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The effect of education on migration: evidence from school reform

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**The effect of education on migration:
Evidence from school reform^{*}**

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Abstract. The polytechnic education reform took place in Finland in the 1990s. It gradually transformed former vocational colleges into polytechnics and expanded higher education to all Finnish regions. The polytechnics constituted a new non-university sector in higher education. We first explore the impact of the reform on the migration of graduating high school students, followed by an investigation of school-to-work migration. We implement instrumental variables estimators that exploit the exogenous variation in the local availability of polytechnic education together with matriculation exam scores. Large longitudinal data on individuals are used. The results reveal a positive causal effect of education on migration at most levels of education.

Keywords: migration, higher education, polytechnic reform, IV estimation

JEL classification: J10; J61; I20; R23

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I. Introduction

The polytechnic education reform took place in Finland in the 1990s. It gradually transformed former vocational colleges into polytechnics and expanded higher education to all regions. The polytechnic reform was the largest single education reform in Finland since the reform of the comprehensive school system in the early 1970s. The polytechnics constituted a new non-university sector in higher education. The main aim of the reform was to respond to new demands for vocational skills that were seen to arise in the local labour markets. However, geographically broader network of higher education was also regarded as a mean to lessen the concentration of the workforce to the central regions of Finland. Today, the number of new polytechnic graduates exceeds the number of new university graduates.

The polytechnic reform has previously been evaluated by comparing employment and earnings of the graduates from the polytechnics to those who had obtained vocational college degrees in the pre-reform system (see Hämäläinen and Uusitalo, 2008; Böckerman, Hämäläinen and Uusitalo, 2009). Hämäläinen and Uusitalo (2008) find that the relative earnings of vocational college graduates decrease after polytechnic graduates start to enter the labour market, which is inconsistent with the pure human capital model and can be interpreted as evidence that supports the signalling model of education. Böckerman et al. (2009) conclude that the reform had positive effects on the earnings and employment levels for the graduates in business and administration but no significant effects in other fields. To our knowledge, no study has, however, examined the regional aspects of this major reform in detail. Hence, it is unknown how the polytechnic reform affected interregional migration flows.

The fear is that the polytechnic reform may have resulted in increased out-migration of the highly educated graduates from the peripheral regions ('brain drain'), for example,

because job opportunities for the highly educated are less local.¹ This finding would be undesirable, since the highly educated migrants tend to possess above average skills and also earn above average incomes. Therefore, the tax burden of those who remain in the peripheral regions rises and the prospects of economic growth weaken. Consequently, regional disparities may increase substantially.

First we explore the effect of the polytechnic reform on the migration of graduated high school students.² Then we use the reform to identify the causal effect of education on the migration rates for young adults, who have graduated from specialized education after matriculation from high school. We use instrumental variables (IV) estimators that exploit the exogenous variation in the availability of polytechnic education across regions and over time. Matriculation exam scores from high school are used as additional instruments. The estimates are based on a particularly rich longitudinal data on individuals.

Our estimates reveal a positive causal effect of education on migration at most levels of education. Vocational college graduates have a higher migration probability than graduates from specialized upper secondary schools. Migration probability is also higher for polytechnic graduates than for vocational college graduates. Contrary to ordinary least squares estimates, our IV estimates do not reveal differences in the migration propensities between polytechnic and university graduates. The findings also point out that the expansion of polytechnic education did not, overall, have much impact on the out-migration of high school graduates.

¹ Herein, the term ‘brain drain’ denotes to the interregional transfer of resources in the form of human capital (i.e. migration of the highly educated individuals) from the less developed regions to prosperous regions within a country. See e.g. Beine, Docquier and Rapoport (2008) for an up-to-date discussion of brain drain from developing to developed countries. For further discussion of brain drain in internal migration, see e.g. Yousefi and Rives (1987) and Gottlieb and Joseph (2006).

² Even without the reform poorer educational opportunities in the peripheral regions may have induced young adults to migrate to the central areas, where the most institutions of higher education are located.

The remainder of the paper is organized as follows. The next section briefly reviews the earlier literature on the effect of education on migration. Section III describes the higher education system in Finland and the polytechnic reform. Section IV introduces our data. Section V describes our empirical approach and reports the results. Section VI concludes.

