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Staying or leaving?
– The effects of regional universities on educational choices and rural depopulation

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Abstract

Making higher education more available by establishing regional universities might limit the depopulation of rural areas. However, individuals with a higher education are more likely to migrate after their studies. Consequently, the effect of regional universities on the rural population is uncertain. We explored this issue in a quasi-experiment arising due to a sudden reduction in the number of student places at a regional university in northern Sweden, in 1998. Using a difference-in-difference approach, we found that the reduction in student places affected educational choices and individuals' long-term propensity to migrate. We also found that women and men responded differently. Women chose a more distant university and were more likely to migrate from their rural home region, while men chose not to study and their likelihood of migration was unaffected. Whereas education in general increases depopulation, individuals studying closer to home is less likely to leave rural areas.

Keywords: [Rural population, migration, education, Sweden, quasi-experiment]

JEL classifications: [I23: I:25: R23]

1. Introduction

Rural regions are often characterized by decreasing populations, low levels of human capital, and slow economic growth. In Sweden, the process of depopulation in rural areas have been driven by migration of young adults: 86% of Swedish municipalities had fewer 25-year-olds in 2012 than they had 18-year-olds seven years earlier (Mellander, 2013). Migration in this age group is often related to education choices. The process of young adults moving away for higher education has been ongoing since the expansion of higher education started in the late 1970s with the formation of several new universities

across Sweden. However, the number of students admitted to higher education only began to take off in the 1990s, following a reform in 1993 that led to rapid expansion in student intake. The number of first-time students nearly doubled during the 1990s, growing from about 150,000 to about 300,000. This expansion mainly occurred at regional universities and was, in part, an attempt to increase rural human capital level, as it was believed that lowering the cost of investing in higher education for young adults in rural regions would potentially make it easier to stay, live, and work locally (Andersson, Quigley, & Wilhelmsson, 2009). However, individuals with tertiary education are known to be more mobile than individuals with only secondary education (see e.g., Ehrenberg & Smith, 2009; Faggian, McCann, & Sheppard, 2007; Haapanen & Böckerman, 2017; Malamud & Wozniak, 2012) and tend to reside in urban areas (Ahlin, Andersson, & Thulin, 2014; Lindley & Machin, 2014; Moretti, 2013). Investments in education in rural areas may therefore increase migration by young people, while studying at a local rather than a more distant university might increase their propensity to stay in a rural region. Consequently, the effect of regional universities on rural human capital is uncertain.

The main contribution of this study is that it explored a quasi-experiment that developed due to a sudden reduction in the number of student places at a rural university, Mid Sweden University, in northern Sweden. A difference-in-difference approach was used to compare potential students living within commuting distance to Mid Sweden University with potential students living closer to another northern university, before and after the change in student places, and to assess whether the decrease in student numbers admitted to the Mid Sweden University affected individuals' long-term propensity to leave their rural home region.

This analysis of the quasi-experiment contributes to a casual understanding of how education affects within-country migration, by accounting for overall changes in educational attainment and migration patterns. Generally, unobservables drive selection into higher education (Cunha, Heckman, Lochner, & Masterov, 2006; Heckman, 2007) and are also likely to affect individuals' propensity to move (Haapanen & Böckerman, 2017). Studies that enable casual inference are scarce and the results

are mixed. However, findings in recent studies suggest that the causal impact of education on within-country migration is economically significant (Haapanen & Böckerman, 2017; Machin, Salvanes, & Pelkonen, 2012; Malamud & Wozniak, 2012).

The literature on education and within-country migration generally focuses on *overall effects* of higher education on the probability of migration and not *heterogeneous effects* across those studying in their home regions and those studying away from home. However, related literature focusing on determinants of migration patterns in individuals *with* higher education suggests that it is important to distinguish between individuals studying in their home region and those moving away to study, because the attachment of the two groups to the region in which they study is likely to differ (Faggian, et al., 2007; Haapanen & Tervo, 2012). Therefore, overall effects are likely to disguise important heterogeneity in the relationship between tertiary education and migration. Individuals who study close to home still live relatively close to family and friends, commuting from the home region to study is possible and it is generally easier to maintain the attachment to the home region. In contrast, individuals studying at a more distant university may become less attached to their home region on entering university, as they attach to the new study region and its labor market (Haapanen & Karhunen, 2017). Moreover, for individuals who have moved in the past the probability of repeated migration is high (see, e.g., DaVanzo, 1983; Dustmann, 2003).

To gain a better understanding of the heterogeneity across individuals, i.e., individuals studying in their home region and individuals studying away from home, we assessed how the decrease in the number of students admitted to Mid Sweden University affected individuals living in the region. We estimated the probability of migrating and the probability of attaining tertiary education, either at the regional university or at another more distant university in Sweden. Hence, we investigated the propensity to leave a rural area following a sudden change in the probability of accessing a university education. We also investigated whether the probability of having a university education was affected

by fewer individuals entering a university or by more individuals leaving for a more distant university as student places at the regional alternative decreased.

This study uses detailed longitudinal register micro-data. The dataset comprised all secondary graduates in Sweden. We selected those who graduated during the Swedish expansion of tertiary education in the period 1993-2003 and assessed their education and migration 10-20 years after secondary graduation (year 2013). The dataset available also included several background variables that enabled us to account for ability proxies (i.e., grades from primary education) and family background (i.e., parental education, income, etc.).

2. Conceptual framework and previous literature

Despite the ongoing debate on causality, it is well-established, both theoretically and empirically, that education is positively correlated with within-country migration (see e.g., Ehrenberg & Smith, 2009). Economic theory describes individuals' choice of education and migration as human capital investments (Becker, 1964; Bodenhöfer, 1967; Sjaastad, 1962). Individuals decide to invest if their expected future benefits from education or migration exceed the costs. The correlation is positive because earnings differentials between regions mean that those with higher education can get a higher wage if they move region (i.e., a higher benefit from moving) and larger cities and regions often have higher wages (i.e., the urban wage premium; see e.g., Glaeser and Mare (2001); Yankow (2006)). Previous research shows that more highly educated people tend to live in large cities (Ahlin, et al., 2014; Lindley & Machin, 2014; Moretti, 2013), and that the pay gap between larger and smaller cities is increasing (Baum-Snow & Pavan, 2013; Davis & Dingel, 2012; Lindley & Machin, 2014).

