CenEA Working Paper Series WP01/12

Job mobility among high skilled and low skilled teachers in Sweden

Krzysztof Karbownik

Abstract:

This paper examines the teacher mobility using matched employee-employer panel data from Swedish lower and upper secondary schools. The core focus is on the teacher quality and its interaction with Swedish institutional setup, which closely resembles what economists usually argue for. In addition to standard quality measures I use a unique dataset containing the population-wide information on cognitive and non-cognitive assessments of males born 1951 or later. The results do not support the common view that schools, in particular these serving disadvantaged students, experience higher turnover of high quality teachers. In fact, both high cognitive and non-cognitive skills teachers are less likely to change employers. The estimates also suggest that teacher mobility decisions can be influenced through changes in monetary compensations and type of employment. Finally, high skilled teachers do not leave the profession, which suggests that the drop in teacher quality should be ascribed to the quality of new entrants.

Centre for Economic Analysis
CenEA
www.cenea.org.pl

Job mobility among high skilled and low skilled teachers in Sweden[1]

by

Krzysztof Karbownik

April 26th 2012

Abstract

This paper examines the teacher mobility using matched employee-employer panel data from Swedish lower and upper secondary schools. The core focus is on the teacher quality and its interaction with Swedish institutional setup, which closely resembles what economists usually argue for. In addition to standard quality measures I use a unique dataset containing the population-wide information on cognitive and non-cognitive assessments of males born 1951 or later. The results do not support the common view that schools, in particular these serving disadvantaged students, experience higher turnover of high quality teachers. In fact, both high cognitive and non-cognitive skills teachers are less likely to change employers. The estimates also suggest that teacher mobility decisions can be influenced through changes in monetary compensations and type of employment. Finally, high skilled teachers do not leave the profession, which suggests that the drop in teacher quality should be ascribed to the quality of new entrants.

Keywords: Teacher turnover, Teacher quality, Student composition, Pecuniary factors
JEL-codes: I21, J44

[1] I would like to thank Per–Anders Edin, Torberg Falch, Erik Grönqvist, Mikael Lindahl, Matthew Lindquist and Björn Öckert for insightful discussions, guidance and comments. Special thanks go to Sara Martinson, who prepared the summary of this research in Swedish. Jörgen Moen provided me with an exceptional guidance regarding the data issues at the early stages of this project. This work has benefited from the comments of seminar participants at Uppsala University, the Educational Systems and Human Capital Workshop in Trondheim and the Warsaw International Economic Meeting. I am indebted to IFAU for allowing me to use their educational database. Part of this project was completed while I was visiting Institute for Policy Research at Northwestern University. I acknowledge financial support from Jan Wallander and Tom Hedelius Scholarship during this visit. Correspond via krzysztof.karbownik@nek.uu.se. I alone am responsible for any remaining errors.

1. Introduction

Public policy makers and governments focus often on educational issues, since the quality of the current education directly affects the future productivity of the country, and thus, its ability to successfully compete in the globalized economy. In their seminal paper Rivkin et al. (2005) disentangle the impact of schools and teachers on student's achievement and conclude that teacher effectiveness seems to be crucial in the determination of schooling quality. On the one hand, Aaronson et al. (2007) show that high quality teachers, as measured by value added models, are especially important for low quality pupils. On the other hand, Grönqvist and Vlachos (2008) document that high cognitive skills teachers may harm low achieving students. Furthermore, the relationship between student achievement and teacher characteristics has been in the centre of interest among economists and educational researchers in the recent years.

There is also a large body of evidence from all over the world that the quality of the teachers who flow into the profession has been falling over the last decades. Grönqvist and Vlachos (2008) document a close to 20 percentile ranks decline in the average cognitive ability of Swedish teachers since the early 1990s and also substantial decrease in social abilities and GPAs. Fredriksson and Öckert (2007) present evidence on deterioration of returns to teacher education and experience among Swedish teachers. Similarly, Nickell and Quintini (2002) report severe declines in investment in teachers in Britain, while Leigh and Ryan (2008) find about 10 percentile rank declines in Australian teacher quality. Both Bacolod (2007) and Corcoran et al. (2004) document convincingly that contemporary teachers in the US are less qualified than their counterparts in the 1960s and 1970s. In the light of this evidence, modern schools are likely to produce lower quality graduates, which in turn may affect the future economic outcomes, even at the macroeconomic level.

Given that teachers influence student's achievement, there is a given stock of teachers at every point in time and the quality of new entrants into the profession decreases over time, the crucial question from the policy point of view seems to be how to keep high skilled teachers in schooling sector. Thus, using population-wide registries on lower and upper secondary schools for years 1996/1997 to 2006/2007, this paper studies job mobility among teachers of different quality[2]. In particular, I investigate how teacher mobility differs by teacher quality,

[2] Job mobility and job turnover although related define the same phenomenon from a different perspective. While individual decisions and covariates can be seen as job mobility from the perspective of the teacher, the school level covariates can be seen as job turnover from the perspective of a management. Throughout, the paper I use job mobility when referring to individual's perspective, while job turnover when referring to institution's perspective. Another distinction that should be made is between quality and skills. Although in this paper I use them interchangeably, one can generally view particular

and whether different job attributes help to retain high skilled teachers. For example, I study if changes in teacher compensations or student composition correlate differently with a decision to leave a school in different groups of teachers. I also describe the differences in the behavior of lower versus upper and private versus public school teachers. Furthermore, I address the heterogeneity issues scarcely investigated in the earlier work i.e. if teacher mobility is related to different job attributes for teachers of different quality. Finally, I attempt to determine what teachers switch schools, and why some other teachers leave the profession.

The research presented here should be also of interest due to the uniqueness of the Swedish institutional setup. Unlike in most countries, the Swedish labor market for teachers does not differ much from other white-collar job markets. It is deregulated, with relatively large and growing private sector, competition between schools and individually negotiated wages. Thus, it can be seen as a institutional setup with a liberal labor market for teachers i.e. what economists typically argue for. Since Sweden, similarly to other countries, struggles with attracting high skilled individuals into the teaching profession and experiences teachers shortages[3], yet has introduced utterly different institutions, it should be of general interest to investigate job mobility among teachers of different quality in such a setup. In this paper I focus on four quality measures (university education, teaching experience, cognitive and non-cognitive assessments[4]) and relate these to teacher turnover, which is important as we have little knowledge, in general, about the quality of moving teachers. To my knowledge, this is the first paper, which relates job mobility to teacher quality in such a detail, and which uses population-wide measures of both cognitive and non-cognitive skills available for male teachers.

Rockoff (2004) studies, among other measures, the importance of teacher experience and concludes that teacher quality may be a key instrument in improving student outcomes. Harris and Sass (2006) study value added models and suggest that many currently employed models measuring the impact of teachers may be mis-specified. Harris and Sass (2011) point out that experience has a positive influence on student outcomes, yet they fail to find any consistent relationship between formal professional development training and teacher productivity. Clotfelter et al. (2007) focus on teacher experience, test scores and regular

skills as inputs to quality measures, for instance emotional stability is a skill that contributes to non-cognitive quality measure.

[3] See for instance Björklund et al. (2006) or National Agency for Education (2003) for details about teacher shortages in the 1990s in Sweden.

[4] For male teachers (born 1952 and later) I utilize military draft registrars, which contain detailed measures of cognitive ability and non-cognitive social interactive ability. The former measure is close to a standard IQ-test, while the latter measure is based on psychological evaluation focused on emotional stability, psychological endurance, ability to take initiatives, social outgoingness as well as sense of responsibility. For further details see section 2.2.

licensure and find that all these measure have positive effects on student achievement. Rockoff and Speroni (2011) document that subjective evaluations of teacher effectiveness have a predictive power for the achievement gains of teachers' students.

At the same time there is a debate about what exactly constitutes a good and productive teacher. In fact, some researchers point out that value added based measures of teacher quality may be highly inaccurate (Harris and Sass, 2006; Kane and Staiger, 2008; Rothstein, 2010 and for counter arguments Chetty et al., 2011). Moreover, Grönqvist and Vlachos (2008) find a substantial heterogeneity in teacher effectiveness in relationship to teachers' cognitive and non-cognitive assessments. Since they use Swedish enlistment data, their results actually cast doubt whether it is reasonable to use intellectual assessment as measures of teacher quality, however, there is literature indicating that intelligence matters in the labor market (Lindqvist and Vestman, 2011), social performance (Heckman et al., 2006a), educational attainment and earnings (Gensowski et al., 2011). Furthermore, the study design in Grönqvist and Vlachos (2008) is not too well suited for identifying the mean effects, as they remove both the students' mean performance and the mean teacher abilities in the school[5].

On the one hand, it may be beneficial to allocate the best teachers to the worst schools and potentially close the widening achievement gap documented by Dobbie and Fryer (2011) or Neal (2006)[6]. On the other hand, research suggests that teachers react to changes in their working environment. Studies from different states and countries show that teachers are responsive to even small variation in wages (Baugh and Stone, 1982; Murnane and Olsen, 1990; Feng, 2009; Falch, 2011; Karbownik, 2012). Another factor affecting teacher's turnover and compensations is the competition between schools, in particular, between these that are publicly and privately run (Jackson, 2011b; Hensvik, 2012)[7]. It is also important to understand the differences between the wages offered to teachers in education and in other sectors of the economy (Dolton and van der Klaauw, 1995, 1999; Brewer, 1996, Fredriksson and Öckert, 2007; Dolton and Marcenaro-Gutierrez, 2011). Thus, one possible policy route relies on incentivizing teachers through wages and competitive environment.

[5] Hanushek (1992) finds positive impact of intelligence-like test score on reading performance among 2-6 graders.
[6] In fact there is a recent evidence that high quality teachers may be helpful in overcoming genetic disadvantages in reading (Taylor et al, 2010), which is crucial given the fact that early inputs in skill formation matter for future performance (Heckman, 2006).
[7] Jackson (2011b) finds small overall effects on turnover, however, difficult to staff schools (low-income, high-minority share) hire fewer new teachers and experience declines in teacher quality. He also finds that schools increase teacher compensations to better retain high quality teachers. Hensvik (2012) finds that increased competition between schools translates into higher wages, also for teachers in public schools. Furthermore, she documents that high ability teachers from areas where the competition is most fierce experience highest growth in compensations.

Other routes may rely on the quality of work environment and job security. In particular, increasing school resources and decreasing school inequalities may help in attracting valuable teachers. In fact, these non-pecuniary characteristics play an important role and sometimes even dominate monetary compensations (Hanushek et al., 2004). As the literature suggests teachers are generally discouraged by high fractions of poor, minority and low-achieving students (Falch and Strøm, 2005; Scafidi et al., 2007; Barbieri et al., 2008; Bonhomme et al., 2011)[8]. Furthermore, there is evidence that low-skilled teachers tend to allocate themselves into disadvantaged schools (Lankford et al., 2002; Boyd et al., 2005), and that the quality of match between a school and a teacher is an important issue (Jackson, 2011a).

The paper is organized as follows: section two presents briefly the institutional background, data sources and econometric modeling, section three presents descriptive evidence, section four contains the main results, section five includes heterogeneity analyses, while section six concludes.

[8] More recent literature relying on quasi-experimental methods (Jackson, 2009) and based on administrative data (Karbownik, 2012) finds rather heterogeneous impact of minorities on teacher turnover. The former paper finds that a sudden inflow of minority students is associated with systematic changes in the makeup of teachers, however, the white teachers are no more likely to leave the affected schools than the non-affected ones. The latter study finds discouraging effects of minorities only in private and upper secondary schools.

2. Schooling in Sweden and the modeling.

2.1. Institutions

The Swedish schooling system starts with pre-school and continues with nine years of compulsory education. The compulsory schooling is divided into three stages covering grades 1-3, 4-6 and 7-9, and the last stage is known as lower secondary school. In each of those levels students often have different sets of teachers and sometimes even the schools are at different locations. The 9th grade grades determine student's ability to apply to upper secondary schools[9]. Swedish municipalities are obliged by law to provide upper secondary schooling to all students who successfully completed the compulsory education. Upper secondary school consists of different programs, lasts three years and provides eligibility for post-secondary education.

Private schooling in Sweden is common and is encouraged by the government. In 1992 Sweden introduced an educational voucher reform that allowed anyone to establish a for–profit school. Moreover, the municipality is obliged to pay the new school roughly the same amount of money per student as it pays a public school[10]. Since the reform the fraction of private schools has risen, and they are more common at the upper secondary level. In the school year 2006/2007 there were 234 private upper secondary schools, which constituted 34.5% of all upper secondary schools in Sweden, a rise from 8.2% in 1996/1997. At the same time the number of private lower secondary schools constituted only 17.8% of all schools at this level starting from 3.4% in 1996/1997[11].