II. Why should migration propensity increase with the level of education?

Following the seminal work by Sjaastad (1962), migration is regarded as a mean of investing in human capital (see also Becker, 1964; Bodenhöfer, 1967). Heterogeneous individuals have different utility functions and consequently encounter differences in the net (money and non-money) benefits of living in a specific location. In this framework individuals move if their expected benefits of migration exceed its costs. Consequently, interregional mobility is necessary to bring higher expected returns to individual human capital investments.

Prior empirical analysis of the effects of educational attainment on migratory behaviour is extensive. The overall conclusion has been that the propensity to move increases with the level of educational attainment (see e.g. Ritsilä and Ovaskainen, 2001; Faggian, McCann and Sheppard, 2007). Several explanations have been provided for this finding. The first one is the existence of greater earnings differential between regions – thus greater potential benefits from moving – for the highly educated (Armstrong and Taylor, 2000, p. 155). Education is a form of general human capital, which is easily transferable to different geographical locations. For example, Levy and Wadycki (1974) found that the highly educated are more responsive to the wage rates in alternative locations.³ Second, education increases a person's capability of obtaining and analysing published information, and of using more sophisticated modes of information

(Greenwood, 1975, p. 406). Hence, the highly educated workers may have a better access to information about job prospects and living conditions in other regions. Therefore, higher level of education may also reduce the income risks associated with migration.

Third, higher level of education attainment may open up new opportunities in the labour market (e.g. Greenwood, 1975, p. 406). As education increases, the market for individual occupations at each level of education tends to become geographically wider but quantitatively smaller in a given location (Schwartz, 1973, p. 1160). For example, the market for cashiers is local, and many are needed; on the other hand, relatively fewer nuclear scientists are needed but their market is international.

Fourth, psychic costs resulting from agony of departure from family and friends are likely to be non-increasing with education (Schwartz, 1973). Higher educational groups are more homogeneous over space in terms of their culture and manners. Therefore, they are more receptive to new environments. Education may also reduce the importance of tradition and family ties and increase the individual's awareness of other localities and cultures. Greenwood (1975, p. 406) also argues that the risk and uncertainty of migrating may be lesser for the better educated because they are more likely to have a job prior to moving.

However, conflicting views have emerged as well. First, simultaneity of the relationship between education and the psychic costs of migration should not be overlooked (Schwartz, 1973). Thus, the attitude of people toward psychic costs of migration may in part contribute to the amount of education they wish to accomplish. *Ceteris paribus*, those with lower psychic costs of migration may invest more in their education. In particular, obtaining education requires in many cases moving to a new region. Having

³ They reason that the highly educated are more mobile primarily because they have a better access to information and greater incentives to make additional investments in a search for

said that, unwillingness to move for work may also result in extensive investment in education, if person lives in a region with good educational opportunities.

Second, some authors maintain that education affects migration only through its impact on earnings (e.g. Falaris, 1988, p. 527; Nakosteen, Westerlund and Zimmer, 2008, p. 777).⁴ That is, the higher incomes of the professional workers also enable them to meet the costs of migration more easily. Hence, they include earnings but not education in their model of the migration decision.⁵ For the reasons discussed above, this specification, which excludes education from the migration equation, is unlikely to be valid. That being said, we argue that it is important to control for the household income level. Otherwise the differences in the credit constraints can partly create the observed positive association between education and migration.

Third, although the prior analyses of the effects of educational attainment on migration behaviour are extensive, they do not generally attempt to establish whether the underlying effect is causal or not (see, however, Machin, Pelkonen and Salvanes, 2010).⁶ Almost all of the existing analyses use simple statistical models that treat the level of education as exogenously determined. However, education and migration decisions are evidently co-determined by the unobserved factors such as personality traits (including e.g. motivation). Indeed, the endogeneity of education decision is taken as granted in other fields of research (see Card, 1999). Therefore, the preceding estimates can be seriously biased. Even though education is correlated with migration, we do not know whether the significant correlation can be interpreted as a causal effect.

better opportunities.

⁴ Finnie (2004) does not consider the effect of education on migration decision.

⁵ However, no theoretical explanation on why education should not directly affect migration is given in these studies.

⁶ Based on the Norwegian compulsory school reform, Machin et al. (2010) show that, at the lowest levels of educational attainment, one additional year of education increases the annual migration rates by 15 per cent from a low base rate of one per cent per year (a statistically significant increase). In contrast to Machin et al. (2010), our paper focuses on the effects at the upper tail of the education distribution.