Besides higher wages, larger cities and urban regions generally offer attractive labor markets with a multitude of employers and greater opportunities to network with other highly educated people, as well as a larger number of jobs that require a high skill level (Détang-Dessendre, Goffette-Nagot, & Piguet, 2008; Glaeser, Kolko, & Saiz, 2001; Glaeser & Mare, 2001). These merits of urban areas contribute to the positive correlation between education and migration, as a higher level of

education may open up new job opportunities in cities. For example, Behrens and Robert-Nicoud (2015) studied the benefits of agglomeration and showed that the proportion of university-educated residents increases with the size of a region. The geographical concentration of highly skilled jobs has increased over time, while less skilled, routine jobs are generally overrepresented in rural areas (Florida, Mellander, Stolarick, & Ross, 2012). Furthermore, education increases an individual's ability to search for and process information, and therefore highly educated individuals may have better access to information about job prospects and living conditions in other regions, and consequently lower costs of moving. Findings by Malamud and Wozniak (2012) suggest that college graduates in the U.S. become more mobile because their careers require it and because they gain a larger network and better knowledge of other labor markets, rather than because of an income premium from moving.

The positive correlation between education and migration found in previous studies does not necessarily imply a causal relationship, given that education and migration decisions are co-determined by unobserved factors such as personality traits and parental values. Selection into higher education might be caused by inherent abilities and attributes that also enable migration. Some people are more open to new experiences than others or they possess a greater ability to accumulate and process information that makes them more likely to attend a university or pursue other opportunities away from home. Moreover, individuals' discount rates might differ: individuals with lower discount rates are more likely to choose higher education and to migrate because the costs of these investments are paid at once, while the benefits are realized in the future.

Studies that enable casual inference are still scarce and the results are mixed: Haapanen and Böckerman (2017), using Finnish data on higher education, and Machin, et al. (2012), using Norwegian data on primary education, explored the effects of educational policy reforms. They found that increased education enhances migration. For example, the results from Finland show that, for graduates with a Bachelor's degree from a polytechnic, the probability of migration is 7.5 (13.7) percentage points higher during a three-year (six-year) follow-up period than for vocational college

graduates without a degree. Malamud and Wozniak (2012), using draft-avoidance behavior in the U.S. during the Vietnam War, found similar results. However, McHenry (2013) detected a negative effect on migration of additional schooling due to a change in compulsory schooling laws in the U.S.

The positive correlation between education and migration is likely to differ depending on where an individual chooses to study, i.e., at a local university or farther away from home (Faggian, et al., 2007; Haapanen & Tervo, 2012). Moving away (regardless of whether the purpose is to work or study) carries a cost of moving, both in monetary terms and in non-monetary terms related to increased distance to family and friends. Increased distance to a university can be assumed to decrease attendance, because the costs of the human capital investment and insecurities about future returns increase with distance to a university. This assumption has been confirmed empirically (Frenette, 2004, 2009; Kjellström & Regnér, 1999; Oppedisano, 2011; Spiess & Wrohlich, 2010; Öckert, 2012), with the strongest correlation between university attendance and distance to a university being reported for distance to the *closest* university (Frenette, 2004; Spiess & Wrohlich, 2010).

3. The Swedish setting and Mid Sweden University

In Sweden, higher education provides free tuition and generous student grants and loans are available for all students. Therefore, the cost of education is primarily the living costs and the social cost of greater distance to family and friends. Thus, if a student either lives with their parents or stays in the rural region close to family and friends, and where housing costs are low, the investment cost of education is lower than for students who have to move to an urban region to study.

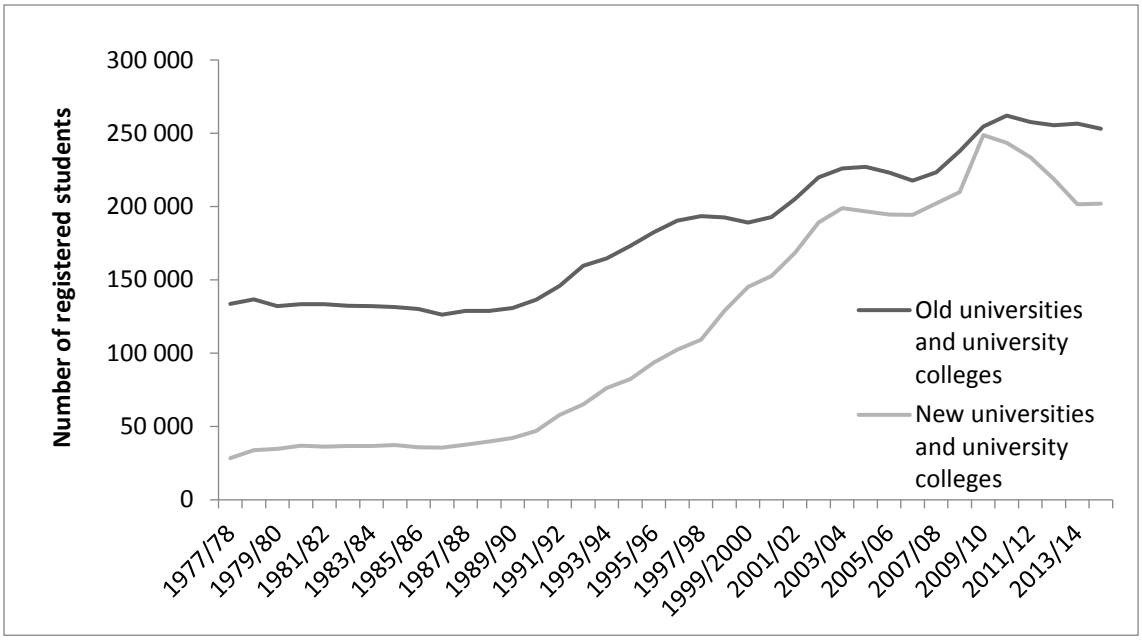

Figure 1. Number of registered students in higher education in Sweden, 1977/78-2014/15.
Source: Own calculations based on SCB data on students enrolled 1977/78-2014/15 by university/university college and sex. Old universities are defined as 11 universities and university colleges that existed before the expansion of higher education in 1977. New universities and university colleges are defined as universities or university colleges that were founded after 1977 (art colleges, providers of psychotherapy education, providers of municipal and regional education (mainly healthcare training) and other private providers of higher education are not included).