Teaching profession in Sweden is regulated and different qualifications are required depending on the subject taught and on the type of school[12]. The certification is obtained by attending and completing a teacher education program or by receiving a university degree in the subject taught supplemented with a minimum of 1.5 years of preparation in pedagogy, didactics and teaching practice. The latter route makes it possible for people from other professions to switch to teaching, and thus, it also gives non–certified teachers with a subject

[9] It is also the first time the students are observed in any aspect related to schooling. Countrywide tests were introduced but not collected in the fifth grade in 1998 and in the third grade in 2009. Grades have been also given for some time in the eighth grade, however, they do not count into academic records. Starting in 2012 the grades will be given in grades 6-9. Furthermore, written feedback to students in grades 1-9 has been given since 2008.

[10] In reality due to the 1992 reform a private school gets around 85% of the amount of money per student given to public schools. The minimum required funding percentage generally changes over years and is below 100% mainly because of the extra costs involved for public schools regarding special education. Some municipalities also have a socioeconomic gradient for the voucher, however, these differences should be accounted for by fixed effects. The private schooling was effectively introduced at lower secondary level in 1992, and at upper secondary level in 1994. For a detailed discussion of the reform, its history, funding and consequences see: Böhlmark and Lindahl (2007, 2008).

[11] This information is based on the data used in the analyses.

[12] Teaching at the secondary school level or a vocational course requires completing special coursework beyond what is required from compulsory school teachers.

degree a chance to obtain certification. Municipalities are the primary employers of teachers in Sweden, and thus, handle the responsibility of recruiting them[13]. Although the municipalities are the formal employers of the teachers in public schools, the decisions regarding recruitment, selection and finally employment of a teacher are made at the school level by principal.

In Sweden teacher wages are determined at local level through individual bargaining between teacher and principal[14]. I consider the individual decisions underlying separations as follows. At every point in time teacher considers whether to leave current school appointment or not. Then, a school principal can either let the teacher leave or re-employ them under new conditions. If the teacher leaves, they can either seek employment at a different school or find a job in a different profession. In that case they negotiate a new contract with the new school principal. In either the case of re-employment or new hire the teacher and school determine the salary in an individual bargaining. In the analysis I consider three types of separations: total mobility, within-teaching mobility and out-of-teaching mobility.

2.2 Data

This paper utilizes Swedish population-wide registries. The baseline data source is the teacher registry that covers all teaches employed in Swedish schools in years 1996/1997 to 2006/2007. It contains information on teachers' education, specialization, experience, certification, place of work, type of employment (permanent vs. temporary) and workload. Additionally, I have background information on age, gender, immigration histories, education, employment and income for all teachers from a separate population enlistment database. The pupil registries for lower and upper secondary schools are used to obtain information on students in a given school. These allow linking children and their parents to

[13] For more information on the reform that shifted responsibility for schooling from central government to municipalities see: Fredriksson and Öckert (2008). There is still a small fraction of schools run by county or state, however, these constitute around 1% of all the teachers between 1996/1997 and 2006/2007. Those schools are excluded from the analysis since they have different sources of funding and their role is diminishing. In school year 1996/1997 the teachers from these schools constituted less than 2.5% of all teachers, while in school year 2006/2007 only 0.39% of the total number of teachers. In times of downturns or staff reductions there can be a surplus of teachers employed in the municipality, so slots may have to be filled with surplus teachers in other schools. Nonetheless, controlling for time-times-county fixed effects should account for any adverse macroeconomic shocks. Time-times-municipality fixed effects yield similar results.

[14] This individualized pay regime was introduced in 1996 and is discussed in detail by Hensvik (2012). For a more detailed description of the Swedish institutional setup also see: Karbownik (2012). The principal autonomy can be circumvented if there are teacher surpluses in other parts of the municipalities' schools. Given the teacher shortages described in Björklund et al. (2006) and National Agency for Education (2003) this should not be very common, however, it may vary greatly geographically. The survey conducted in 2006 by Lärarförbundet revealed that around 40% of salaries were determined in individual negotiations. Additionally, around 50% of teachers believe that salaries should be set via individual negotiations. Two-thirds of Swedish teachers have their salary reviewed every year, while only 13% have never had their salary reviewed. Finally, more then three-fourths of teachers discuss their working conditions, compensations and work satisfaction with principals on regular basis. For more details see: Lindholm (2006).

teachers at the school level, as well as obtaining the average percentiled GPA[15]. The population-wide earnings and wage registries provide information on teachers' monetary compensations[16]. The details of the sample construction are discussed in section 1 of the appendix.

Since, the core focus of this paper is on teacher quality, for the subsample of male teacher who were at most 18 in 1969 I use military enlistment data to obtain information on cognitive and non-cognitive test scores. Since 1902 until the 1st July 2010 the military service in Sweden was mandatory for all males aged 18-47[17]. The enlistment procedure lasts two days and comprises of medical and physical assessments, cognitive ability tests and 20 minutes semi-structured interview with a trained, and often very experienced, psychologist (Mood et al., 2012). The dropout rate in Swedish military training was relatively low as it was not possible to avoid military service by obtaining a low score on cognitive or non-cognitive ability assessments, yet about 5-10 percent of enlisted men did not enter into military service because of the mental or physical handicaps. Furthermore, the earliest digitalized registry dates back to 1969 draft, which means that older teachers are not included in the sample. The data also excludes individuals who were born abroad unless they became Swedish citizens before they turned 24, however, for the sake of consistency I exclude all of the foreign born teachers.

The cognitive assessment of Swedish conscripts was conducted since the mid 1940s. The tests have changed several times over the years and the men in this sample did two different tests[18]. Until 1982 the test consisted of four different measures of "ability": reasoning (logic-inductive ability), verbal comprehension (synonyms), spatial ability (metal folding) and technical ability (including knowledge about chemistry and physics). In the subsequent years the assessment consisted of three different measures based on so called general g-factor: fluid intelligence and problem solving (the closest to logic-inductive ability), crystallized intelligence measuring knowledge from experience (the closest to verbal ability) and visual intelligence (the closest to spatial ability). Each of these tests was graded on a scale

[15] Unlike Rivkin et al. (2005), Grönqvist and Vlachos (2008) or Lavy (2009), I can only link teachers to students at the school level. Swedish registry data does not allow to mach students and teachers at the class or grade level.

[16] I use two types of monetary compensations data in this paper. The main source of data comes from the nationwide earnings registry that contains information on annual earnings split by all jobs that individual undertook. It covers all the individuals that earned money in a given year. As a robustness check, I also use a secondary source of information on monthly wages, which is available for majority of public school teachers.

[17] At the end of 2000s not the whole population was drafted and thus the data are reliable only until 2006. The enlistment usually takes place right after upper secondary schools graduation i.e. when man turns 18 or 19 years old. Among the teachers for whom I have data 96.2% did the enlistment when they were 18 or 19, 2.4% when they were 20, 0.3% when they were below 18 and the remaining 1.1% when they were older than 20 years old.

[18] See: Carlstedt (2000) for an account of the history of psychometric testing in the Swedish military. The dissertation provides evidence that unlike AFQT, the Swedish cognitive assessment is a good measure of general intelligence.

from 1 to 9, where 1 is the lowest possible and 9 is the highest possible score. These scores were then transformed to a discrete variable of general cognitive ability ranging from 1 to 9[19].

Similarly to cognitive assessment, the personality tests were introduced at the military enlistment in the early 1940s and were heavily based on the extensive testing procedure that Germany had build up during the 1930s for the selection of officers and specialists as well as on the experiences from the United States. All the men in the data had their psychological profiles evaluated according to a procedure that was adopted in 1969 and kept unchanged up to 1995 when it was subject to minor revisions. The personality assessment based mostly on behavioral questions can be categorized into four parts: social maturity (extroversion, having friends, taking responsibility, independence), psychological energy (perseverance, ability to fulfill plans, ability to remain focused), intensity (the capacity to activate oneself without external pressure, the intensity and frequency of free-time activities) and emotional stability (ability to control and channel nervousness, tolerance of stress, and disposition of anxiety). The general objective of the interview was to assess the conscript's ability to cope with the psychological requirements of the military service, and in the extreme case, war. As the final outcome of the interview the psychologists assign each man military aptitude score from 1 to 9. This final score is based on the four different dimensions, which are graded on a scale from 1 to 5, where the value 3 means that the conscript is a normally functioning 18-year old male in the measured respect. The sub-scores functioned only as a guide to psychologists and two conscripts with the same sequence of sub-scores could still get different final scores[20].

Some of the scores are missing and I was able to recover information on cognitive and non-cognitive test scores for around 90% of Swedish male teachers born 1951 or later[21]. Since most of the missing individuals were exempted from draft due to mental and physical disabilities, then there are differences in observables between them and those for whom the scores are available[22]. More details regarding the construction of final scores used in the analyses are provided in the last paragraphs of section 1 in the appendix. For details regarding the testing procedure itself and various applications of Swedish military enlistment registries see: Lindqvist and Vestman (2011).

[19] The final score is comparable across years irrespectively whether 4 measures (1982 and before) of ability or general g-factor based on 3 measures (1983 and onwards) are used.
[20] Although I do have data on the sub-scores, their definitions and labels are not publicly available information.
[21] The first draft year I use is 1970 and the last one is 1999. Most of the data for individuals tested in 1978 are lost, and thus only 15 412 observations are recorded for this year. This loss is not systematically related to individual characteristics other than year of birth.
[22] The following differences in observables are significant at 1% level: workload, temporary employment, upper secondary indicator, science and vocational teachers indicators, experience, share of girls, yearly and monthly monetary compensations as well as number of students.

2.3. Econometric modeling

The main analysis is done using a series of binary choice models that attempt to capture the manifestation of teachers' job preferences conditional on teacher quality. The dependent variable is equal to unity if a teacher leaves their current employer from year to year, and such a decision is treated as a signal that a teacher does not value the characteristics of their working environment high enough to stay at the current establishment. In particular, the binary models show whether teachers who remain in their appointments (comparison group) have, on average, different quality than these who leave their jobs (treated group). From the policy point of view, on should also investigate what are the factors that drive high quality teachers to seek a better employment match[23] as such sorting of teachers may indicate permanent quality drop of particular institutions, and thus, have adverse influence on student achievement. Therefore, the heterogeneity analyses based on the differences in school characteristics shed light on what job characteristics are important for low and high quality teachers. Moreover, for the sake of comparison with the literature, using the main specification, I run separate regressions depending on teacher's destination. In particular, I specify two distinct variables of destination. These are: new school within lower and upper secondary schooling and quitting lower or upper secondary education[24]. This analysis should be of interest for policy makers, as loosing highly educated pedagogues in favor of other sectors of economy may lead to worsening condition of the educational system in the future.

In order to maintain simplicity of the interpretation of the results, the estimation strategy is based on the least squares using linear probability model[25]. The following econometric model is estimated:

$$y_{ijt} = \alpha_0 + \alpha_1 Q_{ijt}[I_{ij}] + \alpha_2 W_{ijt} + \alpha_3 X_{jt} + \alpha_4 P_{ijt} + \delta t \cdot c + \varepsilon_{ijt} \qquad (1)$$

where y_{ijt} is equal to unity if teacher i leaves the current employer j at period following t, W_{ijt} is teacher i earnings or wage at school j and time t, X_{ijt} is a vector of observable school

[23] By high quality teachers I understand these with university education (Ehrenberg and Brewer, 1994; Harris and Saas, 2011), longer experience (Rockoff, 2004), above median cognitive and non-cognitive test scores (Hanushek, 1971; Harbison and Hanushek, 1992; Grönqvist and Vlachos, 2008).

[24] An alternative would be to consider quits as leaving teaching for other occupations, however, the two quit measures are similar quantitatively - correlation coefficient is 0.94. From here on the within teaching mobility is referred to as mobility within lower or upper secondary schools, while quit is understood as leaving either of these school types in favor of other employment. As it can be seen in panel A of table 1 there are statistically significant differences among the "quitting" definitions regarding heterogeneous groups of teachers. Nonetheless, to be able to compare my estimates with literature I decided to use the former definition. For further discussion regarding the alternative quit measure see footnote 33.

