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[1] We thank Ole Henning Nyhus for help with preparing the data. The data availability is part of the project "Quality indicators in higher education», no. 662406. The analyses and views in the paper are solely our responsibility.
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Mobility of novice teachers[1]

Torberg Falch[2] and Bjarne Strøm[3]

Abstract

This paper examines the propensity for graduates from teacher education to work as a teacher in the home region after graduation. We use Norwegian administrative register data and present descriptive statistics and results from regression models. On average, those returning to a teacher position in the home region tend to have lower measured academic ability from higher education than others. Females and parents without higher education are also associated with a higher probability to work as a teacher in the home region. This propensity is not significantly associated with the localization of teacher education in the home region, but strongly related to the population of the region. The results suggest that the types of teachers often believed to be underrepresented in schools have the lowest attachment to their home region and the teacher profession.

Keywords: Teacher mobility; Novice teachers; Teacher education; Teacher attrition; Teacher characteristics

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1. Introduction

All over the world, higher education in general, and teacher education in particular, is largely provided by regional institutions. As students are mobile and have become more so in recent years, policymakers have introduced several financial and non-financial incentives to encourage students to attend higher education institutions within their home region.[4] An argument often used in favor of regional institutions is that locally provided higher education is necessary to supply local businesses with skilled workers and to slow brain drain, see Winters (2020). These supply side arguments are highly relevant for the teacher labor market. Novice teachers are found to have preferences for teacher positions in the region where they grew up or studied, see Reininger (2012) and Boyd et al. (2005, 2013). Thus, regional location of teacher education institutions and policies to stimulate students to enroll in these institutions are believed to help regions to provide a sufficient quantity and quality of teachers.

This paper examines the propensity to have a teaching position in the home region after graduation from teacher education. The analysis is framed at the individual and regional level and exploits rich data from administrative registers in Norway. The data include detailed longitudinal information of teachers' education, academic performance, and jobs in the first part of their working career. We find that several individual characteristics are related to the propensity to work as a teacher in the home region, there are important mobility patterns related to the size of the regions, and regional teacher education is not related to regional recruitment of novice teachers.

The paper relates to the general literature on the geographical mobility of graduates from higher education and how this affects the allocation of human capital and subsequently growth and income across regions. Oggenfuss and Wolter (2019) review the literature and find in their analysis for Switzerland that half of the students studying away from their home region do not return to their home region after graduation. Winters (2020) finds that enrolment in a higher education institution in the birth state substantially increase the likelihood of birth state residence later in life.

Empirical evidence suggests that teacher quality is the most important factor for student learning, see the overview of the literature in Falch and Strøm (2020). Teachers' behavior and choices are therefore of great interest. The present paper relates to the large literature on teacher mobility and sorting in the teacher labor market. Teacher choices and the distribution of teachers across schools is found to depend on wage incentives, school hiring practices, student-teacher ratios, student composition and other factors related to teachers' working conditions. Most of the empirical literature relates to the educational system and data availability from states in USA.[5] This literature on teacher recruitment, retention and attrition is summarized in Hong

[4] Incentives in US states are provided in terms of subsidies to reduce in-state tuition rates for in-state students, merit-based scholarships, location-contingent financial aid, adjustments to the composition of enrollment by residency or by field of study, see Groen (2011) and Winters (2020).

[5] There is less knowledge of the functioning of teacher labor markets in other countries. Studies of recruitment and retention in teacher labor markets in developed countries are reviewed in Ladd (2007). Separate studies of UK teachers include Dolton and van der Klauww (1995), Chevalier et al. (2007) and

(2012), Loeb and Myung (2020) and Goldhaber et al. (2021). The literature documents high rates of attrition among novice teachers, and it seems to be partly related to low student motivation and achievement. Nguyen et al. (2020) provide a meta-analysis of correlates of teacher turnover, while Madigan and Kim (2021) provide a meta-analysis of correlates of teachers' intentions to quit.

An important issue has been the effect of teacher sorting on teacher quality and the fact that schools mostly in need of high-quality teachers struggle with recruiting and retaining teachers. Studies assessing teachers' contribution to student learning find large variation across teachers, but few observable teacher characteristics are able to explain this variation, see the overview of the literature in Falch and Strøm (2020). Some studies from the US have however found some evidence that measured academic ability increase teacher contribution, see Clotfelter et al. (2006) and Goldhaber (2007). Recent cross-country evidence in Hanushek et al. (2019) points in the same direction. Grönqvist and Vlachos (2016), using matched student-teacher Swedish data, find a positive association between student achievement in upper secondary schools and male teacher high school GPA, but no effect for female teacher GPA.

We make several contributions to the literature. First, we explicitly consider both the regional mobility and the early working career when considering whether novice teachers are working as teachers in their home region. We focus on the situation three years after graduation to take into account that mobility decisions and search for job might take some time (Goldhaber et al., 2021). Second, we analyze the impact of a range of individual characteristics, including academic performance from higher education, on the propensity to return to a teaching position in the home region after graduation. We investigate whether measured academic ability differs between those who return to a teacher position in the home region and those who go elsewhere after graduation. Third, we investigate the impact of enrolling in a teacher education program in the home region and regional size in terms of population. The regional dimension is almost absent in the literature on teacher attrition, with Goldhaber et al. (2020) as a notable exception. If graduates from teacher college in the home region is more likely to enter teaching in that region but have lower academic ability than other graduates, a quality-quantity trade off may occur. The rich individual longitudinal register data from Norway, including students' achievements during higher education and other individual and regional characteristics, allow us to examine to what extent measured academic ability differ between graduates returning to their home region and other graduates.

The rest of the paper is organized as follows: Section 2 provides the conceptual framework for the analysis, while section 3 describes the institutional background and data. Section 4 presents the main mobility patterns, while section 5 includes the regression analysis of the propensity to return to the home region after graduation from teacher education programs. Section 6 provides concluding comments.

Allen et al (2018), while studies of Norwegian teacher recruitment and retention include Bonesrønning et al. (2005), Falch and Strøm (2005) and Falch (2011).

2. The framework

The aim of this paper is to assess to what extent graduates from teacher education programs reside and work as teachers in the region where they resided during adolescence. In order to answer this question, it is helpful to provide a simple overview of decisions involved.

Figure 1 presents a simple decision-making three for geographical mobility patterns and working career. The figure distinguishes between the "Home" region and "Other" regions, where "Home" is defined as the region where the individual resided during adolescence and "Other" represents all other regions. The point of departure is a young person that aims for a career as a teacher. The first decision is enrollment in a teacher education institution. The second decision is where to reside and work after graduation, and the third decision is whether to work as a teacher or not after graduation. Clearly, the latter two decision might be interchangeable or might be taken simultaneously. Thus, the presentation in Figure 1 is mainly illustrative. In the empirical analysis, we will mainly rely on "reduced form" models, where we do not take the mobility pattern into account but use the endpoints as the dependent variable.

Our main interest in the present paper is the probability that the graduates work as a teacher and reside in the home region. Figure 1 distinguishes between two routes to this outcome, and the two endpoints of interest are in bold in the figure. The individual can either enroll in an institution in the home region or in another region. For some individuals, the second route is the only option because there is no teacher education institution in the home region.

There are several routes to the alternatives to the outcome of interest of the present paper. One might end up residing outside the home region ("Other"), either by study in the home region and move to another region after graduation or by study at an institution located outside the home region and continue to stay outside the home region after graduation. In addition, one might reside in the home region but not work as a teacher.