Sweden has around 50 universities, university colleges, and smaller specialist providers of higher education.[1] As Figure 1 shows, the number of admissions expanded dramatically during the 1990s, especially in regions that had no or only a few student places before the expansion. The proportion of Swedish young people attending university education increased dramatically during this period (Holzer, 2007; Kjellström & Regnér, 1999; Öckert, 2012). However, the number of students admitted to Mid Sweden University showed a different trend than that at other northern universities and the rest of Sweden (Figure 2). Mid Sweden University is located in Östersund and Sundsvall, and also had

[1]The difference between universities and university colleges is that only universities are generally authorized to issue degrees at postgraduate level, while university colleges must apply for permits in specific areas. We use the term 'university' to encompass all providers of tertiary education.

a campus in Härnösand during the study period. The other northern universities are Umeå University and Luleå University of Technology with campuses in Umeå, Luleå, and Skellefteå (Figure 3).

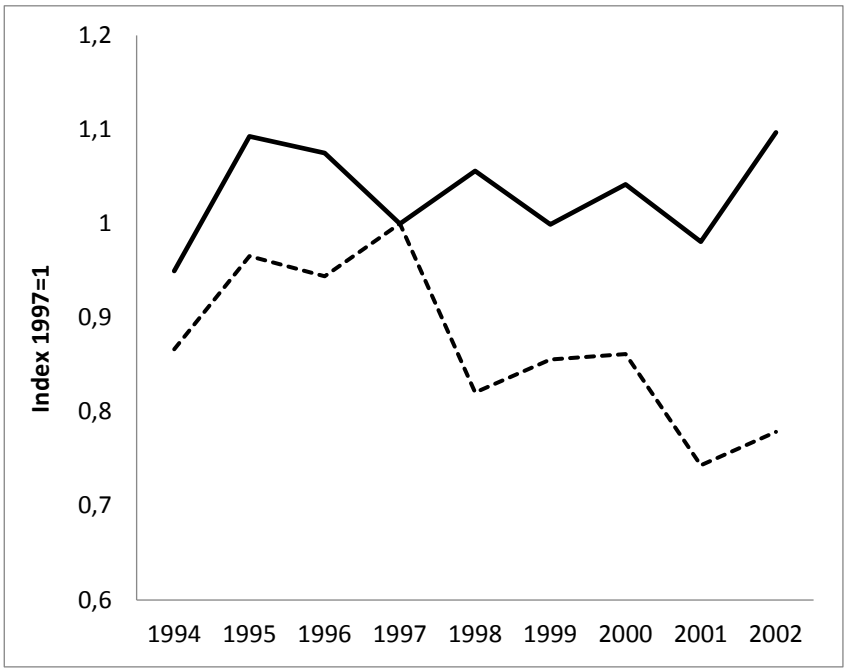

Figure 2. Change in the number of first-year students at Mid Sweden University (dotted line) and at Umeå University and Luleå University of Technology (solid line). 1997 is the reference year.

In 1998, Mid Sweden University actively worked to slow down the expansion of student places, as it had more students registered than covered by its public funding.[2] This ambition resulted in a decrease in the number of first-year students in 1998 compared with 1997 and in a decrease in the total number of students registered for the first time since Mid Sweden University was founded in 1993 (Mid Sweden Univeristy, 1998). Thus in autumn 1998, 11 068 students were registered, which was 933 fewer than in autumn 1997 As Figure 2 shows, the decrease in the number of student places at Mid Sweden University resulted in a smaller number of first-year students registered in 1998-2002 than in the preceding period 1994-1997, while the number remained stable at the other northern

[2]During 1993-1996 there was large overproduction in the Swedish higher education system (Swedish National Agency for Higher Education, 1997).

universities.[3] However, the trend in mean annual labor earnings of the working age population across the municipalities of these two regions was similar over the period (see Figure A1 in Appendix A).

4. Data

The data used were obtained from Statistics Sweden. Information on all students finishing secondary education was taken from the Register of Secondary Education, information about tertiary education from the Register of Higher Education, and data on municipality of residence and individual characteristics from the Longitudinal Integration Database for Health Insurance and Labor Market Studies (LISA) for the period 1990-2013. Data from the Multigenerational Register were used to link individuals to their parents, while the Population and Housing Census provided data on parental education and income during childhood.

Location of residence is the municipality where an individual is registered. Statistics Sweden groups Sweden's 290 municipalities into labor market (LM) regions (n=71 in 2003) based on commuting patterns and neighboring municipalities.[4] We used the LM regions of Östersund and Sundsvall, which comprise all municipalities (n=9) within commuting distance of Mid Sweden University, to define treatment municipalities (i.e., the region of origin for the treatment group), shown as the darker grey area in Figure 3. As controls, we used all municipalities (n=12) within commuting distance of Umeå University and Luleå University of technology located in the LM regions of Luleå, Skellefteå, and Umeå (i.e., the region of origin for the control group), shown as the lighter grey area in Figure 3.

[3]We would have preferred to use information on the number of university places available to potential students rather than the number of first-year students, but this was not possible because of lack of data.
[4]First the commuting independent municipalities (center municipalities) were determined, and then the remaining municipalities were connected to any of the commuting-independent municipalities.