[25] This method yields very similar estimates to the non–linear models. The appropriate regressions using logit and multinomial logit models with marginal effects evaluated at mean are available from the author upon request. Among all the variables used in the analyses the following pairs exert correlations higher than 0.4: earnings with temporary employment; number of students with upper secondary school indicator; parental income with share of immigrant students; parental income with GPA. Majority of correlations are below 0.1 and the correlogram is available from the author upon request.

characteristics[26] of an institution j at time t, P_{ijt} is a vector of personal characteristics[27] of teacher i at school j and time t, and ε_{ijt} is an error term that represents unobserved characteristics, which is heteroskedasticity robust and clustered at school level (Bertrand et al., 2004). The clustering follows the idea that in a perfect experiment one would randomly assign teachers to different schools and observe their mobility decisions conditional on school characteristics. Thus, since the turnover variation occurs at the school level and I have an unbalanced panel of all lower and upper secondary schools in Sweden, it is intuitive that the errors should be clustered at the school level. There are two types of quality indicators. In the full sample of teachers, the quality of teacher i at establishment j and time t - Q_{ijt} is measured using experience and education[28]. In the sample of younger males only, which is of interest due to the data novelty, I use cognitive and non-cognitive military assessment of teacher i from school j - I_{ij}[29]. Vector of δs captures time-times-count fixed effects[30].

[26] These include: polynomial of school size, share of girls, student-teacher ratio in full time equivalence as a proxy for school resources, share of non-Nordic students, student's precentiled GPA and mean parental income.

[27] These include: gender, non-Nordic teacher indicator, marital status indicator, specialization indicators (science, vocational, remedial education), workload, type of school, school ownership indicator, type of employment.

[28] The correlation coefficient between university indicator and teaching experience is 0.28. Furthermore, there is 0.55 correlation between certification and university degree. Due to these correlations the indicator for working outside of certification area is dropped from the regression analysis. Furthermore, polynomial in age is dropped from the analysis due to 0.72 correlation coefficient with teacher's experience.

[29] The correlation coefficient between cognitive and non-cognitive assessment in the studied sample is 0.15, which is lower than the one reported by Grönqvist and Vlachos (2008) for the whole population (0.36). Furthermore, the correlogram between all four measures of quality used in the analysis for individuals for whom the intellectual assessment is available has the highest correlation value of 0.2 (university education and cognitive score). The correlogram is available from the author upon request.

[30] For detailed discussion about the variety of fixed effects specifications tested see footnote 39. Often local labor markets are broader than municipality boundaries and thus estimating time-times-municipality fixed effects may remove too much variation of interest.

3. Descriptive evidence

This paper focuses on four measures of teacher quality: being university graduate[31], teaching experience, cognitive as well as non-cognitive test scores. In order to better understand how these measures relate to particular school characteristics I plot (figures 1-3) their means against the deciles of student's GPA[32], share of minorities and school resources. In particular, the figures illustrate what is the distribution of teacher quality across schools with different characteristics, which should help understanding what type of teachers in terms of quality cluster in the given type of schools.

Teacher education correlates positively with student achievement measured by GPA, and the worst performing students are taught by a lower number of university educated teachers. At the same time, both low and high achievers are taught by rather less experienced teachers. There is increasing pattern in the relationship between the share of university graduates and the share of minorities at school, however, although teacher experience raises with the proportion of immigrants, it then drops in 10th decile. Richer schools generally seem to employ more experienced and educated teachers.

As far as intellectual assessment is concerned the patterns are mostly stable in all three cases. First, in all the dimensions teachers have higher cognitive than non-cognitive scores. Second, up to the 9th decile both cognitive and non-cognitive test scores behave likewise in relationship to student's GPA, yet then at the top schools there is an increase in the cognitive intelligence of teachers. Third, there is widening gap between cognitive and non-cognitive assessment with the increasing proportion of non-Nordic students. Finally, both scores are increasing with school resources.

Figures 4-5 relate teacher quality to their own mobility. Figure 4 provides descriptive evidence over time of thee turnover measures for teachers with and without university degree. Figure 5 depicts the three measures split by intervals of teacher experience and cognitive as well as non-cognitive test scores. Although the patterns of turnover are similar for both teachers with and without university degree, the magnitude differs especially in terms of quits. Moreover, all of the measures decrease with teacher experience and quit rate converges to within mobility rate for teachers with more than 12 years of experience. As far as

[31] A university graduate is defined as an individual graduating three, four or five yearlong university (hogskoleutbildning) education or individual with a research degree. Note that other forms of post-secondary education (eftergymnasial) education are not treated as university graduates.

[32] Lower secondary school GPA is the percentiled GPA from the 9th grade. Furthermore, as showed by Söderström and Uusitalo (2010), about 90% of student population complete 9th grade and is eligible for secondary education, and of those 98% continue. Upper secondary school GPA is the percentiled GPA from the 9th grade for the students who are currently enrolled in a given upper secondary institution.

intellectual assessment is concerned, turnover is stable across deciles of the cognitive and non-cognitive scores, however, it is larger for quits at the bottom of the distributions.

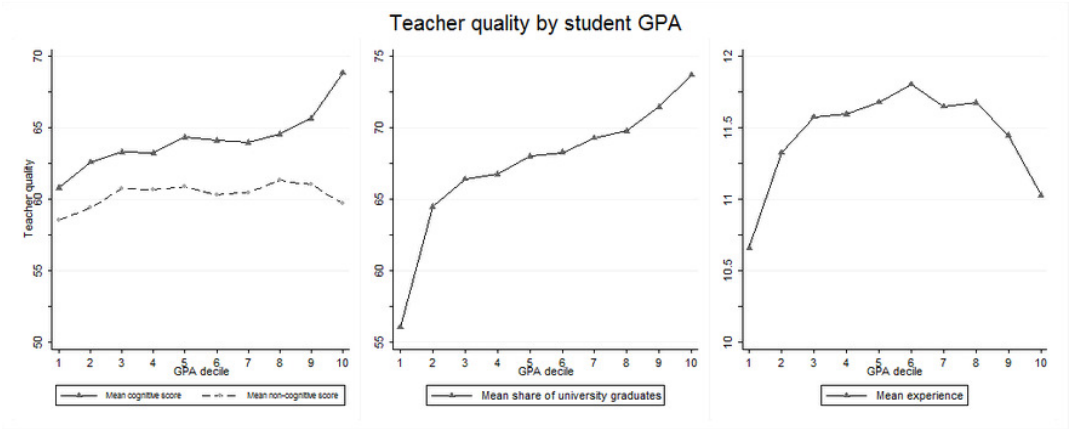

Figure 1. Mean teacher quality (intellectual, university graduates, experience) and deciles of student GPA.

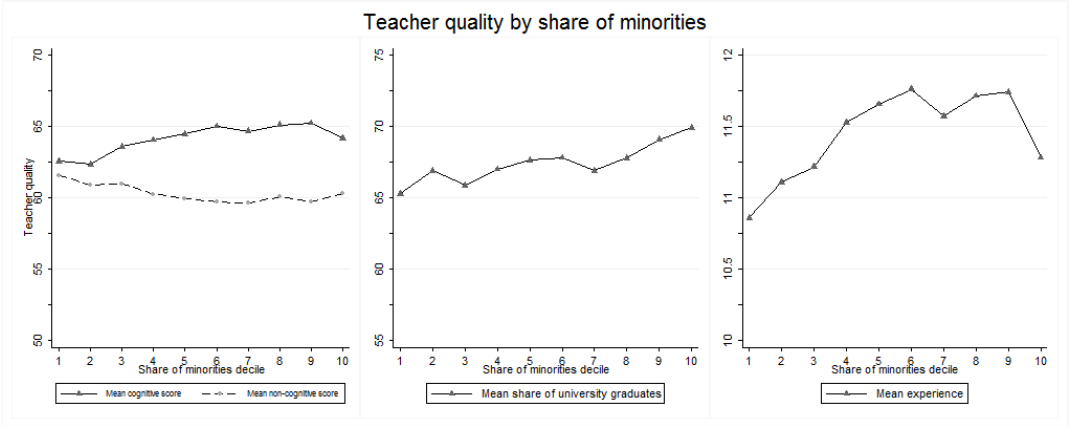

Figure 2. Mean teacher quality (intellectual, university graduates, experience) and deciles of share of minority students at school.

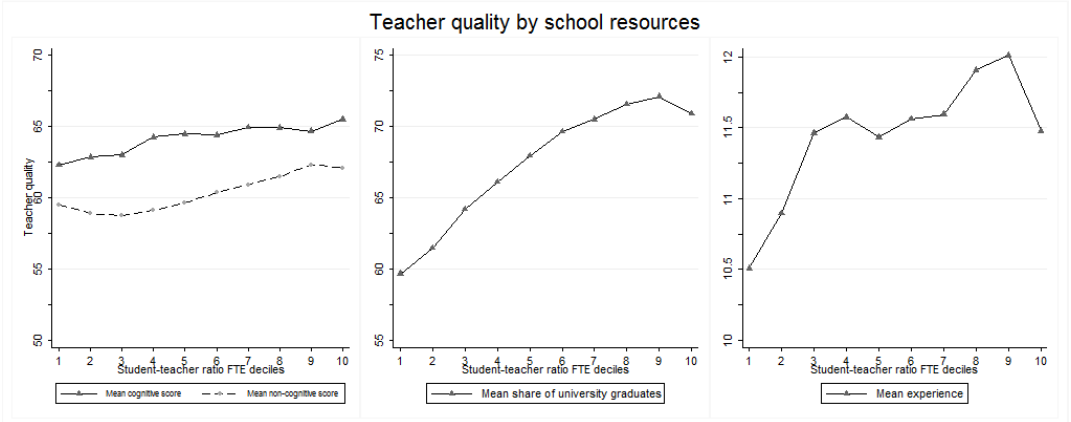

Figure 3. Mean teacher quality (intellectual, university graduates, experience) and deciles of school resources.

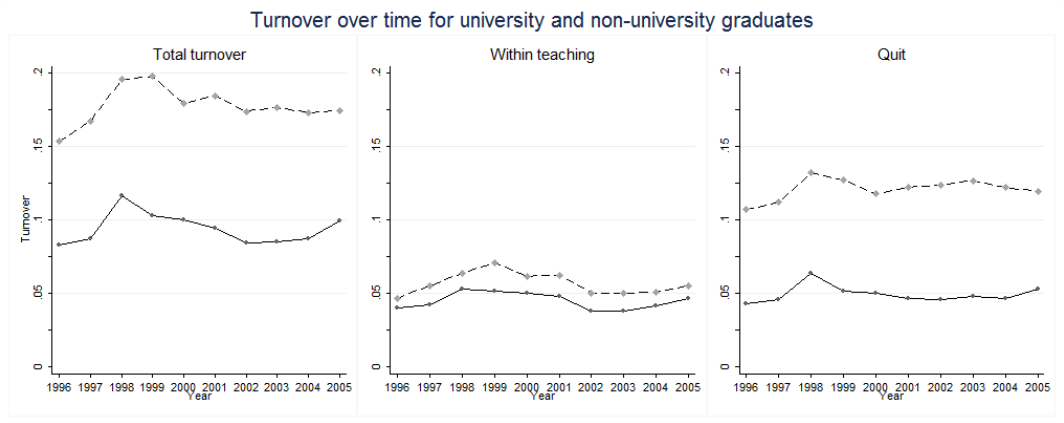

Figure 4. Turnover measures over time for university (solid line) and non-university graduates (dashed line).

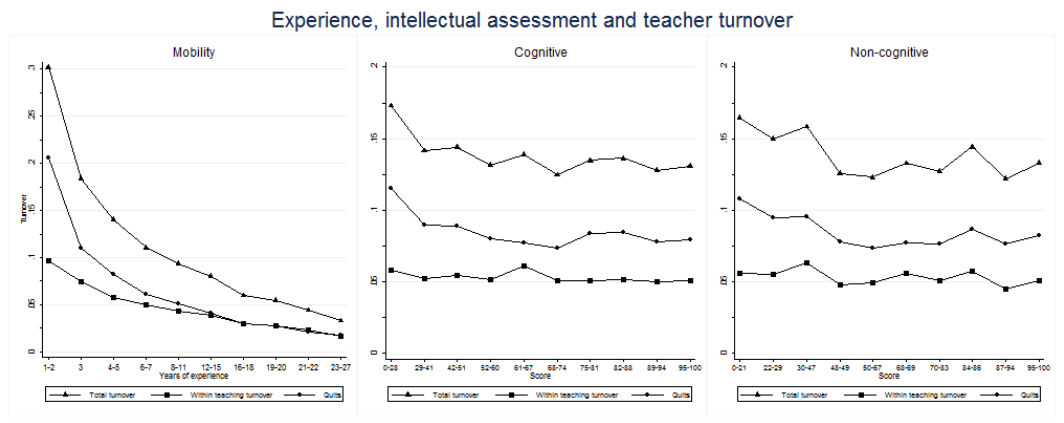

Figure 5. Turnover measures graphed for deciles of teacher experience, cognitive and non-cognitive test scores.