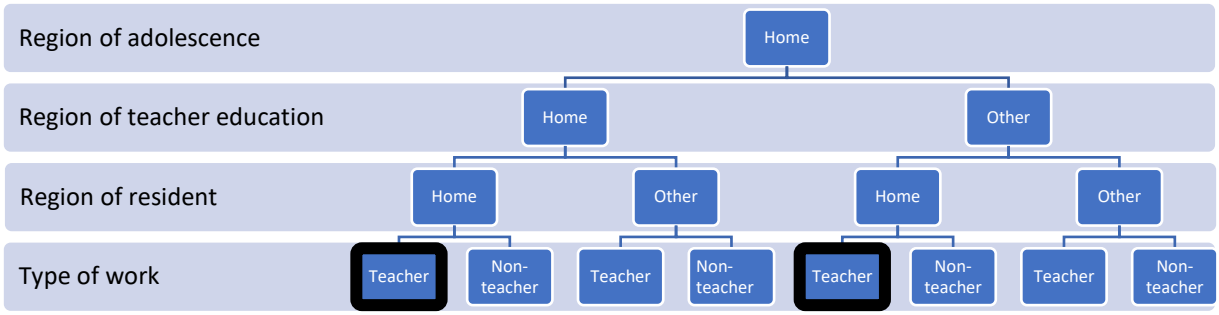

Figure 1. Possible mobility routes.

3. The institutions and the data

3.1. The institutions

We use Norwegian administrative register data, where the available sample consists of all graduates from *teacher education programs* during the period 2003-2010. Teaching certification requires either a teacher college degree or a university degree with a certain amount of course work in pedagogy, didactic and practice studies. In the empirical period, pre-school teacher education for early childhood education and care (ECEC) was a three-year bachelor program, teacher education for compulsory education (grade 1-10) was a four-year bachelor program, while the main education route for secondary education (grade 8-13) was a one-year study in educational theory and practice building on bachelor or master's degrees in relevant disciplines. This one-year program qualifies for teaching both in compulsory lower secondary education (grade 8-10) and non-compulsory upper secondary education (grade 11-13). There exists several other teacher education programs qualifying for teacher positions in secondary schools, in particular for teachers in vocational, practical and esthetic subjects. These teacher education programs qualify the teachers in one or two subjects. In contrast, the teacher education program for compulsory schools qualifies for teaching in all subjects in the empirical period.[6]

There are several *higher education institutions* (HEI) that provides teacher education programs. They vary in size to a large degree. In the empirical period, 22 HEIs graduated teachers to ECEC, 23 HEIs graduated teachers to compulsory schools, and 31 HEIs graduated teachers from at least one of the different teacher education programs that qualify for teaching in secondary education. In total, 37 HEIs had at least one teacher education program. In addition, some individuals receive approved teacher education from abroad. During the period 2003-2010, the largest HEI graduated more than 3,000 teacher candidates (Oslo University College), while the smallest HEIs are some academies of art with less than 30 teacher candidates during the empirical period.

The teachers are employed in *ECEC-institutions and schools*. ECEC expanded in the period 2000 to 2010. The number of children in ECEC increased by almost 50%, and each child spent more time in ECEC.[7] The growth followed a national reform in 2003, which gave families the right to enroll children in ECEC at subsidized prices from about the age of 1½ years. The rise in the capacity in ECEC increased demand for staff, and correspondingly shortages of ECEC teachers. ECEC institutions employ to a large extent "assistants" without teacher education, which are not included in the analysis in the present paper.

Children enroll compulsory education the year they turn 6 years of age. Typically, there are separate schools for primary education (grade 1-7), and larger schools for lower secondary education (grade 8-10). Several primary schools typically feed into larger lower secondary

[6] A reform in 2010 introduced specialization into the teacher education program for compulsory schools, which implied that the teacher graduates were qualified to teach only 3-4 subjects. No graduates from this new education program are included in the sample used in the present paper.

[7] The number of children in ECEC increased from 189,837 in 2000 to 277,139 in 2010 (46% growth) and to 283,608 (49%) in 2015. In addition, the children spent more time in ECEC. The number of children with more than 25 hours per week in ECEC increased from 148,979 in 2000 to 271,134 in 2010 (82%) and to 282,077 (89% growth) in 2015. Source: Statistics Norway, Table 09169.

schools. For many children, the distance from their home to the lower secondary school is longer than to their local primary school. However, there is large variation in the geographical distribution of schools. Some primary and lower secondary schools have different catchment areas, while other schools are combined primary and lower secondary schools and covers all grades 1-10.

Upper secondary education is not compulsory, but about 95% enroll upper secondary education the year they finish compulsory education, typically the year they turn 16 years of age. Youth have the right to enroll into upper secondary education up to the age of 21. In the empirical period there where three different study tracks that qualify for higher education (academic tracks) and 12 different vocational study tracks that give a certificate for work in a broad set of occupations. The academic tracks consist of three years in school, while the vocational study tracks normally consist of two years in school plus two years as apprentice. Which track and school the students actually enroll depends on their achievement in compulsory education. Upper secondary schools offer several study tracks, with only some very few exceptions. They are larger than the lower secondary schools, and some students have to move from their home because of long commuting distance to the nearest upper secondary school.

The municipalities are responsible for ECEC and compulsory education, while the counties are responsible for upper secondary education.[8] They hire teachers and are their formal employer. Enrollment into compulsory schools is based on catchment areas, while the municipalities and the counties decide the admission systems for their ECEC-institutions and upper secondary schools, respectively. In addition, it is possible to choose a private alternative that is highly subsidized, but this is common only for ECEC. In 2010, 47% of the children in ECEC were in private institutions, while the shares of students in private schools in 2010 are 2.6% and 7.3%, respectively.[9]

Wage determination of teachers is highly centralized in *national collective bargaining*, which is common for teachers in most European countries. In Norway, the wage of an individual teacher was completely determined by central wage bargaining up to and including the school year 2000–01. Thereafter the wage growth is determined in national collective bargaining between the teacher unions and the Norwegian Association of Local and Regional Authorities. Some local flexibility in wages and the use of fringe benefits exists, but the room for local variation in other working conditions is very limited.

There are clear *appointment rule*s of teachers in Norway, as discussed in Bonesrønning, Falch, and Strøm (2005), Falch et al. (2009) and Falch (2010). First, the teachers are linked to the schools and not to the local governments. The local governments cannot force teachers in permanent positions to leave a specific school for another school unless in very specific cases, such as the closing of schools or a rare event of huge drop in the number of students. Yearly about 10% of the teachers quit voluntarily for teacher jobs in other schools, other public sector jobs, or to the

[8] There were about 430 municipalities and 19 counties in the empirical period.
[9] Source: Statistics Norway, Table 09169, Table 05232 and Table 05326.

private sector (Falch and Strøm 2005). Teachers are recruited from the same places as well as directly from teacher colleges. Second, the local governments are required by law to appoint the best-qualified applicant to a vacant teacher position. Certified teachers are defined to be better qualified than non-certified teachers. In addition, only certified teachers can be employed on permanent contracts. According to national contracts, representatives of the teacher union participate in the hiring processes.

3.2. The data

This paper is mainly based on two register data sets that are matched using an individual identifier; one register on educational careers and one register on working careers. The two registers are available for this paper for the population of graduates in the period 2001-2014 and the population of workers for the period 2004-2013.