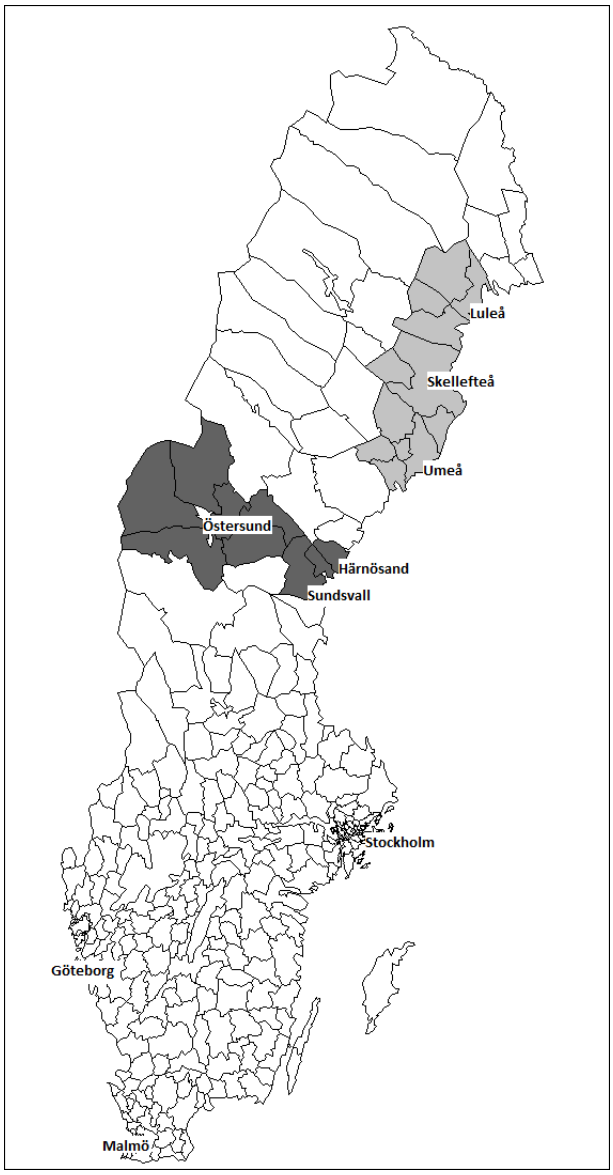

Figure 3. Map of Swedish municipalities showing the three largest cities (Stockholm, Gothenburg and Malmö), treated (dark grey) and control municipalities (light grey), and cities with a university campus in the treated (Östersund, Härnösand and Sundsvall) and control (Luleå, Skellefteå and Umeå) municipalities.

We focused on individuals born in 1972-1984 who were living in Sweden in 2013.[5] These cohorts graduated from secondary education in 1993-2003[6], during the Swedish expansion of higher education. The size of these cohorts was relatively constant during the period (in Sweden in general as well as in the two regions studied) and therefore the competition for higher education places did not

[5]2,759 individuals were not in the data in 2013 because they had either died or left the country.
[6]Among the upper secondary graduates in 1993-2003, we dropped 0.14% of the individuals (those born in 1970-71 and 1985-1984). The excluded individuals are a select group because they completed secondary school either very late or very early and the majority of their respective cohorts are not represented in the data.

change as a consequence merely of changes in cohort size.[7] We assigned individuals to the treatment region (nine municipalities with 23,065 individuals) or the control region (12 municipalities with 40,035 individuals) based on the municipality of residence at the time of graduation from secondary education.

4.1 Dependent variables

Measuring outcomes in 2013 (the last year available), we defined *migration* based on the region of residence of an individual when he or she graduated from secondary education and the municipality of residence in 2013. An individual was defined as having migrated from a region (i.e., treatment or control municipality) if the municipality of residence when graduating was not in the same region as the municipality of residence in 2013 (dummy variable=1 if migrated). Hence, we considered long-term and long-distance migration flows from the LM regions, while short-distance moves between neighboring municipalities within regions were disregarded. If we had included within-LM migration in the variable capturing the migration outcome, we would mainly have captured the move to the university city, a move that is directly related to the educational investment decision and not necessarily a move as an effect *of* the increase in educational attainment.

We defined *tertiary education* as completion of at least one course at a university (dummy variable=1 if tertiary education). Individuals with tertiary education were divided into two groups depending on where they had conducted the majority of their studies. The first group included those who studied at their *regional university*, which Mid Sweden University was for the treatment group and Umeå University or Luleå University of technology for the control group. The second group

[7]In 1997-2002, only those with complete secondary grades are listed in the Register of Secondary Education. In 1993-1996 and 2003, individuals who lack secondary grades in one or more subject(s) are included as well. To test whether the results were sensitive to this change, we repeated the main analysis excluding the individuals with the lowest grades (results not reported). This test confirmed the robustness of the results.

included those who had studied at a more *distant university* in Sweden, i.e. not at their regional university.[8] Later, we consider an alternative definitions of tertiary education.

4.2 Control variables

The control variables were related either to background characteristics of the individuals or to conditions in the municipality where the individual lived when finishing secondary education. The individual's background characteristics were measured, at the latest, in the year when they completed secondary education, so that potential endogenous variables did not affect the estimation results (i.e., the consequences of migration or tertiary education were not mixed up with the causes of migration or tertiary education). Control variables capturing individual and family characteristics are shown in Table 1.

Table 1. Descriptive statistics on background characteristics of the individuals

	Women			Men		
	Treated municipalities	Controls municipalities	p-value	Treated municipalities	Controls municipalities	p-value
Year of birth	1978.601	1978.785	0.000	1978.486	1978.614	0.001
Mean standardized grades (primary education)	0.181	0.263	0.000	-0.274	-0.200	0.000
Missing data on grades	0.006	0.005	0.771	0.007	0.006	0.199
First-generation immigrant	0.032	0.037	0.036	0.032	0.036	0.073
Second-generation immigrant	0.011	0.014	0.011	0.009	0.013	0.000
Age if migrating	6.369	6.112	0.243	6.604	6.944	0.354
Mother						
Year of birth	1949.048	1950.171	0.058	1946.909	1947.422	0.603
Years of education	11.4	11.579	0.000	11.484	11.624	0.000
Log(earnings)	6.632	6.619	0.258	6.615	6.612	0.800
Missing data on education	0.014	0.014	0.790	0.016	0.015	0.815
Father						
Year of birth	1933.93	1934.079	0.939	1934.006	1932.882	0.571
Years of education	11.084	11.316	0.000	11.134	11.372	0.000
Log(earnings)	7.098	7.128	0.019	7.091	7.118	0.042
Missing data on education	0.023	0.021	0.472	0.022	0.024	0.419
Number of observations	11,403	20,193		11,662	19,842	

Note: T-tests were used to assess mean differences in the covariates between the groups.

[8]Individuals who studied via online courses or distance education are included based on the university providing the education.

As Table 1 shows, there were some differences in background characteristics between residents of the Mid Sweden University region and residents of the control region. These differences were small for year of birth, immigration, parental years of education and parental earnings. Mean grades from primary education, which were standardized[9] to account for a change in the grading system in 1997 (as discussed later when assessing the robustness of the results), were less than 0.1 standard deviation higher in the control region, while by comparison the gender gap in primary grades was four-fold larger.