As a final graphical evidence figures A1-A2 in section 2 of the appendix provide the description of teacher turnover for different school characteristics and split by high and low quality, which is measured as being either below or above the median of the cognitive or the non-cognitive test score. In each of the studied cases low quality teachers exert higher turnover, however, the shape of the plotted curves differs across school characteristics. There is no clear pattern with respect to student achievement, yet as far as minorities are concerned teachers outflow from schools with high share of immigrants. Furthermore, they also tend to favor working in relatively richer schools.

In sum the descriptive evidence suggests that there is substantial heterogeneity in teacher turnover with respect to teacher quality, irrespectively whether it is measured as formal education, tenure in teaching or intellectual and behavioral assessments. Furthermore, there are also differences in teacher quality across school characteristics i.e. teachers of different quality tend to cluster at schools with particular observable features. The graphical evidence points towards the importance of heterogeneity analyses and addressing policy interventions towards subgroups of teachers.

Table 1 presents the descriptive statistics of variables used in the econometric analysis. Panel A presents four turnover measures for teachers of different quality. The difference between quit defined as leaving lower or upper secondary schooling and quit defined as leaving teacher occupation is statistically different in all groups, and the former measure is systematically larger[33]. The total turnover rate, when using the former definition, is at 12.1%, which is much lower than the overall turnover rate in all the occupations in Sweden (Edin et al., 2009; Oyer, 2009). It may though be driven by the fact that people who invest heavily in occupation-specific human capital (teaching) may have lower turnover rates in general. Furthermore, in all the quality dimensions I observe statistically significant differences in turnover measures between groups. Although, the quit rate in Sweden is larger than in Norway, these two countries share a common feature that the outflow from teaching (irrespectively of the definition) is larger than the mobility within the profession. In the US registry data from Texas, Hanushek et al. (2004) find the opposite pattern – i.e. there is higher mobility within teaching rather than out of the profession.

Panel B presents the average quality measures in the sample. Both experience and university indicator are based on the whole sample of 523 835 observations from 2703 schools. The intellectual assessment means are based on the sample that is reduced to native males, born prior to 1951 and drafted prior to 1970 for whom the data is available. Teacher experience is not available for all years, and thus I use the predicted experience in the analysis. In particular, since the teacher registries date back to 1979 I explore this feature to construct the "in teaching predicted experience" variable. I create a panel of all teachers between 1979 and 2006 and link it to population enlistment data between 1985-2006 in order to obtain teacher's birth date. I then use all this information and tenure data provided in the later registries (since 1999 and onwards) to construct the predicted measure of experience[34]. The statistics in panel B reveal that 67% of teachers are university graduates and their average experience is over 11 years. The average native, male teacher drafted after 1969 and born after 1950 scores 64 on cognitive and 60 on non-cognitive assessments, and these variables are normalized on the scale 0-100. It means that, on average, teachers in Sweden place themselves in the upper half of the intellectual distribution.

[33] This potentially casts doubt on the reliability of results reported in previous research. To my knowledge, this is the first paper that addresses the difference between quitting particular type of school and teaching occupation in general. From the perspective of public policy makers these two transitions clearly yield different costs. Nonetheless, in the remaining of the paper I provide the estimates based on the former definition that was used so far in the literature.

[34] Detailed Stata code for tenure variable can be obtained from the author upon request.

Panel C reveals that nearly 6.8% of teachers come from non-Nordic countries, around 56% of teachers are women and slightly larger fraction is married. There is 15.6% science, 13.9% vocational and 6.6% remedial education[35] teachers. Furthermore, 21% of teachers are part-time employed and the average workload in the sample is about 87%. Upper secondary schools employ 43.6% of all teachers and 5.6% of teachers work for private institutions.

Panel D gives details regarding monetary compensations. The average yearly earnings for the period 1996-2005 equaled 221 887 SEK which is lower than the countrywide average wage for the whole economy for the same period, which was 234 000 SEK[36]. This amount is not very large because the sample contains 21% of temporarily employed teachers, who earn only a portion of the permanently employed wage. If I limit the sample to permanently and full time employed teachers then the yearly earnings increase to 253 683 SEK. At the same time the average monthly salary in public schools is 22 016 SEK.

Panel E provides information about the average characteristics of Swedish schools. The student-teacher ratio in full time equivalence, which can be seen as proxy for school resources, is 9.9% and the average number of pupils is 454[37]. The unadjusted student-teacher ratio is 8.1%, which confirms that Swedish schools employ a fair number of part-time faculty. There is also on average 8.4% non-Nordic immigrants in Swedish schools. This number is much larger than the one reported for Norway (Falch and Strøm, 2005). The average income of pupils' parents is around 380 000 SEK yearly.

[35] Remedial education teacher (Speciallarare) works with students in need of special assistance concerning learning and development. Special teacher training is a postgraduate education in the regular teacher training and includes 90 credits. Special education teachers focus on either language or math.

[36] Further information about the salaries in Sweden http://www.scb.se/Pages/TableAndChart____149088.aspx. The earnings and wages reported in table 1 are in the form of logarithms.

[37] Number of students in lower-secondary school is measured as the sum of pupils attending grades 7 to 9 and it is provided in compulsory school registry by Statistics Sweden. Number of students in upper secondary school is measured based on the registry of students enrolled in grades 1 to 3 in upper secondary school.

Table 1. Descriptive statistics.

Panel A: Mobility variables					
Group of teachers	N	Within studied schools	Out of studies schools	Total mobility	Out of teacher occupation
All teachers	523835	0.0483 (0.2145)	0.0726 (0.2595)	0.1210 (0.3261)	0.0651 (0.2468)
University graduate	353133	0.0445 (0.2063)	0.0491 (0.2161)	0.0937 (0.2913)	0.0411 (0.1984)
Not university graduate	170702	0.0562 (0.2303)	0.1213 (0.3265)	0.1775 (0.3821)	0.1150 (0.3190)
Teaching experience 0-2	82534	0.0962 (0.2949)	0.2060 (0.4045)	0.3023 (0.4592)	0.1974 (0.3981)
Teaching experience 3-5	92101	0.0641 (0.2449)	0.0930 (0.2904)	0.1571 (0.3639)	0.0857 (0.2799)
Teaching experience 6-10	85586	0.0463 (0.2102)	0.0559 (0.2298)	0.1023 (0.3030)	0.0484 (0.2145)
Teaching experience 11-15	64804	0.0399 (0.1957)	0.0425 (0.2017)	0.0823 (0.2749)	0.0336 (0.1801)
Teaching experience 16-20	117024	0.0284 (0.1662)	0.0290 (0.1679)	0.0575 (0.2327)	0.0205 (0.1419)
Teaching experience 20+	81786	0.0196 (0.1385)	0.0189 (0.1361)	0.0384 (0.1922)	0.0149 (0.1213)
Cognitive score below median	57625	0.0555 (0.2290)	0.0904 (0.2868)	0.1459 (0.3530)	0.0839 (0.2773)
Cognitive score above median	57528	0.0511 (0.2201)	0.0799 (0.2712)	0.1310 (0.3374)	0.0728 (0.2598)
Cognitive score in 90th percentile	11525	0.0512 (0.2204)	0.0797 (0.2708)	0.1309 (0.3373)	0.0721 (0.2587)
Non-cognitive score below median	58463	0.0545 (0.2269)	0.0903 (0.2865)	0.1447 (0.3518)	0.0831 (0.2760)
Non-cognitive score above median	56690	0.0521 (0.2222)	0.0799 (0.2712)	0.1320 (0.3385)	0.0735 (0.2609)
Non-cognitive score in 90th percentile	12245	0.0510 (0.2201)	0.0822 (0.2746)	0.1332 (0.3398)	0.0759 (0.2648)

Panel B: Teacher quality			
Experience	11.44 (7.7795)	Cognitive test score	64.124 (24.404)
University graduate	0.6741 (0.4687)	Non-cognitive test score	60.296 (27.250)
Panel C: Personal characteristics			
Temporary	0.2084 (0.4062)	Science	0.1564 (0.3632)
Workload	86.514 (23.244)	Vocational	0.1387 (0.3457)
Women	0.5616 (0.4962)	Remedial	0.0666 (0.2493)
Foreign	0.0676 (0.2510)	Upper secondary	0.4360 (0.4959)
Married	0.5724 (0.4947)	Private	0.0559 (0.2297)
Panel D: Pecuniary characteristics			
Log yearly earnings (1000SEK)	5.2898 (0.5861)	Log monthly salary[38]	9.9521 (0.1609)
Panel E: School characteristics			
Share of foreign students	0.0842 (0.0868)	Number of students/100	4.5389 (2.9887)
Share of girls	0.4812 (0.0992)	Students' parents income (1000SEK)	379.22 (97.187)
Student-teacher ratio full time equivalence	9.9124 (2.9266)	Student's percentiled GPA	47.869 (6.7731)

Note: Mean values. Standard errors in parentheses.

[38] Mean log monthly salary among the individuals working in public schools for whom the data is available.

4.Main results

The estimates presented in this section correspond to models outlined in section 2.3. Using linear regression, I estimate a binary model with county-times-time fixed effects[39] and the dependent variable equal to unity if the teacher leaves a particular school from year t to year t+1, and zero otherwise. The results are presented in table 2. Column (1) shows the raw correlation between the total mobility and teacher quality measured by university graduation and experience. Column (2) adds individual characteristics to estimates from column (1). Column (3) provides estimates, including both individual and school level covariates. Column (4) adds yearly earnings to specification from column (3). Column (5) estimates column (4) on the sample of public school teachers, which is then used in column (6), where I substitute the log yearly earnings with log monthly salary. This exercise is performed to investigate, how covariates in model from column (4) change when the sample is reduced to public school teachers for whom the monthly wage data are available. The preferred specification is the one in column (4), which is chosen because it includes all teachers and controls for all the possible observable confounding factors like demographic or school characteristics.

The results from columns (1)-(3) yield qualitatively stable results. They suggest that Swedish schools do not lose the university educated and experienced teachers, as both the coefficients are negative and significant. An additional year of experience decreases total mobility by 1.4-2.9 percentage points. At the same time, holding a university diploma

[39] The results are valid conditional on the assumption that controlling for county-times-time effects is an appropriate specification. In particular, one might consider specifications with only time, or only county, or only time and county, or using municipality instead of county fixed effects. While considering the university education and teaching experience analyses (table 2) and: time and county effects – no qualitative or quantitative changes; time effects only – no qualitative and small quantitative changes; county effects only – no qualitative or quantitative changes in teaching experience and losing significance in columns (3) and (4) on university indicator; municipality effects only – no qualitative or quantitative changes on teaching experience and losing significance in column (4) on university indicator; time and municipality effects – no qualitative or quantitative changes in experience and losing significance in column (4) on university indicator; time-times-municipality specific effects – no qualitative or quantitative changes. While considering cognitive and non-cognitive assessments analysis (panel A of table 3) and: time and county effects – no qualitative or quantitative changes; time effects only – non-cognitive score in column (4) becomes barely significant and negative, other than that there are no qualitative or quantitative changes; county effects only – no qualitative or quantitative changes; municipality effects only – no qualitative or quantitative changes; time and municipality effects – no qualitative or quantitative changes; time-times-municipality specific effects – no qualitative changes, more negative estimates on cognitive scores but no quantitative changes in non-cognitive estimates. Thus, all these specifications yield very similar results and even when the university indicator loses significance it stays negative, however, of a smaller magnitude. Therefore, I conclude that the results are not driven by misspecification of fixed effects included. Including school fixed effects removes some of the variation that is of interest in the heterogeneity analyses presented in this paper, and thus these results are not presented in the paper. When I include school specific effects and estimate regression with individual covariates only, then the coefficients on university indicator and experience decrease and university indicator in column (4) becomes insignificant. Furthermore, the estimates on cognitive scores become more negative and on non-cognitive less negative (coefficient on non-cognitive score in column (4) becomes insignificant). As far as linearity assumption is concerned, logit models with marginal effects evaluated at mean are estimated and: the results on teaching experience do not change, the results on university indicator loose significance except for column (1) and become marginally positively significant in column (5), the coefficients on cognitive and non-cognitive scores lose significance in column (6) but other that than remain unchanged. All these regressions are available from the author upon request.

decreases mobility in the range of 0.3-3.7 percentage points[40]. In columns (2)-(4) the coefficient on university education decreases by around 10 folds in comparison to column (1). These changes are virtually entirely driven by inclusion of temporary employment indicator in columns (2)-(3). When the earnings are added (column (4)) both coefficients decrease even more. This means that principals may have scope for changing the mobility behavior of teachers of different quality through manipulation of monetary compensations and type of employment. If these job attributes can help retain experienced and educated teachers, then one would expect the estimates of teacher quality to be stronger when they are added into the model, and indeed this is what happens in the case of Sweden. Furthermore, in the main specification (column (4)) the elasticities at means of yearly salary and type of employment are -2.42 and 0.3 respectively.

