = f(X_s, Z_i)$$

In such a setting, the required wage the teachers demand to compensate for the non-pecuniary characteristics of the schools could be identified by estimating a hedonic wage equation with measured non-wage school and regional characteristics and individual characteristics entered on the right hand side and conditioning on the number of teacher positions, appropriately instrumented to account for wage elastic teacher demand. This approach is not meaningful in the present case, which is characterized by a rigid teacher wage. Instead of wages adjusting to clear the market, teachers sort themselves systematically across schools due to regional differences in living costs and outside opportunities, and on the basis of preferences for non-wage school characteristics. This leads to another set of hedonic equations with teacher characteristics in a given school as functions of non-pecuniary school and regional characteristics.

To illustrate this situation, suppose that the most productive teachers in terms of contribution to student learning systematically tend to prefer schools with certain characteristics, and that the school principals want to hire the most productive teachers. Teacher sorting is then likely to imply significant differences in teacher quality across schools and regions. In particular, if teachers tend to prefer schools with native students and students with favorable socioeconomic background, children from ethnic minorities and other disadvantaged groups are left with the least productive teachers. This will add to the initial costs of providing education for these children. Recent US evidence documents that teacher quality is an important determinant of

educational outcomes (Rivkin et al., 2001), and that teacher characteristics vary widely between schools and regions (Lankford et al., 2002 and Boyd et al., 2003).

Ideally, an analysis of teacher sorting and teacher quality differences across schools should be based on a complete characterization of the individual decisions of occupational choice, the initial matching process of schools and teachers of different quality, and the transition of teachers between schools and out of teaching. Since this is a very demanding task, this paper focuses on a limited part of the sorting process: the teacher's decision whether to stay in his current teacher position or not. We do not consider the determinants of the initial matching of teachers and schools, nor do we consider the decision to choose education to qualify for teacher jobs in the first place.

We base our analysis on the conventional view that teachers make rational decisions on whether to leave a teacher job or not and follow the framework in Hanushek et al. (2002). Consider a teacher currently holding a teacher position and continuously evaluating the current workplace compared to alternative choices. Each year he makes a decision whether to stay on or leave his current teacher position. The decision problem of leaving is formally described in equation (2), where X_s^a denotes characteristics of alternative jobs and c represents the costs of moving from the current job to the alternative measured in utility terms.

$$(2) \quad pV(u_i(X_s, Z_i)) < pV(u_i(X_s^a, Z_i)) - c(Z_i)$$

The teacher will quit if the present value utility, $pV(u_i(\cdot))$, at the present job is smaller than at the alternative, taking moving costs into account. Notice that the alternative includes both teaching in another school, the possibility to exit for a job in the private sector, and leaving the workforce. The mobility costs are likely to differ between different destinations, and to depend on individual characteristics.

To empirically analyze the sorting of teachers, we consider a reduced form quit model, and use equation (2) to discuss the sorting of teachers and to motivate the role of individual teacher characteristics, school characteristics and outside opportunities in determining quit propensity. An important issue is how to establish the link between teacher quality and the quit model in equation (2). If teachers whose characteristics are known to be important for student achievement have a higher propensity to leave schools with high share of disadvantaged students

than other teachers, this would imply that these schools are left with teachers of lower quality than other schools. The empirical literature, however, has not been able to provide much robust evidence on the association between student achievement and measured teacher characteristics. Ferguson (1991) and Ehrenberg & Brewer (1994) present evidence that students exposed to teachers educated at selective colleges in the US has higher achievement than other students, and teachers test scores have been shown to increase student achievement by Hanushek (1971) and Ehrenberg & Brewer (1995). Unfortunately, we have not access to this type of information for the teachers in our sample. Recent evidence based on Texas data (Hanushek et al., 2002) suggests that teachers with only a few years of teaching experience are less productive in terms of student achievement. A school where a lot of teachers quit from one year to another will likely need to hire young and inexperienced teachers in vacant positions and the evidence then suggests that these schools will on average have lower teacher quality. In our data, the correlation between the quit rate (see definition in section 4) at a school and the share of teachers below 30 years of age the next year at the same school is equal to 0.15.⁹

3.3 Explanatory variables

School characteristics

We now consider that part of the vector X_s which corresponds to single school characteristics. Norwegian schools are highly regulated and similar with respect to curriculum taught, teaching methods and the number of hours the teacher has to spend in the classroom. Yet, the schools may differ in other respects, such as physical environments and working conditions. Our hypothesis is that the composition of students and teachers at the school are important determinants of the working conditions, and we assume initially that the composition is exogenous with respect to the individual teacher decisions. First, some student groups are likely to require more effort to teach than other groups. In particular, we will consider the share of the students belonging to ethnic and language minorities and the share of the students with special needs. Ideally, one would like to include a range of variables characterizing the student body composition at the schools in analysis of quit behavior. But due to data limitations, we focus on these two variables that hopefully will capture the most relevant aspects of the student body composition.

⁹ Even if quit occurs randomly among teachers with different productivity, student learning may be less in high turnover schools if student learning is related to teacher cooperation and team-work, since coordination would be less easy in a school where a lot of the teachers quit from year to year. However, there exists no systematic evidence on the level of turnover required to induce such effects.

Ethnic composition measured by the share of black and Hispanic students has been found to be positively related to teacher quits in US schools (Gritz & Theobald, 1996, Hanushek et al., 2002, and Loeb et al., 2002). At the same time, schools with high percentage of minority students in US are often found in inner-city areas and generally poor and unsafe neighborhoods with fiscal problems due to local property tax financing of school expenditure. There is a tendency also in Norway that immigrant people is overrepresented in urban areas.¹⁰ However, it is fair to say that the level of ethnic segregation is much lower than in the US. According to Figure 4 below, relatively few schools have more than 50 percent minority students and most of the schools enrolling minority students have a minority share of less than 10 percent. Another important difference between the US and Norwegian context is that education resources are generally much more evenly distributed in Norway. The fiscal system is heavily centralized with centrally determined tax rates and considerable income redistribution between local areas through the central government grant system which finance a large share of local school budgets. An important question then is why schools in Norway with minority students can still be expected to have a higher quit rate than other schools. In our data, minority students are defined as students whose parents speak a foreign language, for which a large majority arrived Norway during the last 30 years.¹¹ Such students have the right to additional language instruction until they have a good command in the Norwegian language. Recourses targeted to these students usually take the form of instruction support in ordinary classes, see Bonesrønning et al. (2003) for a closer discussion. For these reasons, instruction of such students is likely to require more effort from the teachers than instruction of other students both due to language problems and a more demanding communication with their parents. Thus, our hypothesis is that teachers, all else equal, want to leave schools with a high share of minority students to obtain more pleasant working conditions.

Students with special needs are defined as students for which there are allocated extra resources. A fundamental goal in the integration policy has been that physically, mentally and emotionally disabled students should go to the same schools and be in the same classrooms as ordinary students. According to the school act, such students shall be allocated extra resources based on individual education plans to be designed in an interaction between teachers, parents and

¹⁰ In 2001, more than 50 percent of the immigrants from non-western countries resided in the Oslo area. Also in other parts of the country people with minority background tend to be located in the cities.

¹¹ The most common mother tongue of the minority students in the school year 2002–03 are Urdu (15 percent), Arabian (9 percent) and Somalian (9 percent).

specialists on disabled students. The extent and type of extra resources depends on the type of disability the student possesses, but usually classes with one or more special needs students receive additional instructional support by an extra teacher and/or teacher assistant. There is no special formal certification requirement for teachers teaching special needs students, but often they have some extra courses. While schools with many students with special needs are given more resources, it is still possible that instruction of classes with many special needs students requires extra teacher effort due to communication problems and more disruptive behavior.

Due to the absence of information on other socio-economic characteristics of the students at the school level it is difficult to judge whether special needs students are systematically over-represented in schools in low-income neighborhoods and areas with social problems as is often found in US studies. Using variation across Norwegian local governments, Borge & Pettersen (1998) find some tendency that local government spending on special needs students is negatively related to private income and positively related to the share of children below 18 years with lone mothers. However, their regression models have low explanatory power and most of the variation in the share of special needs students across local governments therefore remains unexplained.