We restrict the sample to individuals graduating from a teacher education program during the period 2001-2010 and follow the graduates during their early working careers.[10] Further, we limit the sample to individuals below 40 years of age at graduation. We expect the search and match process to take some time before preferred job and settlement is revealed. Thus, we focus on the situation three years after graduation. We distinguish between teacher education programs designed for different levels of the educational system; early childhood education and care (ECEC), compulsory schools (grades 1-10) and secondary schools (grades 8-13).

Figure 2 presents the number of observations for each cohort of graduates, separately for the three types of teacher education programs. There is a growth in ECEC-teacher graduates from 2006, three years after the reform increasing availability of ECEC. It seems like the reform increased enrollment in the ECEC teacher education program, reflected in increased number of graduates starting three years later. However, the growth is slow compared to the large increase in the number of children in ECEC. This must be seen in relation to the fact that the number of graduates was on a declining trend up to in 2006 and has been high compared to the other teacher education programs which cover larger age groups of children. Interestingly, the growth in ECEC-teacher candidates from 2006 coincides with a decline in the number of candidates from the teacher education program for compulsory schools. Regarding graduates from the teacher education programs for secondary schools, there has been a growth throughout the period.

The age profile at graduation for the three different types of teacher education programs are presented in Figure 3. The typical progress in the Norwegian education system is to finish upper secondary education the year one turns 19 years of age, then take one year off formal education (military service, Folk high school, travelling, working, etc.), and enrolling higher education the year one turns 20. Thus, it is most common to graduate the three-year ECEC teacher education program at age 23 and the four-year teacher education program for compulsory schools at age 24. For the latter, almost 3,000 students in our sample graduated at age 24. There are also several older students in both programs. About 200-300 candidates graduated during the empirical period for each age group above 33 years of age. The graduation age profile for secondary

[10] See With (2018) for an analysis of recruitment to teacher education.

teachers illustrates some peculiarities. These graduates often have another prior degree, and some labor market experience, before they enroll the one-year study in educational theory and practice. Most institutions offer this program as a part-time study that is designed to be combined with a full-time job.

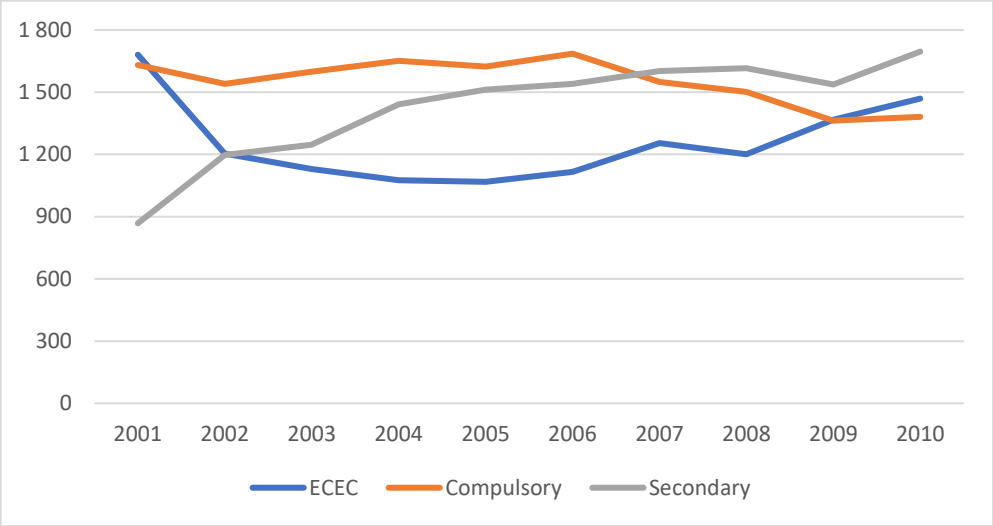

Figure 2. The number of graduates in the three different types of teacher education program

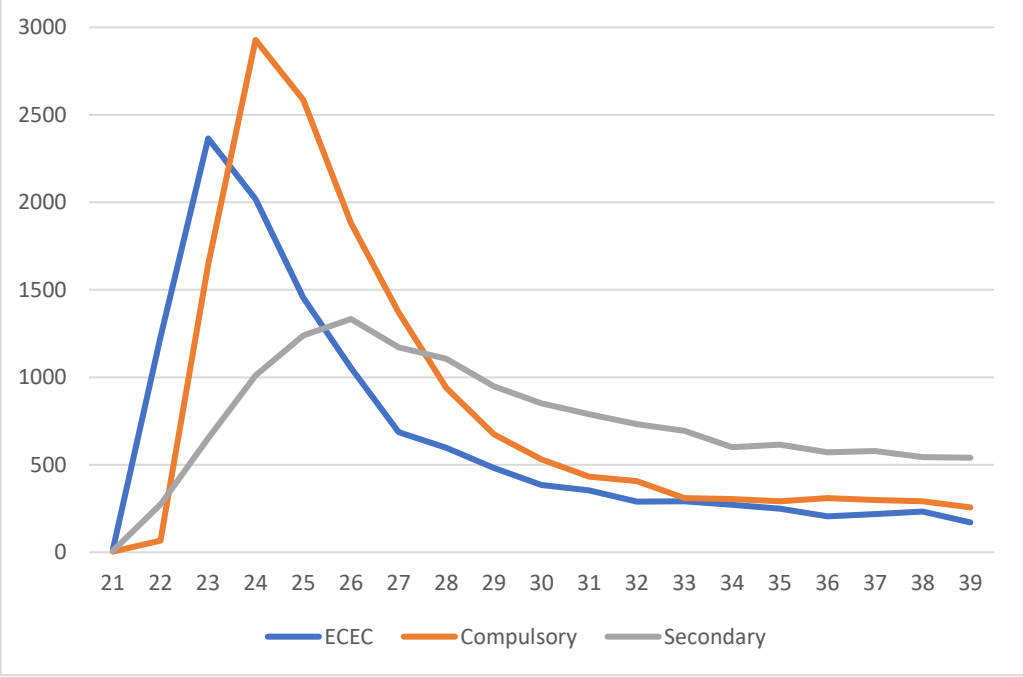

Figure 3. The age at graduation

When analyzing mobility, it is necessary to define relevant geographical regions. The main definition used in this paper is residential and labor market regions defined by The Norwegian Institute for Urban and Regional Research (NIBR) as published in Gundersen and Juvkam (2013). This definition is based on functional regions, relying on commuting time between municipal centers and actual commuting between municipalities. They define 160 residential

and labor market regions. Because the definition relies strongly on possible commuting, and since there are long commuting distances in some parts of the country, several of the regions have a low population. However, in our view, this definition is the most relevant one for the research question on whether teacher graduates return back to their home region to reside and work.

Figure 4 presents the number of observations from each labor market region together with the average population size in the empirical period. The figure to the left clearly illustrates that there are several small regions, and thus few teacher graduates from the region. The Oslo metropolitan area, with population above 1 million and more than 5,000 graduates in the empirical period, stands out as the clearly largest residential and labor market region. The figure to the right cluster the regions in deciles and presents the number of graduates as the share of the population. The smallest regions cover 10% of the sample and is in the first decile, while the Oslo region, including 12.6% of the sample, is the only region in the 10th decile. The fitted line in the figure clearly shows that the number of graduates relative to population is declining in the size of the regions. Small regions have relatively more graduates per inhabitant than the large regions. In the first decile, there are on average 1.41 new graduates per year per thousand inhabitants, while the corresponding number for the three largest decile (decile 8, 9 and 10) is 0.75. The concave relationship between the number of graduates and population size in the figure to the left in Figure 4 represents the same pattern.