Table 2. Main results using university education and experience. The dependent variable is equal to unity if the teacher changes job.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Mobility	Mobility	Mobility	Mobility	Mobility	Mobility
University graduate	-0.03647***	-0.00437***	-0.00336**	-0.00228*	-0.00057	-0.00052
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Experience	-0.02933***	-0.01381***	-0.01371***	-0.01045***	-0.00949***	-0.01228***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	523,835	523,835	523,835	523,835	474,538	474,538
R-squared	0.075	0.138	0.139	0.145	0.143	0.137
Personal characteristics		X	X	X	X	X
School characteristics			X	X	X	X
Log-earnings				X	X	
Log-wages						X
Public school teachers only					X	X

Note: School level clustered standard errors (*** p<0.01, ** p<0.05, * p<0.1). Regressions include time*county specific effects and quadratic in experience. All regressions corrected for school mergers and dissolutions as well as for mobility in grades below 7th that teachers work with. Personal characteristics include: gender, immigration status, marital status, indicators for science, vocational and remedial specialization, indicator for temporarily employed, workload, indicators for upper secondary and private school teachers. School characteristics include: student-teacher ratio in full time equivalence, number of students and its square, indicator for schools with less than 100 students, share of girls and immigrants at school, mean percentiled student GPA and mean parental income.

Columns (5) and (6) report estimates for the public school teachers only. In these specifications the coefficients on educational attainment decrease, become insignificant but remain negative. At the same time, estimates of experience are similar to these from column (4). Importantly, the results do not differ much depending on whether I use log yearly earnings or log monthly wage, so the lack of significance can be attributed to limiting sample to public school only. Thus, since the information on monthly wages is available only for public school teachers, then from here on the heterogeneity analyses (section 5) are conducted on the full sample using log yearly earnings[41].

[40] If the two measures are included separately, the coefficients on teaching experience do not change either qualitatively or quantitatively, while the coefficients on university indicator change quantitatively and in column (5) quantitatively. When the university indicator is included as the only quality measure coefficients increase by around 0.5-3 times in columns (1) – (4) and the coefficient in column (5) becomes negative and significant. Nonetheless, both specifications suggest that teaching experience and university education are negatively correlated with mobility. These results are available from the author upon request.

[41] Estimates for public school teachers and monthly wages are available from the author upon request.

Table 3. Main results using cognitive and non-cognitive assessment. The dependent variable is equal to unity if the teacher changes job.

VARIABLES	(1) Mobility	(2) Mobility	(3) Mobility	(4) Mobility	(5) Mobility	(6) Mobility
			Panel A: Total scores.			
Non-cognitive score	-0.00218***	-0.00152***	-0.00155***	-0.00069	-0.00082*	-0.00084*
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Cognitive score	-0.00248***	-0.00213***	-0.00213***	-0.00142**	-0.00146**	-0.00128*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R-squared	0.013	0.049	0.051	0.131	0.134	0.123
			Panel B: Non-cognitive assessment unconditional on cognitive score			
Non-cognitive score	-0.00256***	-0.00183***	-0.00185***	-0.00079*	-0.00089*	-0.00090*
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
R-squared	0.011	0.049	0.050	0.131	0.134	0.123
			Panel C: Cognitive assessment unconditional on non-cognitive score			
Cognitive score	-0.00285***	-0.00238***	-0.00238***	-0.00153**	-0.00159**	-0.00143**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	115,153	115,153	115,153	115,153	101,999	101,999
R-squared	0.012	0.049	0.050	0.131	0.134	0.123
Personal characteristics		X	X	X	X	X
School characteristics			X	X	X	X
Log-earnings				X	X	
Log-wages						X
Public school teachers only					X	X

Note: School level clustered standard errors (*** p<0.01, ** p<0.05, * p<0.1). Regressions include time*county specific effects, quadratic and cubic terms of the displayed intellectual skills variables. All regressions corrected for school mergers and dissolutions as well as for mobility in grades below 7th that teachers work with. Personal characteristics include: marital status, indicators for science, vocational and remedial education teachers, workload, type of employment and indicators for upper secondary and private school teachers. School characteristics include: student-teacher ratio in full time equivalence, number of students and its square, indicator for schools with less than 100 students, share of girls and immigrants at school, mean percentiled student GPA and mean parental income.

It is a question of general interest, how teacher intellectual capacities affect their decisions to change jobs. Table 3 re-estimates the specifications from table 2, while substituting education and experience by cognitive and non-cognitive test scores in panel A[42]. Panel B further explores non-cognitive assessment unconditional on cognitive score, while panel C studies cognitive assessment unconditional on non-cognitive score. Results in table 3 suggest that higher quality teachers are less likely to change employers. Thus, it seems that Swedish schools are effective in winnowing the wheat from the chaff and do not lose the high cognitive and non-cognitive skills teachers. Similarly to the previous estimates authorities may be able to change mobility behavior by manipulating salaries and type of employment and these methods seem to be more efficient in the case of cognitive skills. As far as public schools are concerned the estimates do not differ qualitatively and are similar quantitatively depending on whether log yearly earnings or log monthly salary is used.

Finally, I can only observe mobility if teachers have different establishment numbers, however, it may be problematic whether this mobility is voluntary or not. In particular, there can be reshuffling of teachers between schools in municipality due to the fact that employment protection is based on employment in municipality and not at the school. Furthermore, it may be the case that if one school has an opening for a teacher and there are other schools in the same municipality laying off teachers, there might be bargaining and

[42] When an university indicator and teaching experience are included in these regressions the results do not change except the fact that the estimate in column (4) in panel B becomes barely insignificant. Nonetheless, since the intellectual assessments are estimated on a completely different sample the measures of university education and experience are not included. The estimates including university indicator and experience are available from the author upon request.

reshuffling of teachers within the municipality. To address this issue I restrict the analysis to the sample of municipalities that never experienced reductions in the teacher stock by more than 5% in the studied period. Note that this is a very restrictive assumption in the sense that it excludes municipalities that experienced only temporary reductions and it also imposes small room for reductions[43].

Tables A2 and A3 in section 2 of the appendix present the estimation results using the sample described above and specifications from tables 2 and 3. The sample size is reduced four fold, however, majority of the results remain unchanged both qualitatively and quantitatively. The university indicator estimates become more negative and also significant in columns (5) and (6), while experience estimates remain virtually unchanged. As far as intellectual assessment is concerned, the estimates in panel A become more negative, however, lose significance on non-cognitive score in columns (5) and (6). Similarly the non-cognitive assessment is not significant in columns (5) and (6) of panel B. Thus, these estimates should reassure the readers that involuntary mobility and reshuffling of teachers within municipalities do not pose a threat to the validity of the main results.

[43] Some of the municipalities experiences as much as over 80% reductions in teacher stock from year to year over the studied period.

5. Heterogeneity analyses

So far the evidence suggests that Swedish schools do not experience increased turnover of high skilled teachers, which is true for the whole population and for the sample of public school teachers. In the heterogeneity analyses, I give insights on how to allocate the highest quality teachers[44] to the most disadvantaged schools. In particular, I explore how teachers of different quality behave with respect to school and personal characteristics. For instance, high quality teachers may be more prone to leave schools with increased shares of minorities or schools with limited financial resources. The quality in table 4 is measured by education and experience, while in table 5 by cognitive and non-cognitive assessment. Columns (3)-(8) in table 4 follow the idea proposed in Hanushek et al. (2004).

Table 4. Heterogeneity analyses in education and experience. The dependent variable is equal to unity if the teacher changes job.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	University graduate		Years of experience					
VARIABLES	Yes	No	0-2	3-5	6-10	11-15	16-20	20+
Log yearly earnings	-0.04217***	-0.06840***	-0.06439***	-0.06040***	-0.03866***	-0.02908***	-0.01392***	-0.00947**
(1000SEK)	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Temporarily employed	0.18502***	0.15881***	0.18840***	0.15883***	0.15692***	0.16269***	0.15608***	0.19657***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.005)	(0.006)	(0.007)	(0.011)
Private school teacher	0.02318***	-0.01022	-0.01321	0.00950	0.01524**	0.03676***	0.03063***	0.03489***
	(0.006)	(0.008)	(0.009)	(0.009)	(0.007)	(0.009)	(0.010)	(0.009)
Student-teacher ratio FTE	-0.00089**	0.00084	0.00051	0.00158**	-0.00028	-0.00051	-0.00195***	-0.00030
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share of immigrants	0.00547	0.03677	-0.00179	0.02367	0.04012*	0.03359	-0.00932	0.00420
	(0.015)	(0.024)	(0.028)	(0.026)	(0.022)	(0.025)	(0.020)	(0.015)
GPA	-0.00120***	-0.00013	-0.00066	-0.00084**	-0.00066**	-0.00124***	-0.00111***	-0.00072***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Mean parental income	-0.00001	-0.00002	-0.00006	-0.00003	-0.00001	0.00001	0.00000	-0.00003
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	353,133	170,702	82,534	92,101	85,586	64,804	117,024	81,786
R-squared	0.115	0.157	0.111	0.094	0.083	0.068	0.052	0.049

Note: School level clustered standard errors (*** p<0.01, ** p<0.05, * p<0.1). All regressions include time*county specific effects, gender, immigrant status, marital status, teacher specialization (science, vocational, remedial), workload, type of school (lower vs. upper secondary), school size (number of students and its square as well as indicator for schools with less than 100 pupils) and gender composition of students. All regressions corrected for school mergers and dissolutions as well as for mobility in grades below 7th that teachers work with. Columns (1) and (2) control for experience and experience squared. Columns (3)-(8) control for university degree and experience squared.

On the one hand, the coefficient on earnings is smaller for teachers with university degree. On the other hand, the coefficient on type of employment is smaller for these without the university education. These coefficients are not statistically different across the two samples. Furthermore, university educated teachers tend to leave private sector, which works against the common perception that private schools cream skim the best teachers from the market (difference significant at 1% level). It is also the highly educated who are affected by the quality of their students (difference significant at 5% level).

As far as experience is concerned, there is monotonic pattern of decreasing earnings coefficients, which is in line with what was found by Hanushek et al. (2004). Moreover, there is no significant positive correlation between mobility and working in private sector only among less experienced teachers. The coefficient on student quality is insignificant also only

[44] As measured by university education, teaching experience as well as cognitive and non-cognitive skills.

for the least experienced individuals, so more experienced teachers favor working with high performing pupils, which is based on the fact that I can reject at 1% level the hypothesis that all parameters are equal. Finally, unlike in Hanushek et al. (2004) I do not find virtually any relationship between the share of minorities at school and teacher mobility for teachers with different education or experience[45]. This supports findings from Karbownik (2012) who found only scarce and heterogeneous evidence of increased teacher turnover in schools with increased minorities' shares[46].

Table 5. Heterogeneity analyses in cognitive and non-cognitive assessment. The dependent variable is equal to unity if the teacher changes job.

VARIABLES	(1) Cognitive score below median	(2) Cognitive score above median	(3) Cognitive score in 90th percentile	(4) Non-cognitive score below median	(5) Non-cognitive score above median	(6) Non-cognitive score in 90th percentile
Log yearly earnings	-0.07954***	-0.08248***	-0.08283***	-0.08724***	-0.07252***	-0.06546***
(1000SEK)	(0.004)	(0.005)	(0.010)	(0.005)	(0.005)	(0.010)
Temporarily	0.17261***	0.17596***	0.18610***	0.18252***	0.16574***	0.17972***
employed	(0.005)	(0.005)	(0.012)	(0.005)	(0.005)	(0.011)
Private school	0.01945**	0.01149	0.00819	0.00693	0.02523***	0.04089**
teacher	(0.009)	(0.009)	(0.017)	(0.009)	(0.009)	(0.016)
Student-teacher ratio	-0.00017	-0.00090	-0.00011	-0.00061	-0.00046	-0.00074
FTE	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share of immigrants	0.05122*	0.03666	0.02509	0.06109**	0.02648	0.00752
	(0.029)	(0.030)	(0.061)	(0.030)	(0.029)	(0.061)
GPA	-0.00026	-0.00082**	-0.00053	-0.00046	-0.00066*	-0.00118*
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
Mean parental	-0.00004	-0.00001	-0.00003	-0.00001	-0.00004	-0.00001
income	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	57,625	57,528	11,525	58,463	56,690	12,245
R-squared	0.135	0.131	0.154	0.149	0.117	0.137

Note: School level clustered standard errors (*** p<0.01, ** p<0.05, * p<0.1). All regressions include time*county specific effects, marital status, teacher specialization (science, vocational, remedial), workload, type of school (lower vs. upper secondary), school size (number of students and its square as well as indicator for schools with less than 100 pupils) and gender composition of students. Additionally regressions studying heterogeneity in cognitive skills control for non-cognitive score polynomial while these studying heterogeneity in non-cognitive skills control for cognitive score polynomial. All regressions corrected for school mergers and dissolutions as well as for mobility in grades below 7th that teachers work with.