While the student body composition is likely to be an important determinant of the working conditions in a school, the quality and characteristics of the other teachers within the school may also influence an individual teacher's decision to quit. The argument that employees prefer to work near similar individuals, with worker segregation as a result, can be dated back to the seminal work on discrimination by Becker (1971). The large majority of the certified teachers in primary and upper secondary schools in Norway are educated at specific teacher colleges. While certified teachers have similar educational background, schools with recruitment problems are forced to use non-certified teachers with very diverse background, which may be less attractive colleges than other certified teachers. This argument suggests that the propensity to quit for tenured certified teachers with permanent appointment is higher in schools that hire non-certified teachers than in schools not hiring non-certified teachers. In the empirical model we include a dummy variable that equals unity if the school employs at least one non-certified teacher at the time when the teacher makes his decision to quit or not. This variable may also capture the effect of other school characteristics. The legal rule in Norway is that applicants for teacher jobs without formal certification can only be appointed in a teacher position when no certified teachers is willing to take the job. Non-certified teachers can only be offered short-term contracts

and accordingly, they are typically young with little experience.¹² A school that needs to hire non-certified teachers is thus likely to face significant recruitment problems. The fact that we model the quit propensity for certified, permanently appointed teachers and measure the hiring of non-certified teachers in the year before we observe the quitting behavior, implies that there should be no mechanical correlation between the quit propensity and the dummy variable for non-certified teachers.

As noted above, several authors have included measures of class size and resource use per student as explanatory variables in teacher turnover studies. The measure of resource use per student used in our model is the number of teaching hours per student. As in hedonic wage regressions as equation (1), the number of teachers is likely to be determined by an interaction between demand and supply. We show below that exclusion of this variable from the model does not alter the effects of the other variables. Another resource use variables included is a dummy variable for whether there is a library at the school.

School size, which we measure by the number of students, may also be important for quit decisions. On the one hand, quits may be seen as a result of mismatch between teacher and school, and as the school size increases, the possibility of moving teachers among classes and subjects within a school will increase and the probability of obtaining a satisfactory match should increase. On the other hand, large schools may be viewed as less unattractive due to crowding and more bureaucracy. Thus, we will include both the number of students squared and dummy variables for the smallest schools in the model to capture the possibility of non-linearities in the school size effects. In addition dummy variables for school type is included.¹³

Regional characteristics

Although teacher wages does not vary between schools, the real teacher wage will obviously vary due to variation in living costs across regions. The real wage associated with teaching in schools within a school district is equal, while real wages associated with schools in different regions varies with the local living costs. Next, expected utility related to the non-teacher

¹² In the school year 1999/2000, 31.6% (11%) of the non-certified (certified) teachers were below 30 years of age.

¹³ The schools are divided into four groups; schools with students at both the primary and lower secondary level with separate classes in each grad (Combined school), schools with students only at the primary educational level with separate classes at each grade (Primary school), schools with students only at the lower secondary level with separate classes at each grade (Secondary school), and schools with students at different grades in the same class (Mixed school).

alternative is equal to the highest expected real wage level the teacher can attain in the private sector. Thus, ideally, we should include a variable describing the amount of money a person with teacher education and given individual characteristics would earn in a non-teaching job as done in Dolton & van der Klaauw (1995). The only available data for alternative wages is private income per capita in the local government. We also include the local unemployment rate to capture variation in the probability of getting outside employment. Since the income variable includes both labor and non-labor earnings it is obviously a very crude proxy for outside pay opportunities for teachers. Given these limitations and since our primary interest is to investigate the effect of school student body composition on teacher quit, one solution is to include a set of regional or school district dummy variables to capture permanent variation in characteristics across regions or districts.

Individual characteristics

We now consider individual characteristics, Z , which may influence the teacher's decision to quit for given school and regional characteristics. According to (2), mobility costs, and thereby the quit propensity, depends on individual characteristics. First, the teacher's family situation may affect the propensity to quit. One reason is that teachers with children are likely to have lower mobility costs than teachers without family obligations. Unfortunately, like the majority of the studies in this branch, we do not have information on the family situation of the teachers. Instead, the teacher's age would capture some of these effects, and since family obligations are not linearly related to age, the square of the age is also included. In addition, the role of family obligations is often different for men and women. A common conjecture is that women are more likely to leave teaching in order to take care of children than men, and Stinebrickner (1998) provide evidence in support of this hypothesis based on a national US sample. However, in the Scandinavian countries, with generous rules for leave due to birth (approximately one year paid leave financed by the national government) and heavily subsidized governmental child care, these mechanisms is expected to be much less prevalent than in the US. Teachers on paid leave are not treated as quitters in our empirical analysis, but the propensity for leaving the school the next school year may be different for these teachers. Thus, we include a dummy variable indicating whether the teacher is on full or partly paid leave.

Third, quit propensity may depend on the teacher's education level. An obvious reason is that the set of outside alternatives increases with education level. As an example, a teacher with two years education in addition to the basic three-year education at a teacher college will likely be

more attractive both for other schools and private sector employers compared to a teacher with only basic teacher college education. The data set also include school leaders. Since their pay and working tasks differ from ordinary teachers, a dummy variable is included in the model. As a final individual characteristic, we include a dummy variable indicating whether the teacher has a fulltime or part-time position.

4. Descriptive evidence.

The present paper uses data on teachers in primary and lower secondary Norwegian schools during the school years 1992-93 to 1999-2000. The data covers the whole country, which means that we avoid the problem of distinguishing between teachers migrating between states and districts and those leaving teaching that has plagued US studies using administrative data. In this section and in section 5.3, we will distinguish between three destinations; mobility to another school in the same local government, mobility to another school in another local government, and leaving the education sector. In addition, since the extent of private schools in Norway is negligible, the exit to such schools is not a realistic option for the teachers.¹⁴

In order to restrict the study to true voluntary quits, we include only teachers with permanent appointment in the analysis. Thus, temporary teachers and teachers on short-term contracts are excluded. In addition, teachers above 60 years of age are excluded in order to avoid including retirement decisions. The data reduction is more closely described in Appendix A.

As to the extent of teacher turnover in Norway, on average, 9.5 percent of the teachers used in the present analysis leave their current school from one year to another. In order to get some further feeling with the main features of the mobility, Figures 1-5 describe how teacher transitions are related to certain school and individual characteristics. The figures present the overall quit rate, and decompose this rate into inter-district mobility (Move_m), intra-district mobility (Move_s), and mobility out of the school sector (Move_o).

Figure 1 shows the development over time in the average turnover rate. While being relatively constant at 8% in the first three years, the rate started to increase in 1996 and was close to 12 % in 1997 and 1998. The turnover rate increased both for male and female teachers and for all age groups. The sharp increase in the average turnover rate from 1995 occurs when the average

¹⁴ In the school year 1995/96, 1.5 percent of the students were enrolled in private schools.

unemployment rate in Norway declined sharply. One hypothesis is that as the unemployment rate declined, more teachers took advantage of the improved possibilities for work and higher pay in other occupations. In accordance with this hypothesis, Figure 1 shows that the increased turnover after 1995 is due to higher propensity to leave the school sector. These changes in turnover rates over time points to the importance of including variables capturing the labor market situation in the econometric model.

Figure 2 plots the teacher turnover rate against school size measured by the number of students. The turnover rate seems to be highest for the smallest and largest schools, which indicates that non-linear terms should be included in the econometric model in order to capture the full effect of school size on turnover. Notice that there are some very small schools in Norway due to scattered population in some areas. We will test whether exclusion of these schools from the sample alter the empirical results.

Figure 3 shows that the turnover rate is declining in age. The average turnover rate for teachers at age 24 is 25 percent, while the average turnover rate for those at age 60 is about 7 percent.¹⁵

Figure 4 shows a positive relationship between the teacher turnover rate and the share of students at the school belonging to ethnic and language minorities. This relationship is driven by mobility out of education and to a new school in the same district. While the average turnover rate among teachers at schools without minority students is around 9 percent, the average turnover rate at schools with at least 55 percent minority students is about 16 percent. As regards to the relationship between teacher turnover and the share of students with special needs, Figure 5 shows that the teacher turnover rate is somewhat higher in schools with a relatively large share of students with special needs, although the relationship is less clear than for minority students. Taken together, Figures 4 and 5 suggest that teacher turnover is related to student composition, although strong conclusions on the causal effect of student composition on teacher mobility behavior cannot be drawn on the basis of these figures. The third variable measuring the working conditions at the school, the dummy variable for whether the school employs non-certified teachers in the previous year, also seems to be important for quits. The average quit rate for

¹⁵ The skewed distribution of observations with respect to age is in large part due to previous changes in teacher demand related to the rapid growth in the number of students during the 1960s and 1970s and a subsequent fall in the 1980s.

permanently appointed certified teachers is 10.4 percent at schools employing non-certified teachers and 8.7 percent at the other schools.