5. Empirical strategy

Using a difference-in-difference approach that compared individuals in the Mid Sweden University region with individuals in the control group before and after 1998, we investigated whether the reduction in student places at Mid Sweden University affected individuals living in the region, their choice of tertiary education (up until 2013), and migration (residence in 2013). The difference-in-difference specification was:

$$y_{imt} = \theta_m + \lambda_t + \gamma Treatment_{mt} + \beta X_{imt} + \varepsilon_{imt} \quad (1)$$

where y_{imt} is the dichotomous outcomes for individual *i* in municipality *m* and cohort *t*, θ_m and λ_t are fixed effects, X_{imt} is a vector of control variables, and ε_{imt} is an idiosyncratic error term. We controlled for two sets of fixed effects: municipality fixed effects, θ_m, which included all the municipality differences that were constant over time, such as differences in primary and secondary education and local labor market differences; and fixed effects, λ_t, of the cohorts leaving secondary education in year *t*, accounting for fluctuations in education and migration that are common to individuals in both the treatment group and the control group, i.e., each cohort is affected differently by cyclical fluctuations in the economy depending on the year of graduation from secondary education (Saks & Wozniak, 2011;

[9]The variable was standardized to have mean 0 and standard deviation 1.

Venhorst, Van Dijk, & Van Wissen, 2011). The vector of control variables, X_{imt} (see Table 1), captured individual characteristics and family background, which are known to affect both education and migration (Haapanen & Tervo, 2012; Nivalainen, 2004). It included an indicator for year of birth, immigration status (own status, parents' status, and year of immigration if immigrated), and mean standardized grades from primary education and a polynomial of the grades to account for non-linearity. Additionally, for parents, it included year of birth, education (years completed), and earnings (logarithmic form).

The coefficient of interest was γ on the treatment indicator, $Treatment_{mt}$, which is an interaction between the treatment municipalities (i.e., the Mid Sweden University region that is a subset of θ_m) and the cohorts graduating from secondary education in the period 1998-2003 (which is a subset of λ_t). This coefficient captured the relative effect of the reduction in student places at Mid Sweden University on outcomes for residents of the Mid Sweden University region compared with the associated change in outcomes for people in the control region, where there was no such reduction in admissions.

The first outcome was *the propensity to study at the regional university*. We started with this outcome to assess whether the reduction in student places at Mid Sweden University indeed reduced attendance as expected. We then continued with *the propensity to study at a distant university, the propensity to have a tertiary education* (irrespective of where one studies), and *the propensity to migrate*. These models were estimated by ordinary least squares.[10]

Because we cannot know what would have happened in the Mid Sweden University region if the reduction in admissions had not happened, we relied on the control group to assess the counterfactual development for students studying at their regional university. For the difference-in-differences approach to be valid, we needed to ensure that the parallel trend assumption held, i.e., that the trends in the propensities to study and migrate were similar before treatment. Therefore, before analyzing

[10]Results using probit models produced similar results (available on request).

the results, we investigated the trend in the propensity to study at the regional university in treated and control regions in the pre-treatment period by visually comparing the development at Mid Sweden University before 1998 with the corresponding development at the control universities. Formally, we modelled these trends by interacting the treatment municipality dummy with the cohort dummies and regressed them on the likelihood of having studied at the regional university.[11]

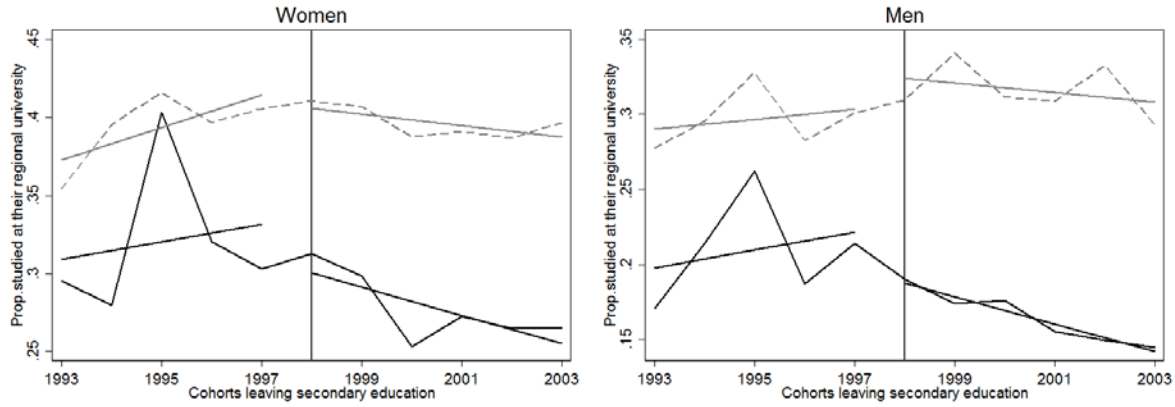

Figure 4. Proportion of women and men who studied at their regional university for each cohort finishing secondary education among the treated (black solid line, with black solid trend lines) and the control (grey dotted line, with grey solid trend lines) regions.

This allowed us to reasonably verify the parallel trend assumption underlying the difference-in-difference approach. A plot of the proportion of women and men who studied at their regional university for each cohort finishing secondary education during the study period clearly illustrated common trends before 1998 (apart from a larger spike at 1995 for women in the treatment group[12]) and a gradual decline at Mid Sweden University after 1997 (Figure 4). This gradual decline is reasonable given that young people in Sweden often take a few years out after secondary education before continuing to tertiary education (Statistics Sweden, 2016). Hence, the decision to reduce the number of student places most likely affected potential new students gradually. Formally, the interaction terms

[11]The model specification also included municipality fixed effects and the main effects of the interactions.
[12]The peak in 1995 was due to a change in the Swedish education system which meant that 1995 was the last cohort that included individuals with a two-year vocational secondary education. To be accepted at a university after a two-year vocational programme, supplementary studies were generally required (Broady, Andersson, Börjesson, Gustafsson, Hultqvist, & Palme, 2000).

of the pre-treatment period were all non-significant (apart from the 1995 cohort for women) when using the cohort of 1997 as reference, confirming the parallel trend assumption (results available on request).

Moreover, as Figure 4 shows, there was a small decrease in the control trends after 1997. However, this decrease was small and was probably due to increased competition for student places at the control universities (Umeå University and Luleå University). As the number of student places at the control universities was constant (see Figure 2) and the number of places at the (nearby) treatment university decreased, some young people in the labor market area of the control universities were most likely outcompeted from their regional university.