In table 5 I focus on the relationship between job characteristics and teacher turnover for teachers from different parts of intellectual assessment distribution. In particular, columns (1) and (4) report results for individuals below or equal to the median, columns (2) and (5) report results for individuals above the median, while columns (3) and (6) report results for individuals in the 90th percentile. The magnitude of the earnings coefficient increases with cognitive abilities, while it decreases with non-cognitive abilities. Thus, it is relatively cheaper to retain "smartest" rather than "most social" individuals. The private sector discourages low cognitive and high non-cognitive abilities individuals[47]. These results also highlight the fact noted in Grönqvist and Vlachos (2008), who suggest that the two tests describe different types of individual behavior. Additionally, table 5 suggests that teachers with low intellectual and social skills are indeed discouraged by the minorities. This is

[45] They find positive correlation between share of blacks and Hispanics, and teacher turnover, especially among less experienced teachers. Here, I only find barely significant positive correlation for teachers with 6-10 years of experience.
[46] This is in contrast to most of the research on teacher mobility. See for example Falch and Strøm (2005), Scafidi et al. (2007), Barbieri et al (2008) or Bonhomme et al. (2011).
[47] See Lindqvist and Vestman (2011) for labor market prospects of individuals with respect to their cognitive and non-cognitive intellectual assessments.

reassuring, as the disadvantaged schools in Sweden do not seem to lose their highly educated, experienced and skilled teachers.

Table 6. Teacher quality and school types. The dependent variable is equal to unity if the teacher changes job.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	University degree and experience analysis				Cognitive and non-cognitive assessment analysis			
VARIABLES	Lower secondary	Upper secondary	Public	Private	Lower secondary	Upper secondary	Public	Private
University graduate	-0.00333*	0.00241	-0.00232*	0.00699				
	(0.002)	(0.002)	(0.001)	(0.006)				
Experience	-0.01157***	-0.00921***	-0.01030***	-0.00998***				
	(0.000)	(0.001)	(0.000)	(0.002)				
Non-cognitive score					-0.00064	-0.00068	-0.00067	-0.00013
					(0.001)	(0.001)	(0.000)	(0.002)
Cognitive score					-0.00146	-0.00126	-0.00142**	-0.00187
					(0.001)	(0.001)	(0.001)	(0.002)
Observations	295,453	228,382	494,566	29,269	58,569	56,584	106,882	8,271
R-squared	0.156	0.139	0.148	0.105	0.149	0.124	0.138	0.107

Note: School level clustered standard errors (*** p<0.01, ** p<0.05, * p<0.1). All regressions include time*county specific effects. Regressions using intellectual assessment data control for square and cubed of teacher's cognitive and non-cognitive scores, while regressions using university graduate indicator and experience control for square of teacher's experience. The latter regressions additionally include log yearly earnings, type of employment, gender, immigrant indicator, marital status, teacher specialization (science, vocational, remedial), workload, school size (number of students and its square as well as indicator for schools with less than 100 pupils), gender composition of students, student-teacher ratio in full time equivalence, share of immigrant students, mean percentiled GPA and mean parental income. The former regressions exclude gender and immigrant indicator as intellectual assessment is available only for native males. Finally, columns (1), (2), (5) and (6) include private school indicator, while columns (3), (4), (7) and (8) include upper secondary school indicator. All regressions corrected for school mergers and dissolutions as well as for mobility in grades below 7th that teachers work with.

Since the mid 1990s there has been an increasing discussion in public debate and among researchers regarding allowing private sector to the public schooling system. There has been research assessing the influence of such changes on student (Ladd, 2002; Sandström and Bergström, 2005; Hsieh and Urquiola, 2006) and teacher (Hoxby, 2002; Hensvik, 2012; Jackson 2011b) outcomes. Karbownik (2012) documented important differences in the teacher turnover between private and public school teachers in Sweden. Furthermore, both tables 4 and 5 suggest that teachers of different quality experience differences in mobility depending on whether they work in private or public institution. Thus, table 6 studies differences in mobility for different measures of teacher quality and different types of schools. In particular, columns (1), (2), (5) and (6) present differences between lower and upper secondary schools[48] and columns (3), (4), (7) and (8) illustrate differences between public and private sector.

Results show significant negative coefficient on university educated teachers only in lower secondary and public schools. Furthermore, the estimates on experience are similar at both school types and levels. These results might be driven by the fact that university graduates in public schools are different from those in private schools[49]. Finally, the only significant correlation regarding intellectual assessment is found for cognitive abilities and public schools, where it is negative.

[48] This distinction is important as Karbownik (2012) shows that although there is no relationship between minorities and turnover in lower secondary schools, it is significant and positive at the upper secondary level.

[49] Statistical investigation confirms that among university graduates those teaching in private schools differ significantly from those working in public schools as far as observable socio-economic characteristics are concerned. Nevertheless, even if these correlations are driven by selection into different sectors, they still should draw an attention of policy makers.

Table 7. Analyses by different destinations.

VARIABLES	(1) Within	(2) Quit	(3) Within	(4) Quit
University graduate	0.01117***	-0.01345***		
	(0.001)	(0.001)		
Experience	-0.00204***	-0.00841***		
	(0.000)	(0.000)		
Non-cognitive score			-0.00013	-0.00057
			(0.000)	(0.000)
Cognitive score			-0.00023	-0.00119**
			(0.000)	(0.001)
Observations	523,835	523,835	115,153	115,153
R-squared	0.035	0.120	0.031	0.114

Note: School level clustered standard errors (*** p<0.01, ** p<0.05, * p<0.1). All regressions include time*county specific effects. Regressions using intellectual assessment data control for square and cubed of teacher's cognitive and non-cognitive scores, while regressions using university graduate indicator and experience control for square of teacher's experience. Regressions in columns (1) and (3) additionally include log yearly earnings, type of employment, gender, immigrant indicator, marital status, teacher specialization (science, vocational, remedial), workload, upper secondary school indicator, private school indicator, school size (number of students and its square as well as indicator for schools with less than 100 pupils), gender composition of students, student-teacher ratio in full time equivalence, share of immigrant students, mean percentiled GPA and mean parental income. Regressions from columns (3) and (4) exclude gender and immigrant indicator as intellectual assessment is available only for native males. All regressions corrected for school mergers and dissolutions as well as for mobility in grades below 7th that teachers work with.

The models used so far force the relationship between the explanatory variables and the probability to exit school to be independent of destination, however, there is research indicating that the impact of teacher characteristics differs depending on the destination (Lankford et al., 2002). To investigate whether the relationship between teacher quality and teacher turnover depend on destination, I estimate the baseline specifications from tables 2 and 3 separately for mobility within lower and upper secondary schools as well as out of these types of schools (i.e. either to kindergarten, or adult education, or completely out of teaching). Columns (1) and (2) in table 7 report estimates based on specification from column (4) in table 2, while columns (3) and (4) report estimates based on specification from column (4) in panel A in table 3. The estimation method is least squares, which is linearization of multinomial logit approach used in Haushek et al. (2004) and Falch and Strøm (2005). The results are similar to the ones obtained using non-linear methods with marginal effects evaluated at means.

Heterogeneity in destinations indeed sheds more light on the previous results. University educated teachers are more likely to switch jobs within lower and upper secondary schools, than leave for alternative jobs. Similar pattern can be observed as far as experience is concerned, however, here both coefficients in the within and out of profession mobility regressions are negative. There is no significant relationship between either cognitive or non-cognitive skills and within teaching turnover, however, there is negative correlation between the latter measure and quitting the profession[50]. These results should be of high importance for the policy makers as high quality teachers do not leave Swedish educational system and even if they change jobs it is done within the profession. It also suggests that answers for the drop in teacher quality over time documented by Grönqvist and Vlachos (2008) should be

[50] Table A1 in the appendix documents that high non-cognitive skills teachers are less likely to move in general and are less likely to quit the profession. Furthermore, mid cognitive skills teachers are less likely to quit the profession. There is no evidence on the relationship between high cognitive scores and any type of mobility.

sought in the declining quality of new teachers entering the profession, rather than in the outflow from schooling sector of highly educated and experienced teachers[51]. The results in this paper are not in opposition to the previous research, and in fact they can be considered as a supplement. I focus on the teacher quality conditional on the selection into teaching and show that among the pool of teachers who decide to pursue teaching career, it is the low educated and low skilled ones who exit. It does not give any insight about the total population of potential teachers, and in that sense the results may be different than in Fredriksson and Öckert (2007). In fact, combining mine and their results, one can draw a conclusion that even though among the whole population of potential pedagogues, it is not the most highly qualified who choose to enter teaching, however, among these who chose teaching careers it is the best ones that do not quit[52].

[51] Fredriksson and Öckert (2007) show that it is the higher abilities individuals who do not enter teaching profession after teacher's training.

[52] To test this hypothesis formally I have to look at the whole population of teachers finishing teacher college and not only the sample of individuals who are pursuing teaching career.

6. Conclusions

The contemporary literature on the teacher mobility lacked the detailed study relating turnover to teacher quality. Furthermore, such research should be of particular interest to policy makers in the Swedish institutional setup, which includes individual variation in wages, competition between schools and growing private sector, and it closely resembles an environment for which the economists usually argue for. This paper attempts to fill in this gap using unusually rich dataset on Swedish lower and upper secondary school teachers covering years 1996/1997 to 2006/2007.

The results indicate that, in Sweden unlike in the US, schools do not seem to lose university educated and experienced teachers, and such teachers also do not leave the profession. This suggests that the drop in teacher quality documented by others should be ascribed to the quality on new entrants. Furthermore, I do not find any support for the common view that schools serving minority students experience high turnover rates. There is no evidence that a higher share of minority enrollment correlates positively with quits of high quality teachers, and in fact there is some indication that such schools experience outflow of low quality teachers. Moreover, the findings suggest that it may be possible to influence teacher's mobility decision through changes in monetary compensations or type of employment. The preferred estimates suggest elasticities at meant of yearly earnings and type of employment of -2.42 and 0.3 respectively.

Another contribution of this paper is the use of intellectual assessment data. These results suggest that both high cognitive and non-cognitive skills teachers are less likely to change employers. Additionally, the private sector seems to attract high cognitive but low non-cognitive skills individuals. Moreover, minorities discourage low cognitive and non-cognitive skills teachers and high quality students retain high skilled teachers.

References

Aaronson, D., L. Barrow, and W. Sander (2007), "Teachers and student achievement in the Chicago public high schools", *Journal of Labor Economics*, 25:1, 95-135.

Bacolod, P.M. (2007), "Do alternative opportunities matter? The role of female labor markets in the decline of teacher quality", *Review of Economics and Statistics*, 89:4, 737-751.

Barbieri, G., C. Rossetti, and P. Sestito (2008), "The determinants of teachers' mobility. Evidence from a panel of Italian teachers", mimeo University of Milan.

Baugh, H.W. and J.A. Stone (1982), "Mobility and wage equilibrium in the educator labor market", *Economics of Education Review*, 2:3, 253–274.

Bertrand, M., E. Duflo, and S. Mullainathan (2004), "How much should we trust differences-in-differences estimates?", *Quarterly Journal of Economics*, 119:1, 249-275.

Björklund, A., M.A. Clark, P-A. Edin, P. Fredriksson, and A. Krueger (2006), "The market comes to education in Sweden: An Evaluation of Sweden's surprising school reforms", Russel Sage Foundation, New York.

Bonhomme, S., G. Jolivet, and E. Leuven (2011), "Estimation of preferences for job attributes using job–to–job mobility: teacher turnover and school characteristics", mimeo CREST.

Boyd, D., H. Lankford, S. Loeb, and J. Wyckoff (2005), "Explaining the short careers of high – achieving teachers in school with low performing students" *American Economic Review*, 95:2, 166–171.