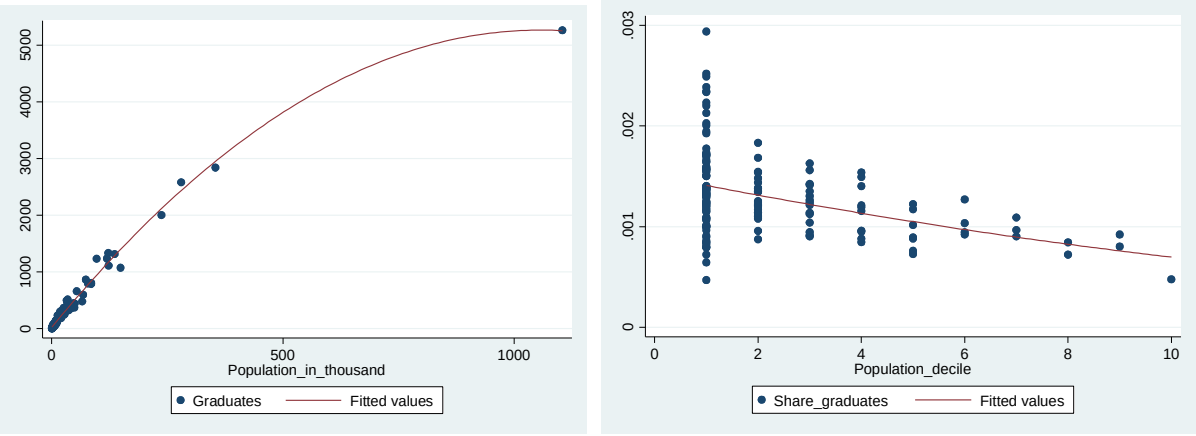

Figure 4. The relationship between the number of graduates and population, home region

Our primary concern is the matching between teacher graduates and teacher positions. We expect some time to search for positions and to obtain a match with an employer before preferred job and settlement is revealed (Goldhaber et al., 2021). The data include information on both the municipality of residence and the municipality of the workplace. Our main dependent variable ("Teach_home") is based on the following conditions:

1. Work or reside in the region in which the individual completed compulsory education at age 16 ("Home").
2. Work in the educational sector ("Teacher").
3. The situation three years after graduation.
4. Regions defined as the residential and labor market region (Gundersen and Juvkam, 2013).

The first condition implies that our dependent variable "Teach_home" includes individuals that work in a neighboring region and resides in the Home region.[11] For the second condition, we include in the category "Teacher" all leadership positions and other than non-teaching positions in relevant organizations for ECEC, primary and secondary education.[12] The third condition implies that we allow some time for search for job and mobility decisions. We relax each of the four conditions in the robustness analysis below, showing that the empirical findings are quite stable across definitions of the dependent variable.

In total, our sample of graduates includes 42,352 individuals. We match them with the register data on worker careers, which includes very detailed information on type of job. Unfortunately, information on type of job is missing for some individuals.[13] Our final sample thus includes 40,882 individuals.

We include some variables from other registers in the regression analyses below. We use the register of students in HEIs to calculate the individuals' grade point average (GPA) in higher education. We calculate the average grade using all exams where the student does not fail, weighted by the number of credits in each course. During 2000-2004, Norway introduced the European system for grading introduced by the Bologna-process. Some institutions introduced the new system before others. This implies that several individuals in our sample have grades from two grading systems. The European grading system is a five-point scale for non-failing results, with an approximate normal distribution. It replaced a more detailed grading system. We convert grades from the old system to the new system by forcing on, within our sample of teacher graduates, the same distribution of grades as in the new system. This conversion makes it possible to calculate individual averages across the two systems. In our sample, 3.2% has all grades from the old system only, 49.4% have all grades from the new system only, 43.6% have grades from both systems, while for 3.7% we do not have any grade information. The latter group consists mainly of graduates from one specific institution only providing ECEC teacher education. In order to estimate unbiased effects of GPA from higher education, the empirical analyses below include dummy variables for grading system, missing information and for each HEI.[14] The latter accounts for, among other factors, potential differences in grading standards between institutions.

In the regression models we include some additional student characteristics, summarized in Table 1. About 75% of the sample are females, 43% has parent(s) with higher education and 1.2% are immigrants. Immigrants are defined by Statistics Norway as both parents are born abroad

[11] This includes 4.7% of the sample.
[12] This includes 3.9% of the sample.
[13] For some observations, the individuals are registered as working without information about the job type. Three years after graduation, which is our focus, this is the situation for 6.9% of the observations. In these cases, we exploit information two years after graduation to reduce attrition in the data. We replace missing information with the situation one year earlier, which reduces the attrition to 3.5%.
[14] Specifically, we include dummy variables for individuals with missing grade information, having at least one grade from the old system and having at least one grade from the new system. The effect of GPA does not, however, depend on whether these dummy variables are included or not.

without having Norwegian citizenship. We will use two variables measured at the regional level, defined by the region in which the individual finished compulsory education at age 16. About 55% of the individuals in the sample grew up in a residential and labor market region that included at least one HEI offering teacher education programs. These graduating institutions are located in 25 of the 160 residential and labor market regions. We will use a logarithmic specification of population size the year of graduation since Figure 4, and Figure 5 below, indicates a concave relationship between the dependent variable ("Teach_home") and population size.

Table 1. Descriptive statistics

	Mean	Standard deviation
Dependent variable: Teach_home	0.495	0.50
GPA from HEI	4.28	0.62
At least one parent has higher education	0.426	0.49
Female	0.746	0.44
Immigrant	0.012	0.11
ECEC teacher graduate	0.295	0.46
Compulsory schooling teacher graduate	0.369	0.48
Secondary schooling teacher graduate	0.335	0.47
Age at graduation	27.9	4.6
Year of graduation	2005.7	2.8
Logarithm of population in home region	11.2	1.6
Teacher education program in home region	0.549	0.50

Note. 40,882 observations

4. The mobility patterns

Table 2 presents the empirical counterparts to the different mobility routes shown in Figure 1. The table uses the same definition of region as above. The upper part of Table 2 presents study region, the middle part present residential region conditional on study region, while the lower part presents occupation conditional on study and residential region. All rows sum to 100%.

First, 29.9% study in their home residential and labor market region. Notice that 45% of the sample are forced to study outside their home region because the home region does not have teacher education (see Table 1), which implies that 25 % of the sample study outside their home region despite location of teacher education in the region.

Second, the middle part of Table 2 shows that the majority of students graduating in their home region also reside and work in their home region three years after graduation. In contrast, among individuals graduating in another region it is about equally usual to reside and work in the home region as in another region. This group consists both of student forced to study outside their home region and students who chooses freely to study outside their home region.

Table 2. The extent of different mobility routes

Region of teacher education							
Home				Other			
29.9%				70.1%			
Region of residence				Region of residence			
Home		Other		Home		Other	
26.3%		3.6%		35.6%		34.5%	
Type of work		Type of work		Type of work		Type of work	
Teacher	Non-teacher	Teacher	Non-teacher	Teacher	Non-teacher	Teacher	Non-teacher
20.8%	5.5%	2.7%	0.9%	28.7%	6.8%	26.4%	8.1%

Note. The number of observations is 42,352 for the two upper parts of the table and 40,882 for the lower part of the table.