Table A1 includes descriptive statistics of all variables used in the empirical model. 65 percent of the teachers are female, 28 percent are working part time, and 2 percent are on paid leave. The average (weighted) school size is 240 students, and almost half of the schools are pure primary schools with separate classes on each grade. Almost half of the teachers work at schools employing both certified and non-certified teachers.

5. Econometric evidence.

In this section we present the results from estimating reduced form quit equations corresponding to the decision rule (2). To facilitate comparison with other studies in the area, our baseline model is a binary model where the teacher's only choice considered is whether or not to leave his current school appointment. In section 5.3 we estimate a less restrictive version where we allow the effect of the explanatory variables to differ between quits for three different destinations.

5.1. Baseline model

We estimate a probit version of the model where the left hand side variable is equal to unity if the teacher leaves a particular school from year t to year $t+1$ and zero otherwise. The baseline results are presented in Table 1. Column (1) shows the preferred model, which includes region specific effects (90 regions) and time specific effects (7 years).¹⁶ For the probit model, we only present the estimated mean probability derivatives throughout the paper. Columns (2) and (3) show that the results do not change much when interaction between the time specific and region specific effects (630 variables) are included, or when the region specific effects are replaced by school district specific effects (432 local government specific effects).

The full model results of the preferred model, including the effects of the individual characteristics, are reported in Appendix Table A1. The effects of the individual characteristics are mainly as expected. Young teachers have a higher propensity to quit than old teachers, confirming results elsewhere in the literature. The numerical results show that the marginal effect of increased age on the probability of quitting at mean values of quit is about -0.60 and -0.15 percentage points when the initial age is 25 and 60, respectively. The propensity to quit increases by educational level. Increasing the educational level from three years of higher

¹⁶ The regions used are the labor market regions constructed by Statistics Norway on the basis on commuting data.

education (28.8 percent of the observations) to the highest possible educational level (which is six years of higher education and account for 2.6 percent of the observations), the quit probability at mean increases by 3.6 percentage points.¹⁷ Although the US evidence on the effect of teacher qualifications is somewhat mixed, the results generally supports the hypothesis that the quit rate is increasing in qualification level. A reasonable interpretation is that teachers with higher education have better outside opportunities and therefore have a higher propensity to quit. This is also consistent with the evidence in Dolton & van der Klaauw (1995).¹⁸

We find that the quit probability is 0.6 percentage points lower for women than for men, evaluated at the sample mean. Several studies from the US have found the opposite result. Using a longitudinal national US sample, Stinebrickner (1998) found that female teachers are more reluctant than males to leave teaching for family reasons. The difference across the countries must be related to more generous Scandinavian rules for leave due to birth, highly subsidized publicly provided child care, high flexibility in working time, and the fact that teachers on paid leave are not defined as quitters in the present analysis. Actually, the higher quitting propensity for male teachers seems perfectly consistent with the reasonable hypothesis that males' opportunity cost in terms of expected wage in other occupations is higher than for women. Although a common belief is that there is much greater gender equality in the labor market in Scandinavian countries than in the US, the overall gender pay gap in Norway is still sizeable. According to Blau and Kahn (2003), the gap in log earnings between men and women in the 1985-94-period was 0.275 and 0.395 log points in Norway and USA, respectively, while the average gap across the 22 countries in their study was 0.309.

¹⁷ Estimations based on a dummy variable approach, using dummy variables for each educational level, showed that the effect was extremely close to linear. According to the raw data, the share of the teachers who quit is 8.1, 9.7, 10.3 and 11.9 percent for teachers with three, four, five and six years of higher education, respectively.

¹⁸ Taken literally, the finding suggests that the wage premium for teachers with higher education is too low, which might be reasonable given the highly compressed wage distribution for teachers. However, such a conclusion is based on the assumption that the mobility in general is independent of educational level and that highly educated teachers perform better than less educated teachers, measured by their contribution to student achievement. While we have not been able to analyze the effect of teacher education on student achievement in Norway, existing US evidence gives very weak support for the hypothesis that more highly educated teachers generate higher student achievement (Rivkin et al., 2001).

Regarding the other variables measured at the individual level, the results are as expected. School leaders, teachers working part time, and teachers on leave are more reluctant to quit than others.

Regarding the variables of main interest, the following results are robust across the specifications in Table 1:

- i) Teachers working at schools with high share of minority students and students with special needs have higher propensity to quit.
- ii) Teachers working at schools using individuals without teacher certification in teaching positions in the previous school year have a higher quit probability.

The composition of the students seems to have an impact on the quit decision. Comparing a school with no minority students with a school with 10 percent minority students, the propensity to quit is about 0.4 percentage points larger in the latter case. For the share of students with special needs, the corresponding figure is 0.6 percentage points higher propensity to quit. These effects are quite large if one compares schools where nearly all students belong to a minority or have special needs with schools without such students.

The model formulation so far implies a linear association between the probability to quit and our variables describing student body composition. However, it is possible that this formulation implies a misspecification of the true effects. To investigate whether the linear specification is reasonable, the effect of student composition on the quit probability was estimated using a dummy variable approach. The model allows the effect of schools with a minority share of, say, $[10,15)$, to differ freely from schools with a minority share outside this range, but restrict the effect of student composition to be equal within each group. For the minority share, schools with a minority share of at least 50 percent are grouped together because they are too few to split into several groups, and the same is the case for schools where at least 20 percent of the students have special needs. The result from this model is shown in Figure 6. Both the effects of the minority share and the share of students with special needs are reasonable linear. According to the results, the quit probability on schools where the minority share is in the range $[15,20)$ is 0.4 percentage points higher than in schools without minority students. The corresponding result for students with special needs is 0.7 percentage points. Thus, it seems fair to conclude that the effects of student composition are not driven by outliers.

According to result ii), the propensity to quit also seems to depend on teacher composition at the school. The mean propensity to quit is about 0.7 percentage points higher at schools that have to utilize individuals without teacher certification in teaching positions than in schools that only employ certified teachers.¹⁹

Even though the results clearly suggest that the student and teacher compositions are important determinants of teacher quit behavior, these effects cannot be interpreted as pure discrimination effects. Both student composition variables may to some extent pick up unmeasured background factors such as low parental income, high share of lone parents and so on, which may be the true variables that affect teacher behavior. In addition, we cannot rule out the possibility that teacher composition may proxy for other factors that makes the school unattractive from a teacher's point of view.

The relation between the probability to quit and school size turns out to be highly nonlinear. The model includes the number of students, the number of students squared, and dummy variables for schools with less than 20 pupils and for schools with $[20, 60)$ pupils. The model implies that there is an "optimal" school size in terms of quit of about 370 pupils. The quit probability is equal for schools with about 70 and 670 pupils, which is about 1.4 percentage points above the quit probability for schools with 370 pupils. For the smallest schools, the quit probability is even higher than implied by the quadratic specification because the dummy variables for the small schools have positive effects.²⁰

Above, we argued that small class size and high resource use at the school may lead to lower teacher quit rate. However, contrary to prior expectations, the variable measuring resource use, teacher education hours per student, has a positive and significant effect at 5 percent level. Increasing the resource use by 2 standard deviations increases, according to the model, the quit probability by 0.4 percentage points. It is possible that the positive effect is due to an omitted

¹⁹ Notice that excluding this variable from the model does not alter the effects of the other variables in the model. We have also calculated a variable measuring to what extent a school has to rely on non-certified teachers. Using this variable instead of the dummy variable for utilization of non-certified teachers gave the same fit to the data and none of the effects of the other variable in the model changed. This result indicated that an increase from zero to 20 percent of non-certified teachers at a school increases the propensity to quit for certified teachers by 1.3 percentage points.

²⁰ The model implies that the mean quit probability for teachers at schools with 10 and 50 pupils are 3.5 and 2.6 percentage points larger than for a school with 370 pupils.

variable bias. There may be some compensating elements in teacher education hours with regard to factors not captured by the model. For example, while the model includes the share of the students with special needs as a separate variable, the variation in ability within this student group is likely to be large. Because we have defined students with special needs as students for which there are allocated extra resources, students with large needs will increase the resource use at school more than students with minor extra needs. Thus, high resource use may in part capture unmeasured student composition effects.²¹ The model includes one other variable that should partly capture resource use not related to student composition, namely a dummy variable indicating whether the school has a library. This variable has the expected negative effect.