Böhlmark, A. and M. Lindahl (2007), "The impact of school choice on pupil achievement, segregation and costs: Swedish evidence", IZA Working Paper 2786.

Böhlmark, A. and M. Lindahl (2008), "Does school privatization improve educational achievement? Evidence from Sweden's voucher reform", IZA Working Paper 3691.

Brewer, J.D. (1996), "Career paths and quit decisions: evidence from teaching", *Journal of Labor Economics*, 14:2, 313–339.

Carlstedt, B. (2000), "Cognitive abilities: Aspects of structure, process and measurement", University of Gothenburg Doctoral Dissertation.

Chetty, R., J.N. Friedman, and J.E. Rockoff (2011), "The long-term impacts of teachers: Teacher value-added and student outcomes in adulthood", Mimeo Harvard University.

Clotfelter, T.C., H.F. Ladd, and J.L. Vigdor (2007), "Teacher credentials and student achievement: longitudinal analysis with student fixed effects", *Economics of Education Review*, 26:6, 673-682.

Corcoran, P.S., W.N. Evans, and R.M. Schwab (2004), "Changing labor-market opportunities for women and the quality of teachers, 1957-2000", *American Economic Review*, 94:2, 230-235.

Dobbie, W. and R.G. Fryer (2011), „Are high quality schools enough to increase achievement among the poor? Evidence from the Harlem children's zone", *American Economic Journal: Applied Economics*, 3:3, 158-187.

Dolton, P. and W. van der Klaauw (1995), "Leaving teaching in the UK: a duration analysis", *Economic Journal*, 105:429, 431–444.

Dolton, P. and W. van der Klaauw (1999), "The turnover of teachers: a competing risk explanation", *Review of Economics and Statistics*, 81:3, 543–552.

Dolton, P. and O.D. Marcenaro-Gutierrez (2011), "If you pay peanuts do you get monkeys? A cross-country analysis of teacher pay and pupil performance", *Economic Policy*, 26:65, 5-55.

Edin, P-A., B. Holmlund, and O. Nordström Skans (2009), "Wage Dispersion Between and Within Plants: Sweden 1985-2000", in E. Lazear and K. Shaw (eds.) *The Structure of Wages: an International Comparison*, University of Chicago Press.

Ehrenberg, G.R. and D.J. Brewer (1994), "Do school teacher characteristics matter? Evidence from High School and Beyond", *Economics of Education Review*, 13:1, 1-17.

Falch, T. and B. Strøm (2005), "Teacher turnover and non–pecuniary factors", *Economics of Education Review*, 24:6, 611–631.

Falch, T. (2011), "Teacher mobility responses to wage changes: Evidence from a quasi – natural experiment" *American Economic Review*, 101:3, 460-465.

Feng, L. (2009), "Opportunity wages, classroom characteristics, and teacher mobility", *Southern Economic Journal*, 75:4, 1165-1190.

Fredriksson, P. and B. Öckert (2007), "The supply of skills to the teacher profession", Mimeo Uppsala University.

Fredriksson, P. and B. Öckert (2008), "Resources and student achievement – evidence from a Swedish policy reform", *Scandinavian Journal of Economics*, 110:2, 277-296.

Gensowski, M., J.J. Heckman, and P. Savelyev (2011), "The effects of education, personality, and IQ on earnings of high-ability men", Mimeo University of Chicago.

Grönqvist, E. and J. Vlachos (2008), "One size fits all? The effects of teacher cognitive and non-cognitive abilities on student achievement", IFAU Working Paper 25.

Harbison, W.R. and E.A. Hanushek (1992), "Educational performance of the poor. Lessons from rural northeast Brazil", Oxford University Press.

Hanushek, E.A. (1971), "Teacher characteristics and gains in student achievement: Estimation using micro data", *American Economic Review*, 61:2, 280-288.

Hanushek, E.A. (1992), "The trade-off between child quantity and quality", *Journal of Political Economy*, 100:1, 84-117.

Hanushek, E.A., F.J. Kain, and G.S. Rivkin (2004), "Why public schools loose teachers?", *Journal of Human Resources*, 39:2, 326–354.

Harris, N.D. and T.R. Sass (2006), "Value-added models and the measurement of teacher quality", Mimeo Florida State University.

Harris, N.D. and T.R. Sass (2011), "Teacher training, teacher quality and student achievement", *Journal of Public Economics*, 95:7, 798-812.

Heckman, J.J. (2006), "Skill formation and the economics of investing in disadvantaged children", *Science*, 312:5782, 1900-1902.

Heckman, J.J., J. Stixrud, and S. Urzua (2006a), "The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior", NBER Working Paper 12006.

Hensvik, L. (2012), "Competition, wages and teacher sorting: four lessons from a voucher reform", *Economic Journal*, forthcoming.

Hsieh, T-C. and M. Urquiola (2006), "The effects of generalized school choice on achievement and stratification: Evidence from Chile's school voucher program", *Journal of Public Economics*, 90:8, 1477-1503.

Hoxby, M.C. (2002), "Would school choice change the teaching profession?", *Journal of Human Resources*, 37:4, 846-891.

Jackson, C.K. (2009), "Student demographics, teacher sorting, and teacher quality: Evidence from the end of school desegregation", *Journal of Labor Economics*, 27:2, 213-256.

Jackson, C.K. (2011a), "Match quality, worker productivity and worker mobility: Direct evidence from teachers", NBER Working Paper 15990.

Jackson, C.K. (2011b), "School competition and teacher labor markets: Evidence from charter school entry in North Carolina", NBER Working Paper 17225.

Kane, J.T. and D.O. Staiger (2008), "Estimating teacher impacts on student achievement: an experimental evaluation", NBER Working Paper No. 14607.

Karbownik, K. (2012), "The determinants of teacher mobility in Sweden", Mimeo Uppsala University.

Ladd, F.H. (2002), "School vouchers: A critical view", *Journal of Economic Perspectives*, 16:4, 3-24.

Lankford, H., S. Loeb, and J. Wyckoff (2002), "Teacher sorting and the plight of urban schools: the importance of alternative labor market opportunities and non – pecuniary variation", *Educational Evaluation and Policy Analysis*, 24:1, 37-62.

Lavy, V. (2009), "Performance pay and teachers' effort, productivity and grading ethics", *American Economic Review*, 99:5, 1979-2011.

Leigh, A. and C. Ryan (2008), "How and why has teacher quality changed in Australia?", *Australian Economic Review*, 41:2, 141-159.

Lindqvist, E., and R. Vestman (2011), "The labor market returns to cognitive and noncognitive ability: evidence from the Swedish enlistment", *American Economic Journal: Applied Economics*, 3:1, 101-128.

Lindholm, A. (2006), "Lärarförbundet och lärarnas riksförbund medlemsundersökning om lön och arbetstid".

Mood, C., J.O. Jonsson, and E.Bihagen (2012), "Socioeconomic persistence across generations: The role of cognitive and non-cognitive processes", in J. Ermisch, M. Jantti, and T. Smeeding (eds.) *Inequality from childhood to adulthood. A cross-national perspective of the transmission of advantage*, New York: Russell Sage.

Murnane, J.R. and R.J. Olsen (1990), "The effects of salaries and opportunity costs on length of stay in teaching: evidence from North Carolina", *Journal of Human Resources*, 25:1, 106–124.

National Agency for Education, (2003), "Behov av och tillgång på pedagogisk personal – Skolverkets bedömning 2003".

Neal, D. (2006), "Why has black-white skill convergence stopped?", in E.A. Hanushek and F. Welch (eds.) *Handbook of Economics of Education*, 1, 511-576.

Nickell, S. and G. Quintini (2002), "The consequences of the decline in public sector pay in Britain: a little bit of evidence", *Economic Journal*, 112:477, F107-F118.

Oyer, P. (2009), "Wage Structure and Labor Mobility in Sweden, 1970-1990", in E. Lazear and K. Shaw (eds.) *The Structure of Wages: an International Comparison*, University of Chicago Press.

Rivkin, S.G., E.A. Hanushek, and J.F. Kain (2005), "Teachers, schools, and academic achievement", *Econometrica*, 73:2, 417–458.

Rockoff, E.J. (2004), "The impact of individual teachers on student achievement: evidence from panel data", *American Economic Review*, 94:2, 247-252.

Rockoff, E.J. and C. Speroni (2011), "Subjective and objective evaluations of teacher effectiveness: evidence from New York City", *Labour Economics*, 18:5, 687-696.

Rothstein, J. (2010), "Teacher quality in educational production: tracking, decay and student achievement", *Quarterly Journal of Economics*, 125:1, 175-214.

Sandström, F.M. and F. Bergström (2005), "School vouchers in practice: Competition will not hurt you", *Journal of Public Economics*, 89:2, 351-380.

Scafidi, B., D.L. Sjoquist, and T.R. Stinebrickner (2007), "Race, poverty, and teacher mobility", *Economics of Education Review*, 26:2, 145–159.

Söderström, M. and R. Uusitalo (2010), "School Choice and Segregation: Evidence from an Admission Reform", *Scandinavian Journal of Economics*, 112:1, 55-76.

Taylor, J., A.D. Roehrig, B. Soden Hensler, C.M. Connor, and C. Schatschneider (2010), "Teacher quality moderates the genetic effects on early reading", *Science*, 328:5977, 512-514.

Appendix

Section 1. Details of sample construction.

I construct the sample of lower and upper secondary school teachers for the school years 1996/1997 to 2006/2007. The information about teacher comes from the teacher registry and the analysis focuses on teachers working in grades 7-9 (lower secondary school) of compulsory education and in grades 1-3 (upper secondary school) in secondary education. Teachers who are on unpaid leave of absence or whose workloads are zero hours (i.e. they do not perform any pedagogical duties) are excluded from the analysis. Such teachers are treated neutrally in terms of mobility if they come back after the absence period to the same school. Similarly, I exclude teachers who are employed as principals, study counselors etc. In each year if teacher has multiple entries in the registry, the one with the higher workload is selected irrespectively whether it is at the same or different schools[53]. Teacher registry is a high quality data set, that allows recovering information on school location (unique identifier), school ownership and type, teacher certification, workload, employment type (temporary vs. permanent), education and position. The construction of teaching experience is presented in the descriptive statistics section.

Teachers are grouped into either lower or upper secondary education and teachers working in grades 7-9 are recovered by merging the teacher registry to the pupil registry via unique school identifier. There exist schools with more grades covered under the same school identifier (i.e. 1-9 or 4-9) and one possible source of bias would be for instance relating teachers who work with students in grades 1-3 to school characteristics measured for students in grades 7-9. Since I have information about the grades in which teachers work I address this issue by excluding teachers coded as primary (grades 1-3) and middle (grades 4-6) school teachers. Such a procedure does not solve the problem completely as some teachers (arts or music) are not necessarily coded by grades. Thus, I may still include some miscoded teachers, however, to this end it is the best I can do. Nonetheless, each included school serves grades 7-9 and only mobility between such schools is considered at lower secondary level. Such a bias will not be present in upper secondary schools as these teachers are directly linked to their students covering grades 1-3.

Teachers are then linked (using unique identifier) to population enlistment registry, which covers all individuals living in Sweden that are older than 15. The population registry is high quality data set that allows recovering information on gender, marital status, age,

[53] The workload of teachers having multiple positions at the same school is not summed and the highest workload position is selected.

family composition (using unique family identifier), immigration history, education and income. Income is measured as a gross salary plus income from business and self-employment plus any work-related allowances. Investment losses are not included, and thus, income is lower-bounded at zero. Teachers are restricted to be younger than 59 years old due to changes in retirement policies. According to the new pension system, that applies only to those born in 1938 and onwards, employees in Sweden can collect pension at the age of 61 at the earliest, however, this amount will be significantly lower than the guaranteed pension, which is available after turning 65. Note that people who were born in 1937 or earlier do not fall into the new pension system. In the first year studied in this paper they are 59 and that is why I restrict the teachers to be younger than 59 years old. The older teachers can retire under different rules and indeed you can see a sharp increase in separations for teachers above 58. Thus, for the sake of logical consistency I present results for the sample of teachers aged 25-58 that all fall into the new pension system. The bottom cutoff is due to university education and possible onsite job training during the last year of college.

The earnings registry covers all individuals while the wage registry covers all individuals employed in the public sector and the sample of individuals employed in private sector[54]. In the latter dataset the information is collected once a year and reflects the employment status and monthly salary as of November 1st each year. In the case of teachers this data is useful as schools are in operation when the data is collected and therefore one can observe how much school pays an individual teacher that is not reflecting part-time or full-time leaves, out of the labor market periods or unemployment. Thus, in that sense the wage data are, unlike the earnings data, not subject to the labor supply decisions critique. The main disadvantage of using monthly wages is that they cover only a sample of private schools and typically different schools over time. Furthermore, the private institution's sampling probability depends on the size of the establishment, so it is likely that the smaller and newly founded private institutions would be underrepresented. It may yield a selection problem, however, when I estimate the regression with yearly earnings on the sample of individuals for whom the monthly wages are available the coefficient on the yearly earnings does not depart much from the one obtained for the full sample.