6. Results

6.1 Mid Sweden University

The estimation results for the treatment indicator, mean grades from primary education, and parental background variables are presented in Table 2 for men and Table 3 for women. Column (1) in both tables shows the probability of studying at the regional university, column (2) the probability of having tertiary education, column (3) the probability of studying at a distant university, and column (4) the probability of migrating out of the region.

Table 2. Estimated treatment effects for men

	(1) Regional university	(2) Tertiary education	(3) Distant university	(4) Migration
Treatment	-0.0435***	-0.0321***	0.0113	0.0115
	(0.00933)	(0.00960)	(0.00957)	(0.0105)
Mean grades (primary education)	0.110***	0.252***	0.143***	0.126***
	(0.00298)	(0.00245)	(0.00301)	(0.00323)
Mean grades^2	-0.0128***	-0.00226	0.0105***	0.0151***
	(0.00179)	(0.00178)	(0.00173)	(0.00200)
Mean grades missing	-0.0529*	-0.107***	-0.0544	0.0282
	(0.0312)	(0.0357)	(0.0342)	(0.0367)
Father				
Year of birth	-0.0000127	-0.0000178	-0.00000501	0.0000227

	(0.0000187)	(0.0000195)	(0.0000188)	(0.0000209)
Log(earnings)	-0.00343	0.00121	0.00464*	-0.00435
	(0.00288)	(0.00286)	(0.00281)	(0.00319)
Education (years)	0.00404***	0.0177***	0.0137***	0.0144***
	(0.000946)	(0.000914)	(0.000940)	(0.00103)
Education missing	0.0334	0.235***	0.201***	0.230***
	(0.0244)	(0.0253)	(0.0239)	(0.0273)
Mother				
Year of birth	0.0000121	0.00000113	-0.0000110	-0.0000476
	(0.0000321)	(0.0000351)	(0.0000325)	(0.0000346)
Log(earnings)	-0.000471	0.00601**	0.00648**	0.00666**
	(0.00288)	(0.00300)	(0.00294)	(0.00329)
Education (years)	0.00227**	0.0177***	0.0154***	0.0131***
	(0.00110)	(0.00107)	(0.00109)	(0.00119)
Education missing	-0.0264	0.210***	0.237***	0.234***
	(0.0243)	(0.0278)	(0.0278)	(0.0301)
Year of birth & immigration status	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes
N	31504	31504	31504	31504
R2	0.146	0.337	0.166	0.129

*Robust standard errors in parentheses. *p<0.10, **p<0.05, ***p<0.01.*

Table 3. Estimated treatment effects for women

	(1) Regional university	(2) Tertiary education	(3) Distant university	(4) Migration
Treatment	-0.0342***	-0.0108	0.0234**	0.0257**
	(0.0107)	(0.00931)	(0.0104)	(0.0110)
Mean grades (primary education)	0.0995***	0.232***	0.133***	0.106***
	(0.00292)	(0.00281)	(0.00271)	(0.00306)
Mean grades^2	-0.0352***	-0.0408***	-0.00561***	0.0104***
	(0.00227)	(0.00221)	(0.00209)	(0.00229)
Mean grades missing	-0.0790**	-0.00949	0.0695*	0.0976**
	(0.0347)	(0.0341)	(0.0377)	(0.0398)
Father				
Year of birth	0.0000195	0.0000379**	0.0000185	0.0000505**
	(0.0000194)	(0.0000185)	(0.0000195)	(0.0000215)
Log(earnings)	-0.00468	-0.000103	0.00458	-0.00152
	(0.00328)	(0.00288)	(0.00322)	(0.00347)
Education (years)	-0.00324***	0.0107***	0.0140***	0.0125***
	(0.00103)	(0.000850)	(0.00102)	(0.00107)

Education missing	-0.0661** (0.0261)	0.132*** (0.0248)	0.198*** (0.0259)	0.184*** (0.0277)
Mother				
Year of birth	0.0000941** (0.0000472)	0.0000468 (0.0000571)	-0.0000473 (0.0000515)	-0.0000339 (0.0000573)
Log(earnings)	-0.00245 (0.00328)	0.00724** (0.00309)	0.00970*** (0.00319)	0.00513 (0.00354)
Education (years)	-0.000385 (0.00121)	0.0151*** (0.00100)	0.0155*** (0.00118)	0.0131*** (0.00125)
Education missing	0.0319 (0.0299)	0.197*** (0.0269)	0.165*** (0.0291)	0.166*** (0.0310)
Year of birth & immigration status	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes
N	31596	31596	31596	31596
R2	0.108	0.267	0.142	0.102

Robust standard errors in parentheses. * *p < 0.10,* ** *p < 0.05,* *** *p < 0.01.*

The results for the probability of studying at the regional university (column 1) showed that the reduction in admissions reduced attendance at Mid Sweden University for potential students in the treatment group. Hence, the treatment indicator appeared to capture a decreased likelihood of studying at Mid Sweden University as intended. The decreased number of student places lowered the likelihood of having a university education from the regional university, by 4.35 percentage points for men and 3.42 percentage points for women. The likelihood of having a tertiary education, irrespective of where the student chose to study (column 2), was 3.21 percentage points lower for men in the treatment group compared with men in the control group, while the likelihood of having studied at a distant university (column 3) appeared to be unaffected (coefficient 0.0113; p>0.10). These findings imply that young men who would have chosen Mid Sweden University before the decrease in admissions no longer attended a university after the number of student places was decreased. For women, the likelihood of having a tertiary education was not affected (coefficient -0.0108; p>0.10) but the likelihood of having studied at a distant university was 2.34 percentage points higher than for women in the control group. These results suggest that women who would previously have chosen to

study at Mid Sweden University choose to study at a more distant university due to the change at Mid Sweden University.

Next, we examined whether these changes in education due to the reduction in the number of local student places affected individuals' willingness to move (column 4). We found that women in the treatment group had a 2.57 percentage points higher likelihood of migrating compared with women in the control group, whereas the likelihood of migration appeared to be unaffected for men (coefficient 0.0115; $p>0.10$). Given that women attended tertiary education to the same extent as before the reduction, they may have become more likely to move elsewhere to study because of the limited number of local student places. However, while fewer men attended university when the local alternative became less available, this did not necessarily mean that their migration decreased, as the overall decreased probability of having a tertiary education (which probably decreases migration) may have been counteracted by a positive (but non-significant) impact on the probability of having studied at a distant university (potentially increasing migration). We return to this potential heterogeneity in Section 6.2.