In an effort to isolate the causal effect of education, we apply an instrumental variables strategy. It takes advantage of the polytechnic reform that exogenously altered the availability of higher education over time and space in Finland. The matriculation exam scores from general upper secondary school are used as additional instruments.

III. Higher education in Finland and the polytechnic reform

Compulsory comprehensive schooling for the Finnish children begins at the age of seven and it lasts for nine years.⁷ Roughly 50 per cent of the pupils continue in the general upper secondary school, which lasts for three years and ends with a matriculation examination. At the beginning of 1990s, vocational schools and colleges were a diverse group of schools. Some took most students directly from comprehensive schools and provided them with two or three years of vocational education. In some vocational colleges most students had completed general upper secondary schooling before entering vocational college. For example, a business degree from a vocational college typically required three years of schooling after comprehensive school or two years of schooling after the general upper secondary school.

After the polytechnic education reform the higher education system comprises two parallel sectors: universities⁸ and polytechnics. The polytechnic degrees are Bachelor-level higher education degrees with a vocational emphasis. These degrees take around three and a half to four years to complete. A major difference between the sectors is that polytechnic schools are not engaged in academic research like universities. Education is free at both levels.

⁷ This description of the higher education system and the polytechnic education reform is based on Böckerman et al. (2009, p. 673-675).

⁸ The Finnish university sector consists of 20 universities and art academies all of which carry out research and provide education-awarding degrees up to doctorates. For further details on the university sector, see e.g. Ministry of Education (2005).

The first 22 polytechnics were established under a temporary licence in 1991 (e.g. Lampinen, 2004). The polytechnics were created by gradually merging 215 vocational colleges and vocational schools.⁹ Hence, the timing of the reform varied across schools and regions, as described in Böckerman et al. (2009, p. 674–675). Seven new temporary licences were granted during the 1990s. The first graduates from the new polytechnics entered the labour market in 1994.¹⁰ The experimental phase was judged to be successful and since 1996 the temporary polytechnics gradually became permanent. Currently there are 27 multidisciplinary polytechnics in Finland. Contrary to the university sector, the network of polytechnics covers the whole country.

The supply of education is controlled by the Ministry of Education through its decisions on the number of study places and the funding of other schools in Finland. Until the end of the 1990s the number of polytechnic study places increased rapidly (Figure 1). By 1996 the number of new polytechnic students exceeded the number of new university students. The number of applications to universities and to the most popular polytechnics exceeds the number of available places by a factor of four.

⁹ The students who had started their studies before a particular vocational college transformed itself into a polytechnic continued their studies in the old college lines and they eventually graduated with vocational college degrees.

¹⁰ The number of graduates grew rapidly and by 2000 the number of new polytechnic graduates exceeded the number of new university graduates; see also Figure 1 below.

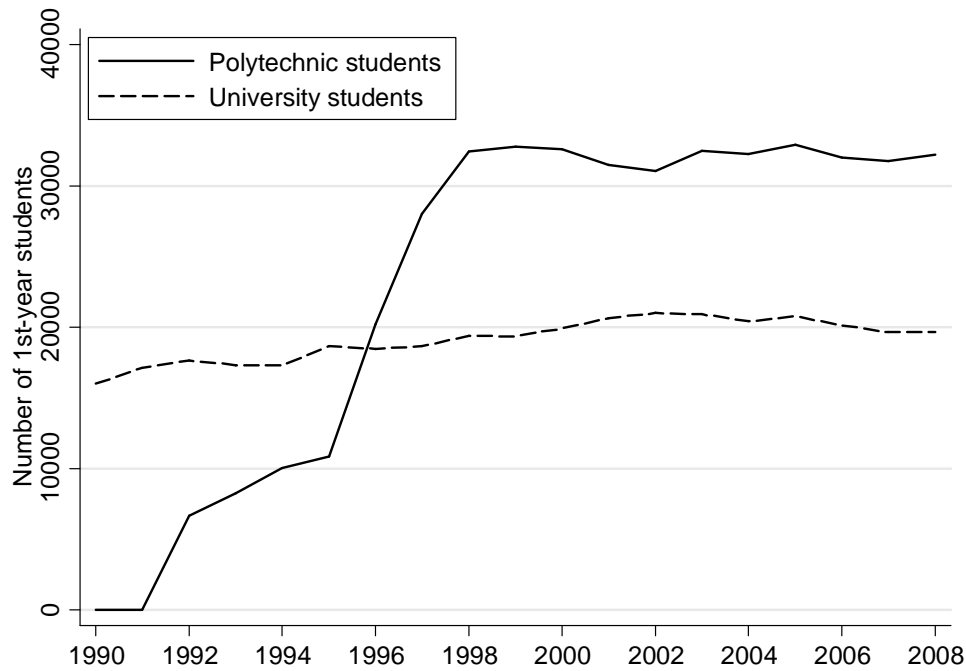


Figure 1. New polytechnic and university students in Finland 1990–2008.