Third, the lower part of Table 2 shows that the majority of the sample work as teachers. In all groups in the table, close to four of five graduates work as a teacher three years after graduation. The decision to become a teacher seems unrelated to the decisions of study region and region of residence. For the total sample, 20.8% study, reside and work as a teacher in the home region. This is lower than the amount graduation in the home region (29.9%) because some move to another region (3.6%) and some do not work as a teacher (5.5%). Most individuals study in a region different from their home region (70.1%), and the majority of these students does not have a teacher position in their home region three years after graduation. Nevertheless, a larger fraction of the individuals working as a teacher in their home region has their education outside the home region (28.6% of the total sample) than in their home region (20.8%). These two groups together sum up to the value of the dependent variable Teach_home in Table 1.

Appendix Table A1 presents the same information for two other definitions of regions, a more disaggregated measure (municipality) and a more aggregated measure (county).[15] The table shows that most of the individuals who work as a teacher in their home municipality have their education from another municipality (30.6% vs. 9.4%), while the opposite is the case for home county (21.4% vs. 32.4%). In total, 50%, 62% and 67% work and reside in their home municipality, residential and labor market region and county, respectively.

The share of graduates working as a teacher in the home region (Teach_home) varies across the regions. The left part of Figure 5 presents the distribution. The unit of observation is the region and not the individual, which is the reason why the average of the distribution in the figure is lower (34.5%) than the mean value of the Teach_home at the individual level in Table 1 (49.5%).

[15] Notice that the municipality is the smallest administrative regional level. Municipalities are therefore nested within residential and labor market regions and within counties. This is not the case for the residential and labor market regions. Some of these 160 regions cross boarders of the 19 counties. Regarding municipalities, the number changes over time because of mergers The individuals in the sample were 16 years of age in the years 1978-2004 (born in the period 1962-1988). In total, there are 463 municipalities in the data.

The right part of Figure 5 considers the relationship between region size measured by population and the share of graduates who have a teacher position in their home. The figure clusters the regions in deciles in the same way as in Figure 3. Clearly, Teach_home is lower in small regions than in large regions. The share working as a teacher in the home region is 30.6% in the first decile, including the 90 smallest regions, while it is 62.0% in the three upper deciles, including the four largest regions. The figure shows that the relationship between Teach_home and population size is concave.

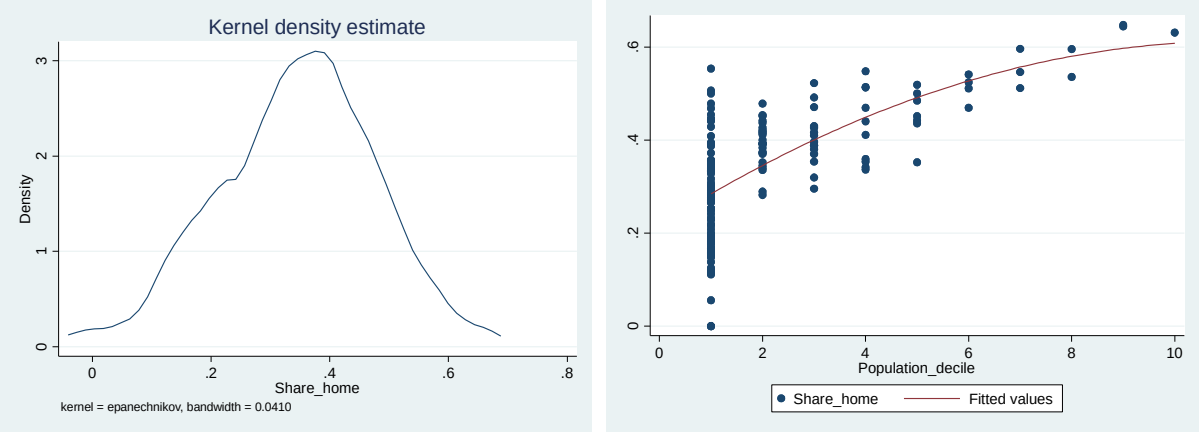

Figure 5. The distribution of residing and working as a teacher in the home region

Figure 6 presents the distribution of the grade point average (GPA) from HEI, separately for individuals working as teachers in the home region (Teach_home) and the other individuals. The distribution of the latter is to the right of the former, which implies that those working as teachers in the home region have somewhat weaker academic ability skills as measured by GPA from higher education.[16] The candidates with high performance in education tends to leave their home region and/or not working as a teacher. We return to this issue in the regression analysis below.

Figure 7 relates the mobility decisions to the three different types of teacher education, gender and parental education. Graduates from the ECEC teacher education program work as a teacher in the home region to a greater extent than graduates from the other types of teacher education, where secondary school teachers stand out with a low share (37.6%). Females move to a smaller extent than males, and high parental education is associated with a lower probability to have a teacher position in the Home region three years after graduation.

[16] The average GPA is equal to 4.23 and 4.33 for individuals working as a teacher in the home region and others, respectively. The difference is equal to 20% of the standard deviation (see Table 1) and is significant at 1% level.