6.2 Sensitivity analysis and additional results

The results in Tables 2 and 3 were robust to the inclusion of parental background factors and grades from primary education. On excluding these variables (results shown in Appendix B), the qualitative interpretation of the estimated coefficients remained, with only some changes in size across specifications. This robustness to the inclusion of grades is reassuring. A key identification assumption of the difference-in-difference model was that there were no other shocks to outcomes over the period for residents of the Mid Sweden University region relative to residents of the control region *coinciding* with the reduction in admissions at Mid Sweden University. In 1997 (the year before the reduction) the Swedish grading system changed from a relative system of ranking students to a goal- and results-driven system with fixed knowledge levels in each subject. However, there is no obvious reason why the change in grading system would have systematically affected the treatment and the control

municipalities differently. Moreover, only three cohorts graduated from primary education after the change in grading system. These cohorts could enter university at the earliest in 2001-2003, when they finished secondary education, i.e., after the change at Mid Sweden University.

To test the robustness of the results to the chosen definitions of tertiary education, we repeated the main analysis with tertiary education defined as having studied three or more years (corresponding to a Bachelor's degree). The results, which are shown in Table 4 (in columns (1)-(3) for women and columns (4)-(6) for men), were in line with the main results. However, because the variation in the outcome variable was smaller, it was more difficult to detect significant differences between the groups. Still, the estimates for men studying at a regional university remained significant ($p<0.01$).

Table 4. Estimated treatment effects with tertiary education defined as having studied three or more years for women (columns (1)-(3)) and men (columns (4)-(6))

	Women			Men		
	(1) Regional university 3+	(2) Tertiary education 3+	(3) Distant university 3+	(4) Regional university 3+	(5) Tertiary education 3+	(6) Distant university 3+
Treatment	-0.0161	-0.00273	0.0134	-0.0263***	-0.0126	0.0136
	(0.00994)	(0.0102)	(0.00977)	(0.00793)	(0.00944)	(0.00862)
N	31596	31596	31596	31504	31504	31504
R2	0.113	0.246	0.148	0.149	0.308	0.174

*Notes: Primary grades, parental background, year of birth, immigration status, cohort fixed effects, and municipality fixed effects controlled for. Robust standard errors in parentheses. *p<0.10, **p<0.05, ***p<0.01.*

To assess whether the results generated from the downturn at Mid Sweden University enable a valid generalization to *all* potential students across rural Sweden (i.e., if distant university studies, in general, is a stronger predictor of migration than university studies nearby), Table 5 (column (1) for women and column (2) for men) show correlations between the likelihood of having migrated and having studied at either a regional or a distant university. The sample was extended to cover all rural areas in Sweden[13] and all variables were defined as in the previous analysis except migration, which was re-defined as having moved away from the municipality of origin (rather than from the region of origin as in the previous analysis). Using a linear probability model with the same set of controls as in

[13]Sweden have 290 municipalities that the Swedish Board of Agriculture has classified as either urban or rural given the municipality's population density, commuting patterns and the share of day and night population.

the previous analysis, this analysis compared individuals with a tertiary education to individuals with a secondary education as their highest level of education. The findings, showing heterogeneity in the relationship between tertiary education and migration dependent on where one have studied, supported the interpretation of the main results. That is, they indicated that individuals who studied at a regional university were less likely to move away from their region of origin later in life compared with those who studied at a distant university. A similar finding based on a sample of individuals with a higher education in Finland was reported in Haapanen and Tervo (2012).

Table 5. Probability of women and men having moved from their municipality of origin

	Women (1) Migration	Men (2) Migration
Regional university	0.00490	0.177***
	(0.00443)	(0.00491)
Distant university	0.181***	0.290***
	(0.00328)	(0.00321)
Observations	130898	139374
R2	0.120	0.167

*Notes: Compulsory grades, parental background, year of birth, immigration status, cohort fixed effects, and municipality fixed effects controlled for. Robust standard errors in parentheses. *p<0.10, **p<0.05, ***p<0.01.*

The heterogeneity among those studying closer to or farther away from home was, in relative terms, particularly evident for women. This was in line with our main analysis in section 6.1. Women who studied at their regional university appeared no different than women without a tertiary education (coefficient 0.00490; p>0.10), whereas women who studied at a distant university had a 18.1 percentage points higher likelihood of migration. The corresponding difference between men with and without a tertiary education was 17.7 percentage points for studies at the regional university and 29.0 percentage points for studies at a more distant university. In contrast to a previous study by Faggian, et al. (2007) using U.K. graduates, our results indicated a stronger relationship between tertiary education and migration for men than for women, as the estimated correlations were higher for men.

7. Conclusions

Previous studies that enabled casual inference of the relationship between education and migration are scarce and the results are mixed. This study contributes by taking a rural perspective and exploring a quasi-experiment arising due to a sudden change in the number of students admitted to a rural university, Mid Sweden University, in northern Sweden. The results showed that the reduction in student admissions to the local university affected individuals' educational decisions and long-term propensity to move away. To study closer to home appeared to make individuals from rural areas more likely to stay in their home region after their studies compared with students who moved farther away from home to attend university. Additionally, women and men appeared to respond differently when the local alternative became less available. Women chose a more distant university and were more likely to have moved away from their region of origin later in life, while men chose not to study and their likelihood of moving away remained unaffected.

Thus, this study confirmed that the spatial heterogeneity in the educational effect on migration is not entirely caused by selection. That is, university studies at a distant university was shown to have a larger impact on migration than university studies nearby, especially for women. Researchers and policymakers should recognize this heterogeneity, to better understand how university education affects migration from rural areas. Rather than focusing merely on educational choices as such, it appears to be important to also consider the choice of location in higher education. In addition, decisions about expanding or contracting regional universities could potentially affect the gender composition of the rural population, as there appear to be different migration effects of women and men.