The most important aim of the polytechnic reform was to respond to new demands for vocational skills that were seen to arise in the local labour markets. Furthermore, the geographically broad network of higher education was regarded as a mean to equalize regional development, for example, by reducing brain drain from the less developed regions to the metropolitan areas. Today, there are, however, pressures to concentrate higher education and research into fewer units in Finland, which probably implies that there will be a decline in the number of universities and polytechnics in the future.

Hence, we argue that it is important to understand how the polytechnic reform has affected the migration propensities – including brain drain from the less central regions. First, the polytechnics reform may have increased migration because after vocational schools were converted into bigger polytechnic units less people were able to access education at their home municipality. Second, incentives for moving may have increased because (free) higher education became more available. However, the reform also expanded higher education to regions that did not have higher education before, which may have reduced the need of some high school graduates to move to obtain

higher education. In addition, if the reform affected the school-to-school migration, it is also likely that it had an impact on the school-to-work migration, because those who have moved in the past are more likely to move again (see e.g. DaVanzo, 1983).

IV. Data

Our data are based on Longitudinal Census File and Longitudinal Employment Statistics File constructed by Statistics Finland. Since 1987, these two basic files were updated annually until 2004. By matching individuals' unique personal identifiers across the censuses, these panel data sets provide a variety of information on the residents of Finland and their spouses. In addition, data on the region of residence can be merged with the individual records.

The working sample comprises of a 7 per cent random sample of the individuals who resided permanently in Finland in 2001.¹¹ The sample was further restricted to the individuals who have completed general upper secondary education (matriculation examination). The matriculation examination is a national compulsory final exam taken by all students who graduate from upper secondary school. The answers in each test are first graded by teachers and then reviewed by associate members of the Matriculation Examination Board outside the schools. The exam scores are standardized so that their distribution is the same every year. The range of the matriculation exam scores is 1–6. With a few exceptions the general upper secondary education is required for the tertiary-level studies. In the following analysis we focus on 18 to 20-year-old graduates

¹¹ Those individuals living in the Åland Islands are not included in the sample. Åland is a small isolated region with approximately 26 000 inhabitants. It differs from the other Finnish regions in numerous ways (e.g. most of the inhabitants speak Swedish as their native language).

from 1988 to 2001.¹² We follow their migration behaviour and educational qualifications¹³ over time until 2004.

Throughout the analyses, migration event is defined as a long-distance migration between the 18 Finnish NUTS3 regions.¹⁴ These migration flows allow us to examine the changes in the geographical distribution of human capital. Focusing on migration between NUTS3 regions is also practical, because the location of educational institution where an individual graduates from is known at this regional level in our data. Furthermore, migration of shorter distances between municipalities or sub-regions most likely reflects housing market conditions rather than labour market prospects.

V. Empirical approach and results

Polytechnic reform and school-to-school migration

A significant proportion of the high school graduates are likely to migrate to attend further education. To understand the implications of the polytechnic reform of the 1990s for the school-to-school migration, we first model their migration propensities during the matriculation year ($t = 0$) and the following two years ($t = 1, 2$):

$$m_{ijt} = Z'_{ij}\alpha + X'_{ij}\beta + \varepsilon_{ijt}, \quad t = 0, 1, 2 \quad (1)$$

where the dependent variable, m_{ijt} , is a dummy variable indicating whether or not an individual i living in region j has migrated during the year t . Z_{ij} is the vector of our instruments, which measure the availability of polytechnic education for an individual i when graduating from general upper secondary education, and the matriculation scores.

The availability of polytechnic education is measured as the number of new polytechnic

¹² In 2001, for example, approximately 83 per cent of the high school graduates were 19-years-olds at the end of the matriculation year.