Both the earnings and wages registries often contain multiple entries per individual, which characterizes different sources of labor compensations. In the former case the data are

[54] In fact the wage data is a secondary source of information because of its quality. Even though it is supposed to cover all the individuals working in public schools over the course of this study some 6 925 (or 6.1%) of public school teaches have missing wage data.

restricted to individuals whose employment started not later and ended not earlier than in October. Individuals with a single record per year are matched based on their unique identifiers. Furthermore, I construct the median rule that matches school codes with establishment identifier i.e. among these individuals who have single records for each school identifier I match most often occurring establishment identifier in earnings registry. The remaining teachers' earnings are matched with individuals based on their unique identifier and mode rule match. As far as monthly wages are concerned individuals coded as teachers are selected and then the maximum workload is chosen. Teacher and wage registries are then merged using unique personal identifier.

The students' characteristics are based on "school in" and "school out" pupil registries. The lower secondary school composition is based on outgoing students, which should not pose a selection problem as majority of students graduate the lower secondary education. Söderström and Uusitalo (2010) report that about 90% of student population complete the ninth grade and is eligible for upper secondary schooling, and of those 98% continue. The quality of students in lower secondary school is measured based on their 9^{th} grade outgoing grades. The measure is calculated for year t as a mean percentiled GPA from cohorts graduating in year t+1, t+2 and t+3. It reflects the fact that teacher characteristics are measured in the fall of the school year while the examination takes place in the spring of the school year. For example, the lower secondary school quality in the school year 2006/2007 is measured using grades from exams administered in years 2007, 2008 and 2009.

The upper secondary school composition is based on all the students that are in a given school in a particular year. The quality of students in upper secondary school is measured based on their 9^{th} grade grades, due to a large selection in graduation rates. Even allowing 4 years for graduation between 25 and 30% of students do not finish upper secondary schools. Additionally given such a selection in graduation rates, the advantage of using lower secondary school grades as a measure of upper secondary school quality is also the fact that it is largely exogenous to upper secondary school teachers. I connect these students to their parents using unique family identifier and obtain the family level socioeconomic indicator i.e. mean parental income.

The enlistment registry covers period 1969 to 2006 and provides information on cognitive and non-cognitive assessments. Each of the parts that contribute to a final cognitive score is graded on 1 to 9 scale, and the final score is given in the same format. To make the variable more continuous and utilize all the information I predict the final score using the separate components. I obtain variable with mean 97.4 and standard deviation of 23.7. The

non-cognitive score is based on 1 to 9 scale and since there is missing data in contributing personality traits (rated on 1 to 5 scale), I do not attempt to create a more continuous from of the non-cognitive measure. Then, I percentile rank all the male, native individuals by type of assessment and year of draft. This procedure yields ranking of individuals in every tests in every draft year for the whole tested population. The data is linked to teacher registry via unique personal identifier and scores are assigned to native, male teachers for whom the data is available.

Finally, having a dataset with teachers and students I match the two using a unique school identifier. Naturally since the mobility itself is a lagged variable school year 2006/2007 is dropped from the analysis. The final sample includes 135 895 teachers and 621 430 person–year observations. I exclude the following observations from the main sample: very small schools with number of teachers in full time equivalence less than 3 (5 232 observations), teachers that are below 25 years old (8 363 observations), teachers that are above 58 years old (82 211 observations), and schools with the number of students less than 15 (1 789 observations). The final sample consists of 121 331 teachers, 2703 unique schools and 523 835 person–years. Adding the data on monthly wages for the public school teachers decreases the sample size to 109 340 individuals, 2171 unique schools and 474 538 teacher–years. Applying the intellectual sample restrictions further reduce the sample to 26 203 teachers, 2626 unique schools and 115 153 teacher-years.

Section 2. Graphs and tables.

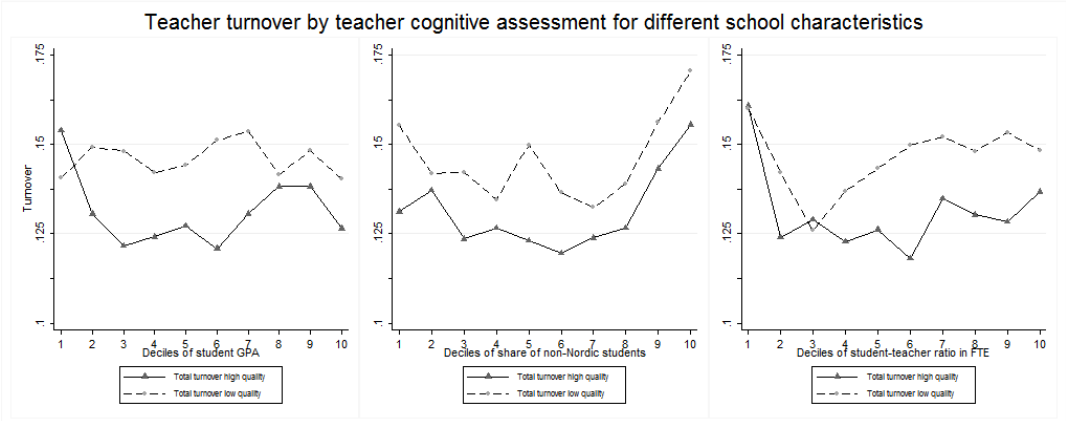

Figure A1. High and low cognitive quality teacher turnover for different school characteristics.

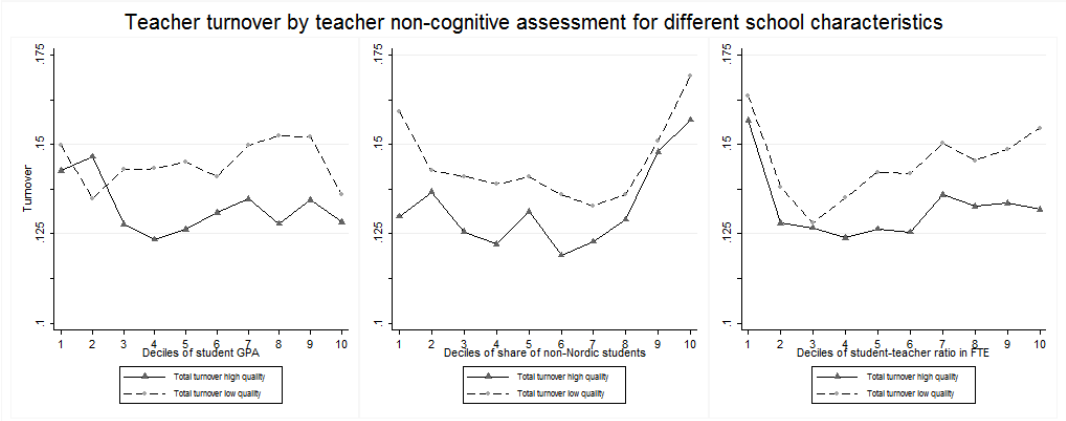

Figure A2. High and low non-cognitive quality teacher turnover for different school characteristics.

Table A1. Heterogeneity in quality. The dependent variable is equal to unity if the teacher changes job.

	(1)	(2)	(3)
VARIABLES	Total	Within	Quit
Cognitive score 2nd	-0.00438	0.00029	-0.00468*
	(0.003)	(0.002)	(0.003)
Cognitive score 3rd	-0.00522	0.00381*	-0.00903***
	(0.003)	(0.002)	(0.003)
Cognitive score 4th	0.00021	-0.00126	0.00146
	(0.003)	(0.002)	(0.003)
Cognitive score 5th	-0.00300	-0.00153	-0.00147
	(0.004)	(0.002)	(0.003)
Non-cognitive score 2nd	-0.00334	0.00236	-0.00571**
	(0.003)	(0.002)	(0.003)
Non-cognitive score 3rd	-0.01092***	0.00013	-0.01105***
	(0.003)	(0.002)	(0.003)
Non-cognitive score 4th	-0.00378	0.00129	-0.00506*
	(0.003)	(0.002)	(0.003)
Non-cognitive score 5th	-0.00558	-0.00457**	-0.00102
	(0.003)	(0.002)	(0.003)
Observations	115,153	115,153	115,153
R-squared	0.131	0.031	0.114

Note: School level clustered standard errors (*** p<0.01, ** p<0.05, * p<0.1). All regressions include time*county specific effects, log yearly earnings, type of employment, marital status, teacher specialization (science, vocational, remedial), workload, upper secondary school indicator, private school indicator, school size (number of students and its square as well as indicator for schools with less than 100 pupils), gender composition of students, student-teacher ratio in full time equivalence, share of immigrant students, mean percentiled GPA and mean parental income.. All regressions corrected for school mergers and dissolutions as well as for mobility in grades below 7th that teachers work with.

Table A2. Estimation results on a sample of municipalities with limited reductions in teacher stock. The dependent variable is equal to unity if the teacher changes job.

VARIABLES	(1) Mobility	(2) Mobility	(3) Mobility	(4) Mobility	(5) Mobility	(6) Mobility
University graduate	-0.03699***	-0.01003***	-0.00894***	-0.00746***	-0.00515**	-0.00465*
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Experience	-0.03008***	-0.01312***	-0.01304***	-0.00948***	-0.00848***	-0.01074***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	131,283	131,283	131,283	131,283	116,748	116,748
R-squared	0.077	0.142	0.143	0.150	0.149	0.144
Personal characteristics		X	X	X	X	X
School characteristics			X	X	X	X
Log-earnings				X	X	
Log-wages						X
Public school teachers only					X	X

Note: School level clustered standard errors (*** p<0.01, ** p<0.05, * p<0.1). Regressions include time*county specific effects and quadratic in experience. Personal characteristics include: gender, immigration status, marital status, indicators for science, vocational and remedial specialization, indicator for temporarily employed, workload, indicators for upper secondary and private school teachers. School characteristics include: student-teacher ratio in full time equivalence, number of students and its square, indicator for schools with less than 100 students, share of girls and immigrants at school, mean percentiled student GPA and mean parental income. Sample reduced to municipalities, which do not experience reductions in teacher stock of more than 5% in any of the studied years. All regressions corrected for school mergers and dissolutions as well as for mobility in grades below 7th that teachers work with.

Table A3. Estimation results on a sample of municipalities with limited reductions in teacher stock. The dependent variable is equal to unity if the teacher changes job.

VARIABLES	(1) Mobility	(2) Mobility	(3) Mobility	(4) Mobility	(5) Mobility	(6) Mobility
			Panel A: Total scores			
Non-cognitive score	-0.00415***	-0.00313***	-0.00299***	-0.00170*	-0.00130	-0.00114
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cognitive score	-0.00218	-0.00213*	-0.00219*	-0.00236**	-0.00249**	-0.00238*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R-squared	0.015	0.054	0.056	0.141	0.149	0.139
			Panel B: Non-cognitive assessment unconditional on cognitive score			
Non-cognitive score	-0.00443***	-0.00336***	-0.00321***	-0.00182*	-0.00142	-0.00124
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R-squared	0.014	0.053	0.056	0.140	0.149	0.139
			Panel C: Cognitive assessment unconditional on non-cognitive score			
Cognitive score	-0.00276**	-0.00251*	-0.00256**	-0.00253**	-0.00266**	-0.00256**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R-squared	0.014	0.053	0.056	0.140	0.149	0.139
Observations	29,241	29,241	29,241	29,241	25,086	25,086
Personal characteristics		X	X	X	X	X
School characteristics			X	X	X	X
Log-earnings				X	X	
Log-wages						X
Public school teachers only					X	X

Note: School level clustered standard errors (*** p<0.01, ** p<0.05, * p<0.1). Regressions include time*county specific effects, quadratic and cubic terms of the displayed intellectual skills variables. Personal characteristics include: marital status, indicators for science, vocational and remedial education teachers, workload, type of employment and indicators for upper secondary and private school teachers. School characteristics include: student-teacher ratio in full time equivalence, number of students and its square, indicator for schools with less than 100 students, share of girls and immigrants at school, mean percentiled student GPA and mean parental income. Sample reduced to municipalities, which do not experience reductions in teacher stock of more than 5% in any of the studied years. All regressions corrected for school mergers and dissolutions as well as for mobility in grades below 7th that teachers work with.