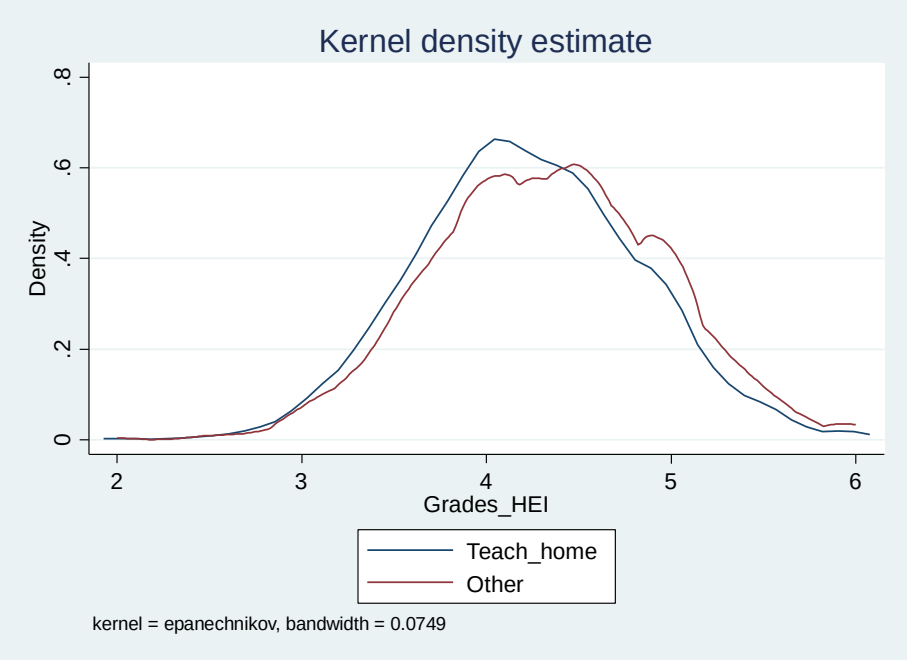

Figure 6. The distribution of GPA from HEI and the mobility decision

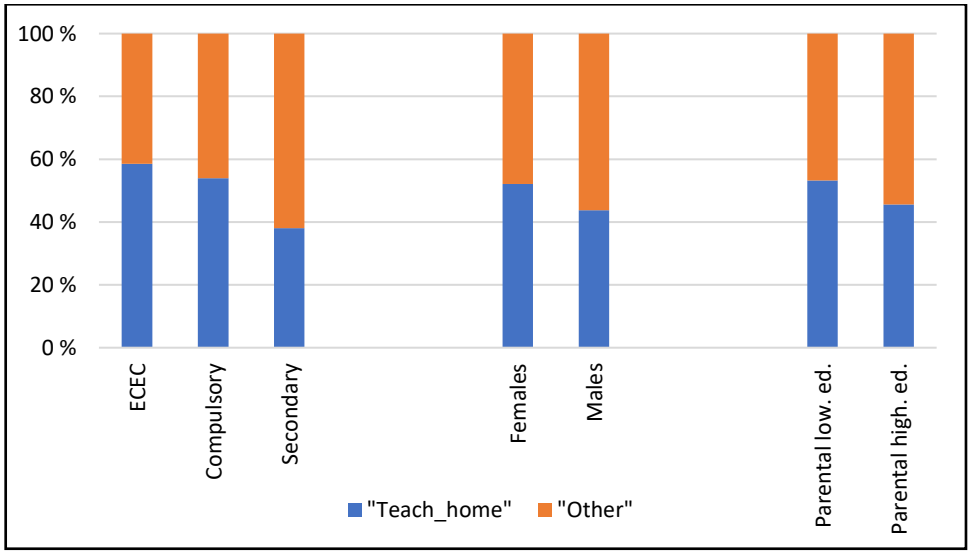

Figure 7. Mobility decisions and characteristics of the graduates

5. The regression analyses

Several of the relevant factors affecting geographical mobility of teacher graduates might be interrelated. For example, the previous section shows that both graduates with high GPA and graduates with parents with higher education are associated with higher propensity to end up in a teacher position outside the home region. It is likely that students with high educated parents also have higher school achievement and thus have higher GPA. In order to assess the separate contributions of the different student characteristics on mobility patterns, we therefore estimate multiple regression models.

We estimate linear probability models by ordinary least squares. The regression models include one observation per individual. The dependent variable in the baseline model is whether the individual work as a teacher in the home region three years after graduation ("Teach_home"). As explanatory variables we include indicator variables for gender, parental education, minority status as well as GPA from higher education. To account for the fact that students in the sample graduated in different years with possibly very different general labor market situations and national educational policies, we include a full set of fixed effects for year of graduation as control variables.[17] In addition, we include a range of control variables to handle complexities in the grading system.[18] We also include the log of the population size of the home region to account for the concave relationship between the dependent variable and population in Figure 5. Finally, in order to assess the effect of geographical proximity to higher education institutions, we include a dummy variable if there is a HEI with teacher education program located in the home region.

First, in sections 5.1 and 5.2, we present results from different reduced form regressions, i.e., models without taking into account whether the individual graduated from a local teacher education program or not. In section 5.3, we go one step further and try to disentangle the effects on the different decisions illustrated in Figure 1.

5.1. Baseline results

The results from the baseline specification are presented in Column (1) in Table 3. Grade point average (GPA) from higher education (HEI) has a negative and significant effect on the probability of working as a teacher in the home region. Increasing the GPA one grade point (for example from C to B, which is an increase of 1.6 standard deviations), reduces the probability by 3.4 percentage points (pp). For the average individual, the probability is reduced from 49.5% to 46.1%, a reduction of 6.9%. The effect is significant at 1% level. This suggests that students with high academic ability have the lowest probability of returning home for work as a teacher, holding other observational characteristics constant. The result is comparable to the finding in the meta study of Nguyen (2020) that teachers with higher scores on university entrance exams have a higher propensity of turnover than other teachers and to the finding in Oggenfuss and Wolter (2019) that top-performing students in general return to their home region less often than others.

[17] The estimated coefficients for the graduation year are typically insignificant from each other and are not reported in the tables below.

[18] We include three set of control variables in order to handle the complexities and changes in the grading system in higher education. The control variables are not of interest of its own and they are thus not presented in the tables below. First, in order to keep in the sample the 3.7% of the observations where grades are missing, we force on the mean value of GPA for these individuals and include an indicator variable for missing grade information in the model. The coefficient of the indicator variable is to be interpreted as whether these individuals on average have a different mobility behavior than those with observed average grades. Second, we include an indicator variable for whether at least one grade from the old grading system is included in the calculation of GPA and an indicator variable for whether at least one grade from the new system is included in the calculation of GPA, including 46.7% and 93.0% of the sample, respectively. Third, the model includes a full set of fixed effects (FE) for the graduating institutions since the grading practice might vary across institutions. The FE will for each institution capture all relevant time invariant aspects with respect to the outcome. Leaving the three sets of control variables out of the model in column (1) in Table 3 increases the effect of the average grade from -0.034 to -0.041.

Second, there is a negative effect of parental education. Having at least one parent with higher education reduces the probability of working as a teacher in the home region by 6.2 pp. This is a strong effect which is significant at 1% level. Third, the effect of being female is 4.1 pp and highly significant. Fourth, the effect of being immigrant is negative at 4.5 pp, but imprecisely estimated (statistically insignificant) due to few immigrants in our sample.

Taking these results at face value, males with GPA from HEI one standard deviation above average and parents with higher education are 13.7 pp less likely to work as a teacher in the home region than females with parents without higher education and average GPA. This is a major difference of 28% of the average probability to work as a teacher in the home region. This is an interesting pattern as shortages of teachers with high academic ability and males are regarded as a problem in many schools. Below we return to the question of whether graduates move away from the home region or end up in non-teaching occupations.

Further, while the probability to work as a teacher in the home region is about the same for graduates for ECEC and compulsory schooling, graduates from teacher education programs for secondary schooling are about 15 pp less likely to work as a teacher in the home region. Age at graduation seems unrelated to mobility.

As expected, population size is a strong predictor for the probability to work as a teacher in the home region. Doubling the population size increases the probability by 7.7 pp, and increasing the population size by one standard deviation increases the probability by 12.3 pp. Graduates living in large regions during adolescence tend to take teacher positions in the home region to a large degree, while graduates from small regions, which typically are rural areas, tend to leave their home region for work. In this sense there is a "brain drain" to the cities. One hypothesis is that localization of teacher education programs in the home region would reduce this kind of "brain drain". However, our finding is that the effect of having a HEI with teacher education program in the region is small (1.5 pp) and insignificant. Moreover, since most rural areas struggle with teacher shortages, lack of vacant teacher positions are also unlikely to be the explanation for this pattern. Thus, other features than the geographical structure of HEIs and teacher demand seem likely explanations of the mobility of teacher graduates to larger regions and cities. The analysis in this paper is not able to investigate more closely to what extent this pattern is due to school and work related factors or more general centralizing forces.[19]

The large effect of population size in the home region may possibly reflect many other characteristics of the home region. To account for all observed and unobserved time-invariant characteristics of the home region that might affect mobility, the model in column (2) includes a full set of home region fixed effects. A consequence is that we are not able to identify effects of variables that changes slowly over time, as population size and the HEI-structure. However, it is interesting to note that this more flexible model formulation gives very similar estimates for the individual characteristics.

[19] See Carlgren and Klette (2008) for a discussion of teacher's working conditions.