In addition to the individual and school factors discussed above, school district factors also influence the decision on whether to quit or not. The quit rate is higher in large local governments than in small local governments measured by the log of the population, probably due to more school choice alternatives in such communities as discussed below. In addition, the quit decision seems to be influenced by the unemployment rate. The results suggest that a doubling of the local unemployment rate reduces the probability that a teacher quits by about 0.8 percentage points. The effect of the income level of the inhabitants in the local government is positive as expected, but not statistically significant. The absence of any significant effect of this variable is not surprising, since it is only a crude proxy for the alternative wage outside teaching. A fair conclusion is that outside wages are better proxied by the teacher's level of education.

5.2. Sensitivity analyses

While the results so far seems to be quite robust across specifications, it is important to undertake further sensitivity analyses to check whether the model is robust in different dimensions. Firstly, we have been assuming that non-pecuniary school factors are exogenous to the individual teacher's quit decision. One problem with this assumption is that teachers who desire stability may seek out, for example, schools with few minority students in which to work if there is less inherent turnover at these schools. Alternatively, teachers with a preference for more variation across years in where they work may enjoy working in schools with a higher percentage of minority students. One way to address the importance of such effects is to include

²¹ As noted above, the number of teachers and thereby the number of teaching hours at school is likely to be determined in an interaction between teacher supply and demand. Thus, this variable may be endogenously determined together with teacher quit behavior. Notice that if this variable is excluded from the model, the effect of the student composition variables increases slightly, the effect of the shares of minority students and special needs students in the preferred specification increases from 0.038 to 0.041 and from 0.057 to 0.062, respectively.

individual fixed effects in the model. The results of a fixed effects logit model are presented in column (4) in Table 1. All major effects remain significant at conventional levels.

One feature of the individual fixed effect approach is that only teachers quitting at least once contribute to the log likelihood. Thus, stable non-quitting teachers, which account for the majority of the teachers, are excluded from the sample. In the reduced sample, the mean probability of quitting is about 25 percent compared to about 10 percent in the total sample. The marginal effects presented in brackets in column (4) in the table is evaluated at mean of the sample used in the estimation, while evaluating the effects at mean for the whole sample yields affects that are about half of the size reported. Nevertheless, the estimated negative effect of the minority share on quit propensity is clearly larger in the individual fixed effect specification than in the baseline specification. Also the effect of the share of students with special needs remains strong, and the difference between small and medium sized schools increases. The effect of non-certified teachers employed at school seems to become smaller, but are still significant at five percent level.

Secondly, we have so far assumed that the individual teacher characteristics only affect the probability to exit from the current school. In this section we investigate whether the effect of school characteristics differ across different type of teachers and schools. First, quit behavior may differ between women and men because of different mobility cost for family reasons, and the fact that our model does not include variables describing the family situation may in particular bias the results for women. But as the first two columns of Table 2 show, the behavior of men and women are surprisingly similar. However, there is a tendency that the quit decision for female teachers is more responsive to both the student and teacher compositions than is the case for men. More surprisingly, the effect of local unemployment is also larger for women than for men.

So far we have assumed that differences in mobility costs may affect the quit propensity directly. However, differences in mobility costs may also affect the relationship between individual quit behavior and non-pecuniary job attributes. In particular, quit propensity may differ between young and mature teachers as first suggested by Bartel (1982) who found that young men were more likely to quit repetitive jobs than mature men. Hanushek et al. (2002) using Texas data, find that the positive quit effect of high minority share of students is highest among the least experienced teachers. In order to investigate whether the relationship between quit propensity

and non-pecuniary variables depends on the teacher's age, we estimated the model on six sub-samples; teachers below 30 years of age, between 30-50 years of age, and above 50 years of age, separately for men and women. Due to the skewed age-distribution in the total sample of teachers as seen in Figure 3, the sub-sample of the youngest teachers is relatively small. The results from this exercise are presented in columns (3)–(8) in Table 2. The effect of both the student and teacher composition variables has the same sign as in the baseline model for all groups but the effects are less precisely estimated especially for men in different age groups. But taken together, while some differences exist, the results do not seem to vary dramatically between teachers of different age and gender.

As a further check on the robustness of our results, we split the sample with respect to working time and estimate separate models for those working full-time and those working part-time. According to the results presented in columns (9)-(10) in Table 2, teachers working part time respond somewhat stronger to the student and teacher compositions at the school than teachers working full time, but all effects of these three variables are significantly positive at 5 percent level for both groups. On the other hand, only teachers working full time seem to respond to the local labor market conditions measured by the local unemployment rate.

So far, the effect of school size in the different sub-samples is remarkably similar. One objection may be that this result, and possibly also the effects of other variables in the model, is driven by special circumstances at small schools. Restricting the sample to schools above 200 students, for which the results are presented in column (11) in Table 2, we find that schools with 390 pupils have the lowest quit probability. Thus, we conclude that the result for the “optimal” school size is not driven by the inclusion of small schools in the sample. In addition there are only minor changes in the effect of the other variables.

An additional question is whether it is reasonable to pool several years in the sample in one equation. With our approach, teachers who come into the sample in the later years have a smaller window in which to make mobility decisions than more experienced teachers. We have investigated whether this may bias the results in two ways. First, we reduced the sample only to those teaching in the first year of the sample, the school year 1992–93. Second, we included a full set of cohort–year interaction variables (27 variables), where cohort is defined as the first

year a teacher is in the sample. The results of both these specifications are qualitatively equal to the baseline results.²²

5.3. Multinomial model.

The model used so far restricts the effects of the explanatory variables on the probability to exit a school to be independent of destination. As noted above, most studies of the relationship between non-pecuniary school factors and teacher quits restrict the analysis to cover between district moves within certain US states. However, recent evidence provided by Betts et al. (2000) from California and Loeb (2000) from New York State, suggests that teacher characteristics differ considerably within school districts. To investigate whether the effect of non-pecuniary school characteristics on teacher quit probability depends on destination, we estimate a multinomial logit model with three possible destinations: new school in same school district, new school in another school district, and out of teaching. Staying at the current school is chosen as the reference state.²³ The results are presented in Table 3.

The quit model in equation (2) above gives some information on the likely effects of the included variables on these different kinds of moves. First, it is likely that the decision to leave the education sector is more responsive to labor market variables as outside pay and local unemployment rate than the decision to change school within a local government. Second, the decision to change school within local government is likely to be most responsive to school characteristics. Since taking a teacher job in another local government often means a change in residence, the moving costs involved in obtaining a satisfactory match between the teacher's preferences and school characteristics is smaller for moves within than between local governments.

Our working hypothesis is that teachers search for the "best" school mainly within the school district, which implies that school characteristics should be most important for within-school-districts mobility. The results from the multinomial model give some evidence that this is indeed the case. The estimated coefficients for the student composition variables are larger for the

²² In the first case, the sample is reduced by 20 percent, and the marginal effects of the minority share, the special needs share, and of non-certified teachers employed are equal to 0.036, 0.042 and 0.005, respectively. In the second case, the marginal effects are equal to 0.034, 0.055 and 0.007, respectively.

²³ A multinomial model can be theoretically justified by using a random utility model combined with the assumption that choices are independent of irrelevant alternatives. This means that the relative choice probabilities between two alternatives are independent on the other alternatives (Green, 1997).

probability to move to another school within the same school district than for the other destinations. However, student composition also significantly affects moves out of the school sector. The results imply that, evaluated at mean values and using the formula in Greene (1997, p. 916), increased minority share from zero to 0.2 increases the probability to move to another school in the same school district, to a school in another school district and out of the education sector by 0.4, 0.1 and 0.3 percentage points, respectively. The importance of school size is also strongest for moves within the school district.

On the other hand, the teacher composition is less important for within-district-mobility than for other types of quits. One may speculate that this result partly reflects that this variable may capture some other unfavorable aspects of the school district not included in the model.

Regarding the included variables at the school district level, the effects of population size is as expected. The large positive effect of school district size on within-school-district mobility and the negative effect on the mobility to other school districts are consistent with the hypothesis that large districts contain more choice opportunities for teachers. The small but significant effect on the mobility out of the school sector may be a result of a larger alternative labor market. Regional unemployment have the expected negative sign on the mobility out of the school sector, but has also an significant impact on within school district mobility.