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Appendix A

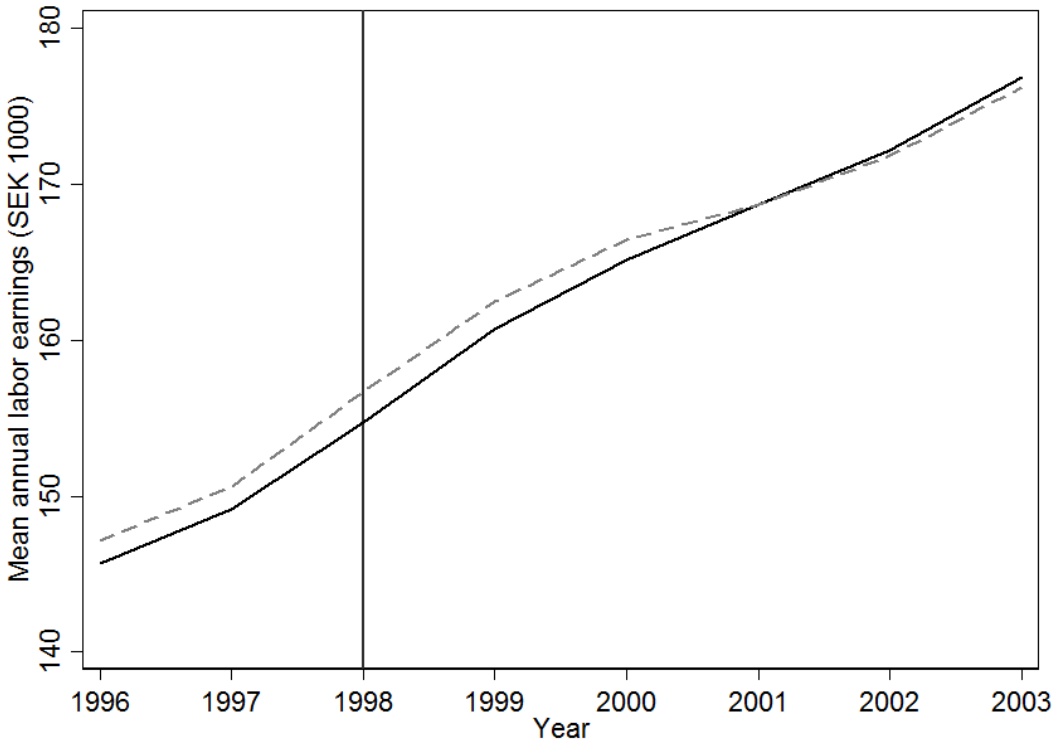

Figure A1. Mean annual labor earnings of an average member of the working age population from the municipalities of the Mid Sweden University region (black solid line) and Umeå University and Luleå University of Technology region (grey dotted line). Own calculations based on municipality-level data from Statistics Sweden.

Appendix B

Table B1. Estimated treatment effects for men, alternative specifications

	(1) Regional university	(2) Regional university	(3) Tertiary education	(4) Tertiary education	(5) Distant university	(6) Distant university	(7) Migration	(8) Migration
Treatment	-0.0491***	-0.0483***	-0.0478***	-0.0454***	0.00123	0.00288	0.00155	0.00359
	(0.00953)	(0.00951)	(0.0114)	(0.0108)	(0.0105)	(0.0101)	(0.0111)	(0.0108)
Father								
Year of birth		-0.0000286		-0.0000499**		-0.0000214		0.00000892
		(0.0000193)		(0.0000213)		(0.0000191)		(0.0000211)
Log(earnings)		0.000879		0.0106***		0.00968***		-0.000334
		(0.00298)		(0.00333)		(0.00297)		(0.00328)
Education (years)		0.0107***		0.0324***		0.0217***		0.0214***
		(0.000951)		(0.00101)		(0.000957)		(0.00103)
Education missing		0.108***		0.404***		0.296***		0.315***
		(0.0245)		(0.0279)		(0.0253)		(0.0280)
Mother								
Year of birth		0.00000301		-0.0000138		-0.0000168		-0.0000618*
		(0.0000335)		(0.0000399)		(0.0000334)		(0.0000342)
Log(earnings)		-0.00319		-0.000198		0.00299		0.00306
		(0.00296)		(0.00340)		(0.00307)		(0.00337)
Education (years)		0.0107***		0.0362***		0.0255***		0.0219***
		(0.00110)		(0.00118)		(0.00110)		(0.00119)
Education missing		0.0769***		0.433***		0.356***		0.340***
		(0.0250)		(0.0310)		(0.0287)		(0.0308)
Year of birth & immigration status	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	31504	31504	31504	31504	31504	31504	31504	31504
R2	0.0816	0.0933	0.0521	0.147	0.0372	0.0947	0.0403	0.0821

Robust standard errors in parentheses. $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

Table B2. Estimated treatment effects for women, alternative specifications

	(1) Regional university	(2) Regional university	(3) Tertiary education	(4) Tertiary education	(5) Distant university	(6) Distant university	(7) Migration	(8) Migration
Treatment	-0.0292***	-0.0295***	-0.00274	-0.000390	0.0265**	0.0291***	0.0278**	0.0299***
	(0.0108)	(0.0108)	(0.0107)	(0.0103)	(0.0111)	(0.0108)	(0.0114)	(0.0112)
Father								
Year of birth		0.00000816		0.00000913		0.000000972		0.0000359*
		(0.0000198)		(0.0000205)		(0.0000203)		(0.0000218)
Log(earnings)		-0.00130		0.00771**		0.00901***		0.00207
		(0.00333)		(0.00325)		(0.00337)		(0.00358)
Education (years)		0.000427		0.0202***		0.0197***		0.0174***
		(0.00104)		(0.000929)		(0.00103)		(0.00108)
Education missing		-0.0367		0.213***		0.250***		0.229***
		(0.0261)		(0.0274)		(0.0272)		(0.0284)
Mother								
Year of birth		0.000112**		0.0000702		-0.0000415		-0.0000341
		(0.0000458)		(0.0000598)		(0.0000557)		(0.0000568)
Log(earnings)		-0.00350		0.00358		0.00708**		0.00277
		(0.00334)		(0.00347)		(0.00335)		(0.00355)
Education (years)		0.00541***		0.0304***		0.0249***		0.0212***
		(0.00119)		(0.00108)		(0.00118)		(0.00124)
Education missing		0.0990***		0.381***		0.282***		0.268***
		(0.0302)		(0.0303)		(0.0302)		(0.0312)
Year of birth & immigration status	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cohort fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	31596	31596	31596	31596	31596	31596	31596	31596
R2	0.0765	0.0776	0.0355	0.0972	0.0436	0.0892	0.0365	0.0673

*Robust standard errors in parentheses. *p<0.10, **p<0.05, ***p<0.01.*