Table 3. Main results. The dependent variable is Teach_home

	(1)	(2)
GPA from HEI	-0.034***	-0.033***
	(0.004)	(0.004)
At least one parent has higher education	-0.062***	-0.060***
	(0.006)	(0.005)
Female	0.041***	0.041***
	(0.007)	(0.007)
Immigrant	-0.045	-0.047
	(0.034)	(0.037)
Compulsory schooling teacher graduate	-0.016*	-0.015*
	(0.009)	(0.009)
Secondary schooling teacher graduate	-0.152***	-0.153***
	(0.014)	(0.015)
Age at graduation	0.002	0.002
	(0.001)	(0.001)
Logarithm of population in home region	0.077***	-
	(0.009)	
Teacher education program in home region	0.015	-
	(0.017)	
Year of graduation FE	Yes	Yes
Controls for complexities in HEI grades	Yes	Yes
Regional fixed effects	No	Yes
Observations	40,882	40,882
R-squared	0.104	0.114

Note. Robust standard errors in parentheses, clustered at the regional level. *** p<0.01, ** p<0.05, * p<0.1.

5.2. Robustness analyses

Table 4 presents results for different specifications of the dependent variable. We relax all the three criterions described in Section 3. The main message from Table 4 is that the effects of key student and regional characteristics are qualitatively independent of the particular specification of the dependent variable, but with some interesting nuances.

Column (1) of Table 4 replicate the main specification in Table 3 for reasons of comparability. Columns (2) and (3) use variants with different definitions of the home region. We use counties and municipalities as the definition of regions, respectively. Columns (4) and (5) use variants of the second criterion for the main specification. We do not correct for residential region when it differs from the working region, and we use the situation one year after graduation instead of three years after graduation. So far, we have restricted the dependent variable to be defined as being in a teacher position in the home region after graduation. The last column relaxes this restriction by defining the outcome to cover graduates that work or reside in the home region, independent of type of work. The last two rows report the mean value of each dependent variable and the correlation with that in the baseline specification. The dependent variables in the two last definitions have the lowest correlation with the dependent variable in the baseline specification.

The effects of GPA, parental education and being immigrant are remarkably stable across the specifications. The effect of being female is lower the first year after graduation (column 5), which indicates that the gender differences in mobility increases over time. The estimated effect of having teacher education for secondary schooling is much lower when we do not take type of occupation into account (column 6).

Regarding variables measured at the regional level, the estimated effect of population size is largest when we use the counties as the regional level and smallest when we use the municipalities as the regional level. Interestingly, the location of a HEI in the region has a positive effect of 5.6 pp when we only look at mobility and do not take type of job into account (column 6). The probability for teacher graduates to work or reside in the home region, independent of occupation, is higher when there is a teacher education program in the region.

Table 4. Variation in the definition of the dependent variable

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable compared to baseline in Table 1 and 3	Baseline	Region: County	Region: Municipality	Not correction for residence	Using first year after graduation	Not taking type of job into account
GPA from HEI	-0.034***	-0.030***	-0.029***	-0.029***	-0.034***	-0.035***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
At least one parent has higher education	-0.062***	-0.063***	-0.056***	-0.059***	-0.057***	-0.064***
	(0.006)	(0.010)	(0.006)	(0.005)	(0.006)	(0.006)
Female	0.041***	0.046***	0.030***	0.045***	0.021**	0.036***
	(0.007)	(0.006)	(0.006)	(0.007)	(0.009)	(0.008)
Immigrant	-0.045	-0.034	-0.035	-0.040	-0.043	-0.046
	(0.034)	(0.039)	(0.031)	(0.030)	(0.030)	(0.040)
Compulsory schooling teacher graduate	-0.016*	-0.017	-0.007	-0.013	-0.016	-0.030***
	(0.009)	(0.011)	(0.008)	(0.009)	(0.018)	(0.008)
Secondary schooling teacher graduate	-0.152***	-0.168***	-0.122***	-0.162***	-0.164***	-0.063***
	(0.014)	(0.017)	(0.011)	(0.014)	(0.018)	(0.011)
Age at graduation	0.002	0.003**	0.001	0.004***	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Logarithm of population in home region	0.077***	0.121***	0.069***	0.088***	0.069***	0.088***
	(0.009)	(0.029)	(0.005)	(0.009)	(0.008)	(0.009)
Teacher education program in home region	0.015	-0.0004	0.015	0.016	0.020	0.056***
	(0.017)	(0.025)	(0.015)	(0.017)	(0.017)	(0.019)
Year of graduation FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls for complexities in grades	Yes	Yes	Yes	Yes	Yes	Yes
Observations	40,882	40,882	40,882	40,882	33,360	42,352
R-squared	0.104	0.080	0.078	0.122	0.097	0.125
Mean of dependent variable	0.495	0.537	0.396	0.449	0.506	0.619
Correlation coeff. dependent var. and baseline dependent var.	1	0.84	0.82	0.91	0.68	0.78

Note. Robust standard errors in parentheses, clustered at the regional level. *** p<0.01, ** p<0.05, * p<0.1

5.3. Disentangling different mobility routes.

So far, we have analyzed the net effect of student characteristics on the probability to end up in a job or teacher position in the in the home region, i.e., "reduced form" effects. Our aim in this

section is to disentangle the effects of these characteristics on the decisions behind this outcome. We analyze the three types of decisions illustrated in Figure 1.

Column (1) in Table 5 considers the decision to graduate from a HEI in the home region or not, i.e., the first decision in Figure 1. We exclude GPA from HEI in this regression because it is revealed after the enrollment decision. The estimated coefficients of the individual characteristics are in most cases smaller than for the decision on where to work, as found in the reduced form models above. While individuals with parents with higher education are associated with a lower probability to graduate from a local HEI, the effect is clearly smaller than the total "reduced form" effect (estimate of 2.4 pp vs. 6.2 pp). In addition, there are clear differences between types of teacher education, and older graduates use the local HEI to a greater extent than younger graduates. The relationship with population size is insignificant, but there is naturally a strong positive association between graduating from a local HEI and having a HEI with teacher education in the home region. The estimated effect of 48 pp is close to the average share choosing a local HEI when it exists. At first sight, this might indicate that having local HEI is important for recruitment of qualified teachers. However, as shown in the reduced form regressions above, this does not turn out to be the case. The reason is the second and third decisions in Figure 1, the choice of residing in the home region or not and having a teacher job or not.

Column (2) in Table 5 considers the second decision in Figure 1. Thus, we investigate to what extent a teacher graduate return to the home region, conditional on having graduated from a HEI in the home region. We do so by including in the model an indicator of whether the individual graduated from a HEI in the home region, i.e., the dependent variable in column (1). The model is otherwise equal to the baseline model. Column (3) in Table 5 considers the third decision in Figure 2, whether the individual have a teacher job or not in the home region. We do so by including in the model an indicator for the second decision in the model, i.e., the dependent variable in column (2).

As expected, graduating from a home region HEI is naturally strongly related to residing in the home region. The probability increases by 36 pp. Likewise, working as a teacher in the home region is naturally strongly related to residing in the home region.