Consider next the effect of private income on quit probability. This variable is a crude proxy for teachers' alternative wage in the external labor market and may affect the quit probability through two main mechanisms. To illustrate, consider a local government with high private income. This will partly reflect high wages in the private sector, which in turn also yields high housing prices. Because the teacher wage is equal in each local government, the real teacher wage is likely to be low in such a community. Thus, if high private income mainly reflects high housing prices, we would expect teacher mobility to other local governments to be relatively high. On the other hand, if private income mainly captures high wages in the alternative labor market for teachers, we would expect the effect on mobility out of the school sector to be high. The results in Table 3 show that private income has a negative effect on intra-district mobility and a positive effect on the decision to move out of the school sector, which may indicate that the second effect dominates.

6. Concluding remarks.

Industrial researchers, sociologists and psychologists all stress the idea that non-pecuniary job attributes are important determinants of an employee's decision to quit a job or not. Yet, economists are used to view differences in pecuniary rewards measured by wages as main arguments in the quit decision since wages themselves should adjust endogenously to match differences across jobs in such attributes. However, the assumption that wages are flexible does not fit well with the actual functioning of many labor markets. Thus, the relation between non-pecuniary job attributes and quit behavior should be a concern also for economists. However, the empirical identification of the effect of such factors is surely difficult when wages themselves to some extent responds to these attributes.

A novel feature of teacher labor markets in Europe is that teacher wages are more or less equal within a country and depends almost exclusively on education and experience. In such an environment, non-pecuniary job characteristics could be very important determinants of teacher mobility. Taken together with recent evidence indicating that teachers are the most important input in education production, this point to the importance of understanding teachers quit decisions. This paper presents some new econometric evidence from Norway consistent with the hypothesis that non-pecuniary job attributes in schools are important determinants of teachers' probability to quit. We find that the propensity to quit is especially high in schools with high shares of minority students and students with special needs. Moreover, our model results suggest that the teachers leaving these schools tend to move to other schools within the same school district. At the same time, the international evidence on student achievement consistently shows that minority students have lower achievement than other students, see for example Fertig & Schmidt (2002) who, using OECD's PISA study of student performance in over 30 countries, find that regular language at student's home different from the test language have a large negative effect on achievement. The type of teacher sorting revealed in this paper suggest that a rigid teacher wage may add to the problems that already exist in providing education for these students.

References:

- Bartel, A.P. (1982). Wages, nonwage job characteristics, and job mobility. *Industrial and Labor Relations Review* 35 (4), 578-589.
- Baugh, W.H. & Stone, J.A. (1982). Mobility and wage equilibration in the educator labor market. *Economics of Education Review* 2 (3), 253-274.
- Becker, G.S. (1971). *The economics of discrimination*, 2d ed. Chicago, University of Chicago Press.
- Betts, J.R., Reuben, K.S. & Danenberg, A. (2000). Equal resources, equal outcomes? The distribution of school resources and student achievement in California. San Francisco, Public Policy Institute of California.
- Blau, F. D. & Kahn, L.M. (2003): Understanding international differences in the gender pay gap. *Journal of Labor Economics* 21 (1), 106-144.
- Bonesrønning, H., Falch, T. & Strøm, B. (2003). Teacher sorting, teacher quality, and student composition. *European Economic Review* (forthcoming).
- Borge, L.E. & Pettersen, I. (1998): Likeverdige skoletilbud og kommunale inntekter. Allforsk report.
- Boyd, D., Lankford, H., Loeb, S. & Wyckoff, J. (2003): Analyzing the determinants of the matching of public school teachers to jobs: Estimating compensating differentials in imperfect labor markets. NBER Working Paper 9878.
- Brewer, D.J. (1996). Career paths and quit decisions: Evidence from teaching. *Journal of Labor Economics* 14 (2), 313-339.
- Burdett, K. (1978). Employee search and quits. *American Economic Review* 68, 212-220.
- Clark, A.E. (2001). What really matters in a job? Hedonic measurement using quit data. *Labour Economics* 8, 223-242.
- Dolton, P., & Mavromaras, K.G. (1994). Intergenerational occupational choice comparisons: The case of teachers in the UK. *Economic Journal* 104, 841-863.
- Dolton, P., & van der Klaauw, W. (1995). Leaving teaching in the UK: A duration analysis. *Economic Journal* 105, 431-444.
- Dolton, P., & van der Klaauw, W. (1999). The turnover of teachers: A competing risks explanation. *Review of Economics and Statistics* 81 (3), 543-552.
- Eberts, R.W., & Stone, J.A. (1985). Wages, fringe benefits, and working conditions: An analysis of compensating differentials. *Southern Economic Journal* 52, 274-280.
- Ehrenberg, R. & Brewer, D. (1994). Do school and teacher characteristics matter? Evidence from high school and beyond. *Economics of Education Review* 13, 1-17.

- Ehrenberg, R. & Brewer, D. (1995). Did Teachers' verbal ability and race matter in the 1960's? *Economics of Education Review* 14, 1-21.
- Falch, T. (2003). Estimating the elasticity of labor supply to an enterprise utilizing a quasi-natural experiment. Working Paper no. 7/2003, Department of Economics, Norwegian University of Science and Technology.
- Ferguson, R. (1991). Paying for public education: new evidence on how and why money matters. *Harvard Journal on Legislation* 28 (Summer), 465-498.
- Fertig, M., & Schmidt, C.M. (2002): The role of background factors for reading literacy: Straight national scores in the PISA 2000 study. IZA Discussion Paper No 545.
- Greenberg, D., & McCall, J. (1974). Teacher mobility and allocation. *Journal of Human Resources* 9 (4), 480-502.
- Greene, W.H. (1997). *Econometric Analysis*, third edition. Prentice Hall, New Jersey.
- Gritz, M.R., & Theobald, N.D. (1996). The effects of school district spending priorities on length of stay in teaching. *Journal of Human Resources* 31 (3), 477-512.
- Hanushek, E.A. (1971). Teacher characteristics and gains in student achievement: Estimating using micro data. *American Economic Review* 60 (2), 280-288.
- Hanushek, E.A., Kain, J.F., & Rivkin, S.G. (2002). Why public schools lose teachers. *Journal of Human Resources* (forthcoming)
- Kenny, L.W., & Denslow, D.A. (1980). Compensating differentials in teachers' salaries. *Journal of Urban Economics* 7, 198-207.
- Lankford, H, Loeb, S. & Wyckoff, J. (2002): Teacher sorting and the plight of urban schools: A descriptive analysis. *Educational Evaluation and Policy Analysis* 24 (1), 37-62.
- Levinson, A.M. (1988). Reexamining teacher preferences and compensating wages. *Economics of Education Review* 7, 357-364.
- Loeb, S., & Page, M.E. (2000). Examining the link between teacher wages and student outcomes: The importance of alternative labor market opportunities and non-pecuniary variation. *Review of Economics and Statistics* 82 (3), 393-408.
- Mont, D., & Rees, D.I. (1996). The influence of classroom characteristics on high school teacher turnover. *Economic Inquiry* 34, 152-67.
- Murnane, R.J., & Olsen, R.J. (1989). The effect of salaries and opportunity costs on duration in teaching: Evidence from Michigan. *Review of Economics and Statistics* 71 (2), 347-352.
- Rivkin, S.G., Hanushek, E.A., & Kain, J.F. (2001). Teachers, schools and academic achievement. Revised version of NBER Working Paper 6691.

Stinebrickner, T. (1998). An empirical investigation of teacher attrition. *Economics of Education Review* 17, 127-136.

Stinebrickner, T. (1999). Estimation of a duration model in the presence of missing data. *Review of Economics and Statistics* 81 (3), 529-542.

Stinebrickner, T. (2001). A dynamic model of teacher labor supply. *Journal of Labor Economics* 19 (1), 196-230.

Theobald, N.D. (1990). An examination of the influence of personal, professional, and school district characteristics on public school teacher retention. *Economics of Education Review* 9 (3), 241-250.

Appendix A. The data

The register data consist of all teachers in primary and lower secondary public schools for the school years 1992/1993 to 1999/2000. This includes the 1–10th grade, covering students 6 to 16 years old. The dependent variable is whether the teacher works at the same school in year $t+1$ as in year t . Thus, the last year of the sample is only used to construct the dependent variable. The total sample for the school years 1992/1993 to 1998/1999 includes 84,417 teachers and 383,894 person-year observations. The following observations are excluded from the analysis: Teachers without permanent appointment (68,191 observations), the school is closed in year $t + 1$ (1,422 observations), the school has paid the teachers a wage premium due to an experiment evaluated in Falch (2003) at least once during the empirical period (5,144 observations), teachers above 60 years of age (15,397 observations), teachers below 23 years of age (125 observations), and missing data at the school level (5,467 observations). The final sample consists of 60,444 teachers and 288,151 observations.