¹³ Unfortunately, our data are not able to distinguish the polytechnic graduates from those who have completed a bachelor degree in the university sector. Fortunately, it was uncommon to get a bachelor degree from Finnish university in the 1990s.

study places divided by the hundreds of 19 to 24-year-olds in the region of residence. This measure takes into account the fact that the regional cohort size is likely to have an impact on the availability given any fixed number of new polytechnic study places in a region. It is also used later as an instrument for the educational choices when we study the causal effect of education on school-to-work migration.

All our control variables, X_{ij} , relate to the year before individual graduates from high school, so that the consequences of migration are not confused with the causes of migration.¹⁵ Of the personal characteristics, we control for gender, age and annual earnings subject to state taxation. Household characteristics comprises of marital status, having children, and spouse's labour income, employment status and the level of education. Furthermore, we use several regional characteristics, such as the regional unemployment rate and the share of service sector workers in the region, as well as whether individual matriculates from his or her region of birth; see Appendix A1 for the detailed definitions of the control variables and their mean values. Furthermore, we control for the effects that are specific to the year and region of matriculation. Since interregional mobility tends to follow cyclical fluctuations in the economy (Milne, 1993), matriculation year fixed effects are used. The regional fixed effects pick up the regional differences in the migration intensity that are stable over time.

Table 1 reports the estimated marginal effects of the availability of polytechnic education on the migration probability during the three-year period during and after matriculation.¹⁶ The first row gives the estimation results of simple bivariate models that do not control for any other factors. A positive estimate from linear probability and

¹⁴ Small region of Itä-Uusimaa is combined with Uusimaa in the analyses, because of their close proximity and similarity. It is also only region that does not currently have its own polytechnic.

¹⁵ This also assures that our instrument do not affect the (future) values of control variables and hence bias the results.

¹⁶ Individual fixed effect model is not estimated because it does not allow us to identify time-invariant covariates (e.g. coefficient of the availability of polytechnic training).

probit model is unlikely to provide reliable causal estimate. Instead, it could also reflect reverse causality: more polytechnic study places (relative to the young population) were allocated to the regions with higher out-migration. More reliable estimate is obtained after other relevant covariates have been controlled for. The average marginal effects¹⁸ from probit models reported in rows (C) to (D) suggest that, on average, the migration probability was not influenced by the regional availability of polytechnic education during matriculation. Estimated average marginal effect is very close to zero and is insignificant. Linear probability model shows small positive, but significant marginal effect on the migration propensity.

Table 1. The estimated marginal effects of the availability of polytechnic education on the migration probability (sample of matriculated, 3-year follow-up period)

Model specification	LPM	AME from probit
(A) No controls	0.009*** (0.001)	0.009*** (0.001)
(B) Matriculation year dummies	0.009*** (0.001)	0.007*** (0.001)
(C) Matriculation year and region dummies	0.003*** (0.001)	0.000 (0.001)
(D) = (C) + Extensive set of controls	0.003*** (0.001)	0.001 (0.001)

Notes: Sample: Individuals are observed during the matriculation year and the following two years. Number of observations is 81,630 in all estimations. Dependent variable: NUTS3 migration during the current year. Explanatory variable of interest: Number of 1st year polytechnic students divided by the number of 19-24-year olds in the NUTS3 region. The set of controls are defined in Appendix, Table A1. * (**, ***) = statistically significant marginal effect at the 0.10 (0.05, 0.01) level. Robust standard errors reported in parenthesis allow for clustering at the matriculation year and regional level. LPM = Linear probability model, AME = average marginal effect is computed as average over all observations.

To explore the long-run effects of the polytechnic reform on the migration probability of the matriculated, we also study the effect over more extensive period. Since the last year of observation in our data is 2004 we are able to follow those individuals who matriculated, for example, in 2001 and 1988 for 3 and 17 years, respectively. The availability of polytechnic education is now measured during i) the matriculation year or

¹⁸ The marginal effects were computed as averages over all observations as discussed in Cameron and Trivedi (2005, p. 467).

ii) the matriculation year and the following two years (i.e. as average over three years).

Again several model specifications are reported (Table 2).