The interesting parts of Table 5 are the impacts of the individual characteristics included in the baseline model. In these models, the effects of the individual characteristics must be interpreted as conditional on the previous decisions represented in Figure 1. For example, while the estimated effect of having parents with higher education is small and insignificant on the choice of graduating from a HEI in the home region, it is -5.6 pp on the decision to reside in the home region (column 2), and -1.1 pp on the decision to work as a teacher (column 3). Thus, the baseline reduced form result is mainly driven by the choice of residence region.[20]

[20] The total effect, which is the "reduced form" effect in the baseline model in column (1) in Table 3, can be calculated from the results in Table 5. The impact of a variable on previous decisions must be weighted by the impact of that particular decision. For example, the impact of parental education on the choice of residential region is equal to the impact on the first decision (-0.015) times the impact of the first decision

The effects of GPA in HEI, gender and parental education estimated in the baseline "reduced form" relationships are mainly driven by choice of residence after graduation. Graduates obtaining high grades and males appear more likely to move away from their home region than others. Regarding the size of the region, the "reduced form" relationship also seems to be driven by the choice of residence and not the choice of HEI or the choice of being a teacher or not.

Table 5. The three different decisions in Figure 1

	(1)	(2)	(3)
Dependent variable	Graduated from HEI in the home region	Residing in the home region	Working as a teacher in the home region
GPA from HEI	-	-0.029***	-0.008***
		(0.005)	(0.003)
At least one parent has higher education	-0.015	-0.056***	-0.011***
	(0.009)	(0.007)	(0.004)
Female	0.015	0.031***	0.012***
	(0.011)	(0.008)	(0.003)
Immigrant	0.042	-0.061	-0.010
	(0.051)	(0.038)	(0.014)
Compulsory schooling teacher graduate	-0.045***	-0.016**	0.007
	(0.014)	(0.007)	(0.005)
Secondary schooling teacher graduate	-0.126***	-0.025**	-0.103***
	(0.038)	(0.011)	(0.008)
Age at graduation	0.005***	-0.001	0.001***
	(0.001)	(0.001)	(0.0003)
Logarithm of population in home region	0.031**	0.079***	0.006**
	(0.013)	(0.006)	(0.003)
Teacher education program in home region	0.477***	-0.114***	-0.027***
	(0.062)	(0.025)	(0.007)
Graduated from HEI in home region	-	0.355***	-
		(0.031)	
Reside in the home region	-	-	0.789***
			(0.005)
Year of graduation FE	Yes	Yes	Yes
Controls for complexities in HEI grades	No	Yes	Yes
Observations	42,352	42,352	40,882
R-squared	0.369	0.190	0.617

Note. Robust standard errors in parentheses, clustered at the regional level. *** p<0.01, ** p<0.05, * p<0.1.

The effect of living in a region with a HEI during adolescence on the probability to reside in the home region after graduation is *negative* and statistically significant in column (2) in Table 5. Put differently: When deciding where to reside after graduation, more graduates end up outside the home region when there is a local HEI, given graduation from a local HEI. When graduating

on the second decision (-0.015*0.355=-0.005) plus the direct estimate on the second decision (-0.056), i.e., -0.005-0.056==0.061. Likewise, the effect on the outcome working as a teacher and residing in the home region is equal to the impact on the second decision (-0.061) times the impact of the second decision on the third decision (-0.061*0.789=-0.048) plus the direct estimate on the third decision (-0.011), i.e., -0.048-0.011=-0.059. This is not exactly the same estimate as in the "reduced form" in column (1) in Table 3 (-0.062) because there are some stochastics in the models.

from an institution not located in the home region, more individuals move back home for a teacher position when a local HEI does not exist. A local HEI automatically provides candidates from the home region who want to work in the home region. Whether this gives better recruitment in the home region depends on the behavior of those forced to study away from home because no local HEI exist. The results in Table 5 implies that these two effects are positive. A larger share of the graduates resides in the home region when there is a HEI in the home region, similar to the finding in column (6) in Table 4. However, this effect is offset by the estimate on the propensity to be a teacher in the last column in Table 5.[21] One concern might be that these findings may reflect the fact that the regions with and without HEI are of very different sizes. However, this does not seem to be the case.[22]

Overall, the results indicate that the probability for graduates with teacher education in their home region to work as a teacher depends mostly on the choice of residence after graduation.

6. Concluding comments

This paper has examined the propensity for students to return to a teaching position in the home region after graduation from teacher education using Norwegian register data. Several interesting findings stand out. First, there are significant differences related to individual characteristics. On average, those returning to a teacher position in the home region tend to have lower academic ability, measured by their GPA from higher education. Female students and students who have parents without higher education are also associated with a higher probability to end up as teachers in their home region. These groups are less geographical mobile than others, and they also appear to have a higher probability to enter teacher positions after graduation than others. Males with high GPA from teacher education programs and higher educated parents are less likely to end up in teacher positions in the home region. They appear to be more mobile and exhibit characteristics that make them attractive both in the teacher labor market in general and in alternative occupations.

Second, teacher mobility patterns are related to home region size. We find evidence of a kind of "brain drain" that teacher graduates move from small and rural regions to populous regions. The propensity to reside in the home region has a strong positive association with population size. Third, having a higher education institution in the home region does not appear to increase the probability to enter teacher positions in the home region after graduation. This is a warning to those arguing that establishing a very decentralized structure of teacher education institutions

[21] It follows from the results in column (1) and (2) in Table 5 that the effect of having a HEI in the home region on the probability in the home region is equal to 0.055. This is equal to the direct estimate in column (6) in Table 4. However, the finding in column (3) in Table 5 is that the probability to work as a teacher is lower for graduates from regions with teacher education. The total "reduced form" effect is close to zero (0.789*0.055-0.027=0.016) and the baseline result in column (1) in Table 3.

[22] For example, we have estimated models excluding the students from the five largest regions with teacher education (Oslo, Bergen, Trondheim, Stavanger and Drammen). This reduces the share of students having a HEI in their home region from 55% to 33%. The effect in the "reduced form" is still close to zero (changes from 0.015 to -0.006), and the effect on choice of resident in column (2) in Table 5 is somewhat reduced, from -0.114 to -0.086. These results are available from the authors on request.

would reduce shortages of teachers in rural areas. It does not seem to increase the possibilities to recruit high quality teachers.

The evidence in this paper indicates that regions with teacher recruitment problems should try to make teacher positions more attractive to graduates. The type of novice teachers often believed to be underrepresented in schools seems to have limited attachment to their home region, and more likely to leave teacher professions than others. The localization of higher education institutions with teacher education programs does not seem to matter much. In particular, scattered populated areas seems to recruit a small share of teacher graduates living in the region during adolescence. There is a tendency for graduates from these areas to move to more populous regions.

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Appendix Table A1. The extent of different mobility routes for different definitions of region

	Region of teacher education	
Definition of region	Home	Other
Municipality	15.2%	84.8%
Residential and labor market region	29.9%	70.1%
County	45.3%	54.7%

	Region of residence		Region of residence	
	Home	Other	Home	Other
Municipality	12.1%	3.0%	37.7%	47.1%
Residential and labor market region	26.3%	3.6%	35.6%	34.5%
County	39.8%	5.5%	27.2%	27.6%

	Type of work		Type of work		Type of work		Type of work	
	Teacher	Non-teacher	Teacher	Non-teacher	Teacher	Non-teacher	Teacher	Non-teacher
Municipality	9.4%	2.7%	2.4%	0.6%	30.6%	7.1%	36.2%	10.9%
Residential and labor market region	20.8%	5.5%	2.7%	0.9%	28.7%	6.8%	26.4%	8.1%
County	32.4%	7.5%	4.3%	1.2%	21.4%	5.7%	20.6%	7.0%

Note. The number of observations is 42,352 for the two upper parts of the table and 40,882 for the lower part of the table.