Table A1. Descriptive statistics and the baseline model

	Mean	Standard deviation	Minimum	Maximum	Baseline model
Move	0.095	0.29	0	1	Dependent variable
Move_m	0.023	0.15	0	1	-
Move_s	0.016	0.12	0	1	-
Move_o	0.056	0.23	0	1	-
Age / 100	0.449	0.086	0.23	0.60	-0.947 (16.3)
(Age / 100) squared	0.209	0.074	0.05	0.36	0.007 (10.6)
Years of higher education	3.97	0.78	2	6	0.012 (15.6)
Leader	0.101	0.30	0	1	0.024 (11.6)
Working part time	0.284	0.45	0	1	0.032 (21.9)
On leave with full or partly pay	0.021	0.15	0	1	0.094 (22.4)
Women	0.653	0.48	0	1	-0.006 (4.72)
Share of minority students at school	0.050	0.09	0	1	0.038 (3.35)
Share of students with special needs at schools	0.064	0.04	0	1	0.057 (3.32)
Non-certified teachers employed at school	0.452	0.50	0	1	0.007 (5.03)
The school has a library	0.311	0.46	0	1	-0.004 (2.32)
Teacher education hours per student / 100	0.881	0.263	0.41	15.6	0.071 (2.15)
Pupil / 100	2.37	1.30	0.01	7.83	-0.161 (4.33)
(Pupil / 100) squared	7.33	7.39	0.0001	61.31	0.022 (3.40)
Below 20 pupils	0.012	0.11	0	1	0.020 (2.93)
Between 20 and 60 pupils	0.068	0.25	0	1	0.012 (3.30)
Combined school	0.160	0.37	0	1	-0.001 (0.51)
Secondary school	0.250	0.43	0	1	-0.010 (5.09)
Primary school	0.421	0.49	0	1	-
Mixed school	0.169	0.37	0	1	-0.001 (0.29)
ln (Population in the middle of school year)	63,057	123,714	212	502,867	0.008 (5.75)
ln (Unemployment at the end of school year)	0.038	0.02	0.003	0.183	-0.008 (2.81)
ln (Mean private income (NOK))	104,621	23,576	57,258	194,513	0.014 (0.99)
1992	0.136	0.34	0	1	-
1993	0.135	0.34	0	1	0.006 (2.19)
1994	0.136	0.34	0	1	0.003 (0.87)
1995	0.141	0.35	0	1	-0.002 (0.64)
1996	0.141	0.35	0	1	0.019 (4.15)
1997	0.156	0.36	0	1	0.020 (3.30)
1998	0.159	0.37	0	1	0.016 (2.33)
Region specific effects					Yes
Observations (person-years)					288,151
Log likelihood					-86,224

Note: The baseline model in the last column is estimated by the probit-model. Mean probability derivatives presented. Asymptotic t-values in parenthesis, calculated based on standard errors corrected to account for within-school clustering of errors.

Figure 1: Mobility over time, and the number of observations each year

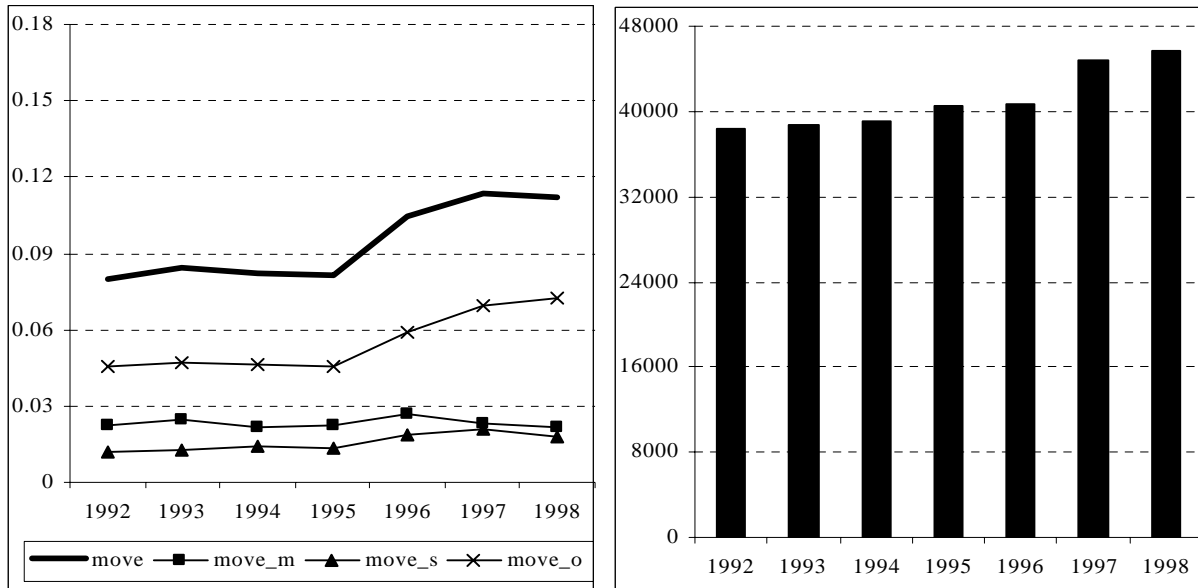


Figure 2: Mobility as a function of school size, and the number of observations in each group.

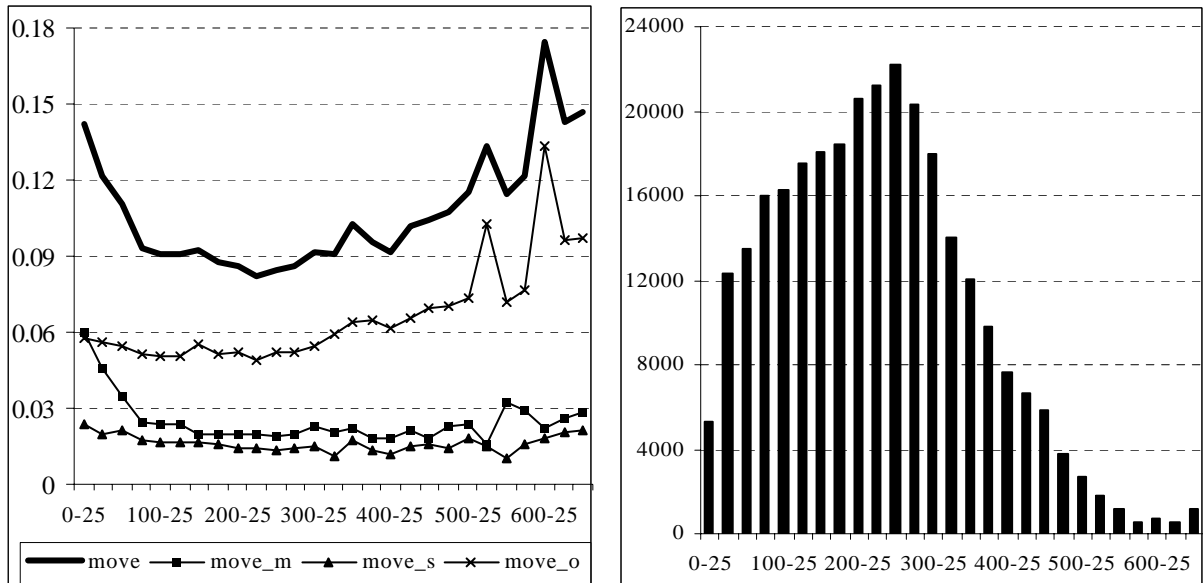


Figure 3: Mobility as a function of age, and the number of observations at each age.