Table 2. The estimated marginal effects of the availability of polytechnic education on the migration probability (sample of matriculated, extensive follow-up period)

Model specification	Availability during the matriculation year		Three-year average in availability	
	LPM	AME from probit	LPM	AME from probit
(A) No controls	0.006***	0.006***	0.006***	0.006***
(B) Matriculation year dummies	0.008***	0.007***	0.008***	0.007***
(C) Matriculation year and region dummies	0.001***	0.000	-0.000	-0.001
(D) = (C) + Extensive set of controls	0.002***	0.000	-0.000	-0.000
(E) = (D) + Time since matriculation				
t = 0 (matriculation year)				
t = 1	0.011***	0.024***	0.005	0.017***
t = 2	0.031***	0.045***	0.020***	0.035***
t = 3	0.037***	0.052***	0.030***	0.045***
t = 4	0.050***	0.064***	0.044***	0.060***
t = 5	0.059***	0.073***	0.054***	0.070***
t = 6	0.062***	0.077***	0.059***	0.074***
t = 7	0.056***	0.071***	0.054***	0.070***
t = 8	0.056***	0.072***	0.055***	0.071***
t = 9	0.040***	0.055***	0.038***	0.054***
t = 10	0.035***	0.049***	0.033***	0.046***
t = 11-16	0.015***	0.022***	0.012***	0.018***
+ Interaction between time since matriculation and availability of polytechnic education:				
(t = 0)*Availability	0.005***	0.005***	0.002	0.003**
(t = 1)*Availability	0.009***	0.006***	0.007***	0.006***
(t = 2)*Availability	0.004***	0.002***	0.003***	0.002**
(t = 3)*Availability	0.001	-0.000	-0.000	-0.001
(t = 4)*Availability	-0.001	-0.002***	-0.002	-0.003**
(t = 5)*Availability	-0.001	-0.003***	-0.002*	-0.003***
(t = 6)*Availability	-0.002*	-0.003***	-0.003**	-0.004***
(t = 7)*Availability	-0.003***	-0.004***	-0.004***	-0.004***
(t = 8)*Availability	-0.007***	-0.008***	-0.007***	-0.008***
(t = 9)*Availability	-0.009***	-0.009***	-0.008***	-0.008***
(t = 10)*Availability	-0.009***	-0.010***	-0.009***	-0.009***
(t = 11-16)*Availability	-0.007***	-0.006***	-0.008***	-0.005**

Notes: Sample: Individuals are observed during the matriculation year and all the following available years. Number of observations is 272,430 in all estimations. Dependent variable: NUTS3 migration during the current year. Explanatory variable of interest: Number of 1st year polytechnic students divided by the number of 19-24-year olds in the NUTS3 region. The set of controls are defined in Appendix, Table A1. * (**, ***) = statistically significant marginal effect at the 0.10 (0.05, 0.01) level. Significance levels are based on robust standard errors that allow for clustering at the matriculation year and regional level. LPM = Linear probability model, AME = average marginal effect is computed as average over all observations.

The results from the first of the four specifications (A–D) in Table 2 correspond to those reported in Table 1. The effect of the polytechnic reform on migration seems also negligible in the long-run. In the last specification (E) we have added time since matriculation dummies to the specification and interacted it with the availability of polytechnic education during matriculation. The parameter estimates now suggest that the availability of polytechnic education increases migration propensity marginally close to matriculation, reverse is likely later. This conclusion does not depend on whether the availability is measured only during the matriculation year or also two years after. Note that linear probability model and probit model imply similar pattern.

To illustrate the quantitative magnitude of one unit increase in the availability of polytechnic education, it is useful to note that the number of 19 to 24-year-olds is ~20,000 in a typical Finnish NUTS3 region. Hence, in this typical region one unit increase in the availability is achieved, for example, by increasing the number of starting places by 200 students. The regional average of the number of starting places has grown from zero to roughly 1,700 between 1990 and the early 2000s.

Polytechnic reform, education and graduate migration

Next we proceed to the study of graduate migration (school-to-work migration). In the analysis, we now restrict our sample to the observations after graduation from the first specialized education programme (e.g. specialized upper secondary school, vocational college, polytechnic or university). This analysis enables us to identify the causal impact of education on migration. To identify the causal impact, one needs an instrument that predicts the changes in the level of education but is unrelated to the changes in the migration propensity after controlling for other relevant factors. Our vector of the instruments Z_{ij} , introduced above, contains the availability of polytechnic

education in his or her region during the matriculation year as well as the matriculation exam scores.¹⁹

Hence, our first-stage model for the determination of education for an individual i (who graduates at year $t = 0$) takes the form:

$$s_{ijt} = Z_{ij}'\gamma + X_{ij}'\delta + \mu_{ijt}, \quad t = 0, 1, 2, \dots, \tau_i \quad (2)$$

where s_{ijt} is the relevant educational outcome variable, X_{ij} is a vector of the control variables and Z_{ij} is the vector of the excluded instruments. Again the model includes the year and regional fixed effects measured at the time of the matriculation. The educational outcome is measured as the levels of education and the years of schooling. To compute the years of schooling, the highest level of education (up to the current year) was converted into years by using the official figures provided by Statistics Finland; see Appendix, Table A1 for details.