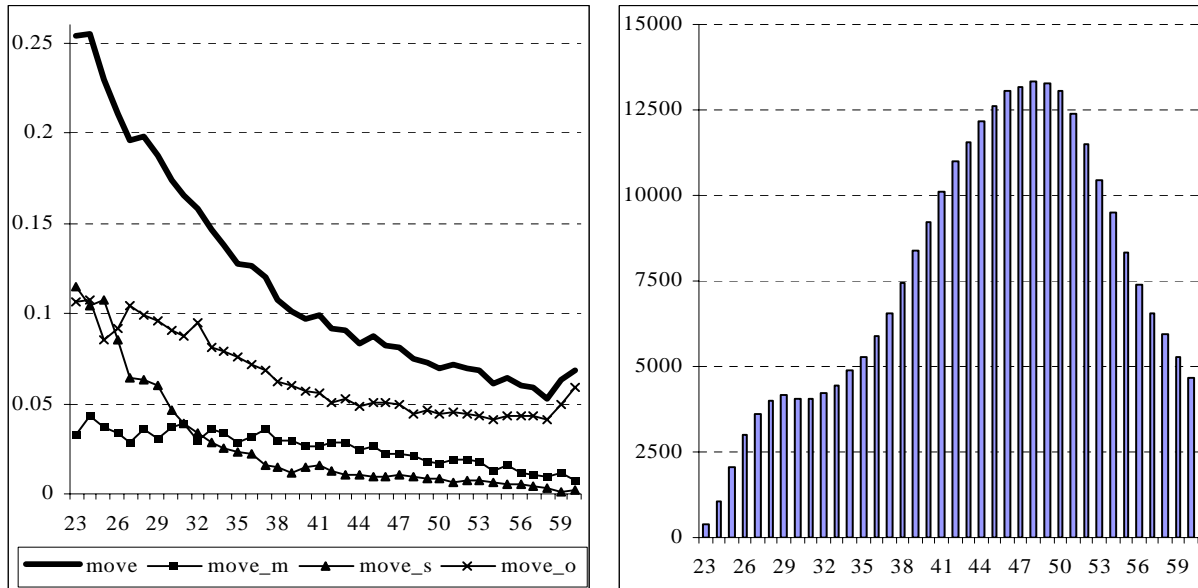


Figure 4: Mobility as a function of the share of minority students, and the number of observations in each group.

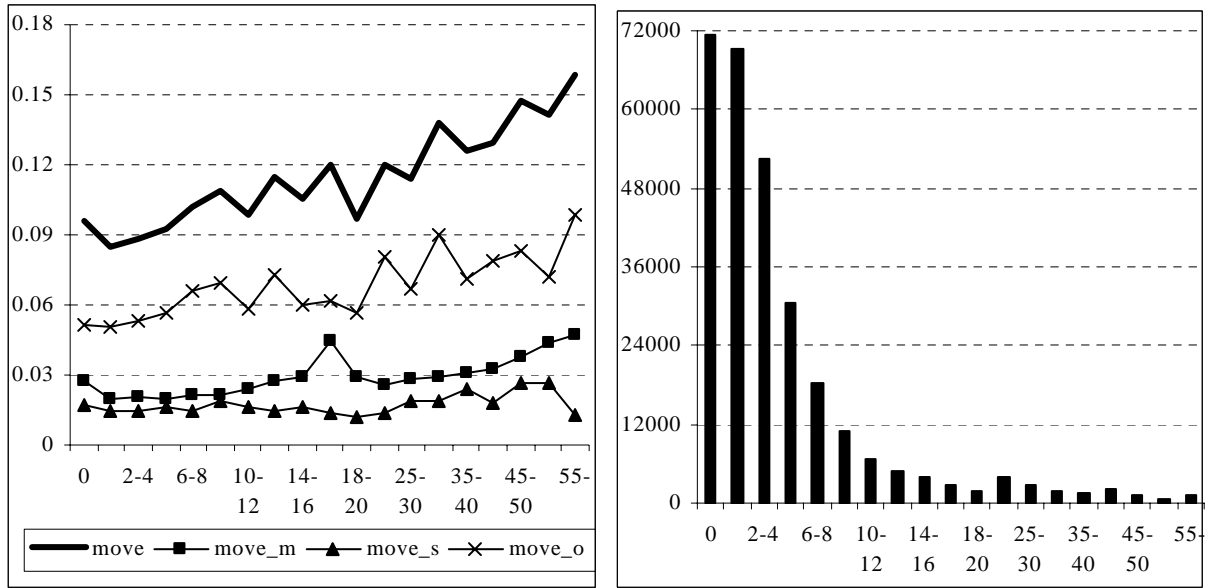


Figure 5: Mobility as a function of share of students with special needs, and the number of observations in each group.

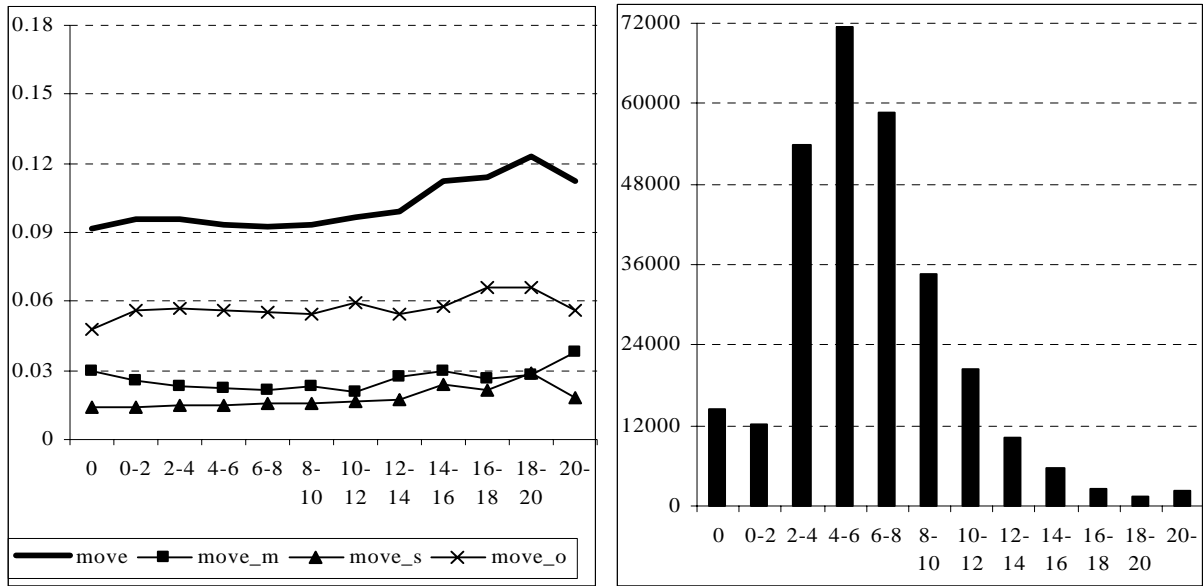


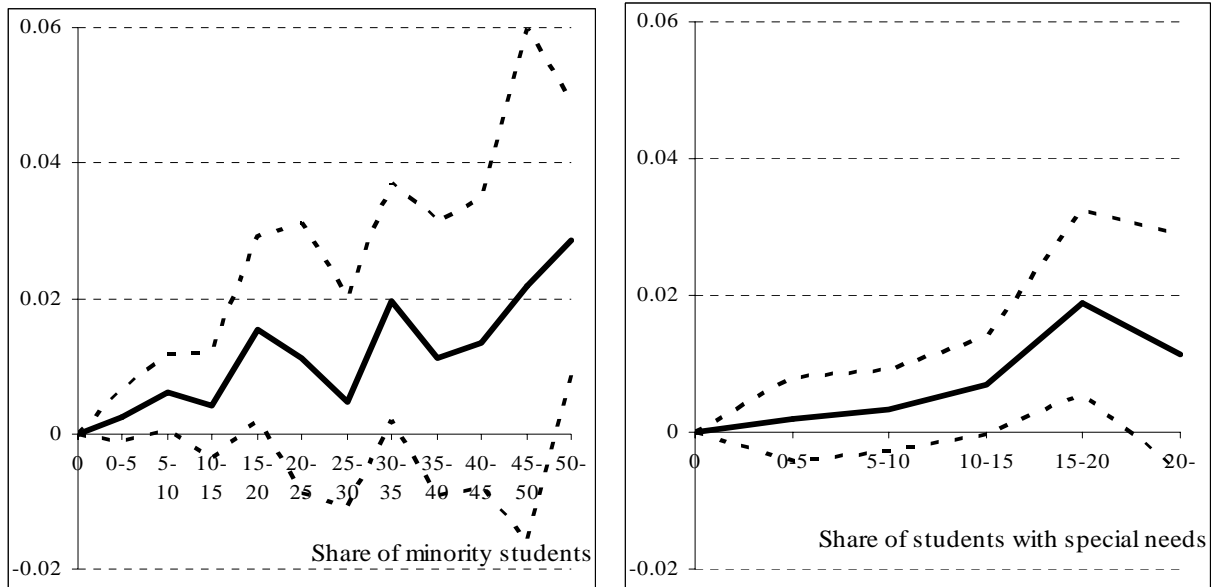
Figure 6: The effect of student composition ± 2 standard errors using a dummy variable approach

Table 1. Estimation results. The dependent variable is equal to unity if the teacher move

	(1) ^a	(2) ^a	(3) ^a	(4) ^b
Share of minority students at school	0.038 (3.35)	0.038 (3.47)	0.041 (3.51)	0.967 (4.50) [0.180]
Share of students with special needs at schools	0.057 (3.32)	0.059 (3.37)	0.050 (2.91)	0.726 (3.03) [0.135]
Non-certified teachers employed at school	0.007 (5.03)	0.008 (5.64)	0.006 (4.26)	0.046 (2.28) [0.009]
The school has a library	-0.004 (2.32)	-0.004 (2.28)	-0.003 (1.62)	-0.031 (1.32) [-0.006]
Teacher education hours per student / 100	0.071 (2.15)	0.077 (2.34)	0.085 (2.62)	0.796 (1.68) [0.148]
Pupil / 100	-0.161 (4.33)	-0.167 (4.73)	-0.149 (3.91)	-3.060 (6.12) [-0.571]
(Pupil / 100) squared	0.022 (3.40)	0.022 (3.73)	0.021 (3.17)	0.309 (4.24) [0.058]
Below 20 students	0.020 (2.93)	0.019 (2.76)	0.023 (3.40)	0.607 (5.00) [0.113]
Between 20 and 60 students	0.012 (3.30)	0.011 (3.13)	0.012 (3.27)	0.241 (3.68) [0.045]
Combined school	-0.001 (0.51)	-0.001 (0.57)	0.001 (0.25)	0.450 (8.56) [0.084]
Secondary school	-0.010 (5.09)	-0.010 (5.06)	-0.011 (5.54)	-0.139 (2.52) [-0.026]
Mixed school	-0.001 (0.29)	-0.001 (0.27)	-0.001 (0.29)	0.326 (5.62) [0.061]
ln Population	0.008 (5.75)	0.008 (5.76)	0.052 (1.40)	-0.253 (6.22) [-0.047]
ln Unemployment	-0.008 (2.81)	-0.008 (2.35)	-0.004 (1.05)	0.018 (0.33) [0.003]
ln (Mean private income)	0.014 (0.99)	0.013 (0.91)	0.037 (1.27)	0.019 (0.06) [0.004]
Region specific effects	Yes	No	No	Yes
Region – year specific effects	No	Yes	No	No
Municipality specific effects	No	No	Yes	No
Individual fixed effects	No	No	No	Yes
Observations (person-years)	288,151	288,151	288,151	92965
Log likelihood	-86,224	-85,692	-85,785	-28,939
Mean of predicted probability	0.095	0.095	0.095	0.248

Note: ^a Columns (1)–(3) are estimated by the probit-model, mean probability derivatives presented. Asymptotic t-values in parenthesis, calculated based on standard errors corrected to account for within-school clustering of errors.

^b Column (4) is estimated by the fixed effects logit model, asymptotic t-values in parenthesis and probability derivatives evaluated at mean of the relevant sample in brackets.

Individual characteristics and year specific effects are included. The full results of the model in column (1) are presented in Appendix Table A1.

Table 2. Estimation results for sub-samples. The dependent variable is equal to unity if the teacher move

Sample	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Women	Men	Women below 30 years of age	Men below 30 years of age	Women [30,50] years of age	Men [30,50] years of age	Women above 50 years of age	Men above 50 years of age	Working full time	Working part time	More than 200 students
Share of minority students at school	0.037 (3.04)	0.038 (2.32)	0.097 (1.71)	0.136 (1.62)	0.028 (2.04)	0.037 (1.84)	0.043 (2.48)	0.021 (1.02)	0.028 (2.32)	0.074 (3.38)	0.030 (2.27)
Share of students with special needs at schools	0.064 (3.22)	0.044 (1.87)	0.076 (0.91)	0.315 (2.15)	0.077 (3.12)	0.036 (1.22)	0.022 (0.75)	0.024 (0.77)	0.048 (2.57)	0.082 (2.80)	0.064 (1.95)
Non-certified teachers employed at school	0.009 (5.32)	0.004 (1.71)	0.010 (1.23)	-0.010 (0.67)	0.011 (5.31)	0.005 (2.10)	0.006 (2.35)	0.001 (0.38)	0.005 (3.15)	0.013 (4.91)	0.008 (3.71)
Teacher education hours per student / 100	0.045 (1.18)	0.099 (1.97)	0.240 (1.19)	0.815 (2.81)	0.034 (0.73)	0.074 (1.23)	0.035 (0.55)	0.054 (0.65)	0.091 (2.55)	0.008 (0.13)	0.122 (1.28)
Pupil / 100	-0.149 (3.98)	-0.178 (3.41)	-0.324 (2.41)	-0.473 (1.79)	-0.147 (3.44)	-0.151 (2.45)	-0.096 (2.09)	-0.210 (3.80)	-0.162 (4.26)	-0.174 (3.39)	-0.186 (2.22)
(Pupil / 100) squared	0.022 (3.51)	0.020 (2.23)	0.045 (2.25)	0.047 (1.17)	0.021 (3.00)	0.016 (1.67)	0.016 (2.31)	0.027 (3.11)	0.021 (3.33)	0.025 (3.07)	0.024 (2.15)
In Population	0.009 (5.87)	0.006 (3.22)	0.005 (0.85)	0.001 (0.11)	0.012 (6.29)	0.007 (3.42)	0.005 (2.15)	0.003 (1.27)	0.008 (5.33)	0.009 (3.86)	0.011 (4.47)
In Unemployment	-0.012 (3.28)	-0.003 (0.72)	-0.011 (0.78)	-0.024 (0.97)	-0.015 (3.64)	-0.001 (0.10)	-0.003 (0.58)	-0.004 (0.73)	-0.009 (2.94)	-0.005 (1.00)	-0.007 (1.35)
In (Mean private income)	0.009 (0.55)	0.021 (1.16)	0.032 (0.51)	0.061 (0.52)	0.005 (0.27)	0.009 (0.41)	0.010 (0.39)	0.038 (1.56)	0.014 (0.97)	0.010 (0.41)	-0.020 (0.87)
Observations (person-years)	188,043	100,108	13,789	4,418	124,694	63,190	49,555	32,466	206,439	81,712	169,715
Log likelihood	-57,760	-28,174	-6,712	-2,161	-39,099	-18,595	-11,759	-7,227	-57,459	-28,511	-49,831
Mean of predicted probability	0.0990	0.0872	0.2031	0.2123	0.1004	0.0914	0.0666	0.0620	0.0846	0.1209	0.0924

Note: Estimated by the probit-model. Mean probability derivatives presented. Asymptotic t-values in parentheses, calculated based on standard errors corrected to account for within-school clustering of errors. The models have the same specification as the model in column (1) in Table 1 except that the samples differ.

Table 3. Estimation results taking different destination into account. Multinomial logit model.

Moving decision	Moving to another school in the same local government	Moving to another school in another local government	Moving out of the schooling sector
Share of minority students at school	0.860 (3.54) [0.835]	0.330 (1.32) [0.291]	0.329 (1.99) [0.304]
Share of students with special needs at schools	0.951 (2.88) [0.907]	0.040 (0.10) [-0.025]	0.732 (2.69) [0.709]
Non-certified teachers employed at school	0.050 (1.40) [0.042]	0.099 (2.74) [0.091]	0.111 (4.84) [0.108]
Teacher education hours per student / 100	-0.054 (0.66) [-0.063]	0.174 (2.90) [0.169]	0.114 (2.65) [0.123]
Pupil / 100	-0.400 (5.93) [-0.391]	-0.079 (1.23) [-0.062]	-0.124 (2.19) [-0.113]
(Pupil / 100) squared	0.039 (3.73) [0.038]	0.008 (0.80) [0.058]	0.022 (2.35) [0.021]
ln Population	0.366 (10.6) [0.365]	-0.211 (7.12) [-0.224]	0.076 (3.54) [0.071]
ln Unemployment	-0.144 (2.04) [-0.137]	-0.050 (0.72) [-0.040]	-0.108 (2.44) [-0.104]
ln (Mean private income)	-0.580 (1.71) [-0.607]	0.237 (0.77) [0.227]	0.402 (1.90) [0.412]
Observations (person-years)		288,151	
Log likelihood		-110,118	
Mean of predicted probability	0.0233	0.0157	0.0559

Note: Estimated by the multinomial logit-model. t-values in parentheses, calculated based on standard errors corrected to account for within-school clustering of errors, and marginal effects in brackets, calculated as suggested by Greene (1997) and by using mean of predicted probabilities. The model includes the same variables as the model in column (1) in Table 1.