The estimation results of the first-stage regressions are presented in Table 3. The estimation results are based on linear models that control for other matriculation year and region dummies and other relevant factors (list “D” in Table 1). The first column reports the effects of the instrumental variables on the years of schooling. The overall estimate of the reform on the years of schooling in our graduate sample is insignificant, but still positive (0.005). The three remaining columns clarify this result. In the second column only graduates from vocational colleges and specialized upper secondary schools are included in the sample. The negative estimate for the availability of polytechnic education (-0.014) implies that the probability of completing vocational college degree reduces relative to completing a specialized secondary degree as the

¹⁹ For the availability to be a valid instrument it must be correlated with education, but it must not be a determinant of migration, i.e. it must be uncorrelated with the error term in the equation for migration after controlling for other relevant factors. Therefore, the identification assumption is that the availability must have no influence on migration other than through the first-stage channel; see equations (2) and (3) below.

availability of polytechnic education increases. This result is exactly what one should expect given the fact that the reform gradually transformed vocational colleges into polytechnics. Accordingly, enhanced availability of polytechnic education increases the probability that a matriculated individual completes a polytechnic degree relative to vocational college degree (0.017). Bit surprisingly, we do not, however, find that the reform reduced the probability of obtaining a master's degree relative to polytechnic, after controlling for other factors. Looking at the other instruments, we observe that a higher score from matriculation exams significantly increases the level of education in all subsamples (including the years of schooling). In all cases the instrumental variables are jointly significantly different from zero (F-test) supporting the validity of our first-stage regressions.

Table 3. The estimated effects of the instrumental variables on education (OLS, first stage of IV estimates, sample of graduates)

Variable	Full sample, using years of schooling	Vocational college vs. secondary degree	Polyt. vs. vocational college degree	Master's vs. polytechnic degree
Availability of polytechnic education	0.005 (0.011)	-0.014*** (0.005)	0.017*** (0.005)	0.004 (0.004)
Matriculation results	0.598*** (0.011)	0.058*** (0.006)	0.049*** (0.006)	0.182*** (0.005)
Matriculation results not missing	-2.656*** (0.107)	-0.235*** (0.047)	-0.235*** (0.057)	-0.850*** (0.048)
<i>Diagnostics</i>				
Joint significance of the instruments (F-test)	8,686.3 (p < 0.001)	425.19 (p < 0.001)	320.87 (p < 0.001)	3720.14 (p < 0.001)
Number of observations	110,927	64,865	55,698	46,062

Notes: Sample: Individuals are observed during the graduation year from specialized education and the following years. Dependent variable: NUTS3 migration during a year. * (**, ***) = statistically significant marginal effect at the 0.10 (0.05, 0.01) level. Robust standard errors are reported in parenthesis that allow for clustering at the matriculation year and regional level. OLS = Ordinary least squares. See Appendix, Table A1 for the set of control variables (incl. matriculation region and year dummies) and definitions of the instrumental variables (availability of polytechnic education is measured during the matriculation).

In the second stage, graduate migration decision is regressed on the predicted education \hat{s}_{ijt} from (2) and all the exogenous variables:

$$m_{ijt} = \eta \hat{s}_{ijt} + X'_{ij} \pi + \varepsilon_{2ijt}, \quad t = 0, 1, 2, \dots, \tau_i \quad (3)$$

where the dependent variable, m_{ijt} , is 1 if graduate's region of residence at the end of the year is different from the previous year, and 0 otherwise. The instruments are excluded from the migration equation (reflecting the so-called exclusion restriction). In practise, the equations (3), and (2), are estimated by using two-stage least squares. These IV estimates are compared with the ordinary least squares (OLS) and limited information maximum likelihood estimates (LIML); see e.g. Angrist and Pischke (2009) for further details on the methodology. Robust standard errors are reported for all models. Again we examine migration behaviour until 2004.

If we were willing to assume that the treatment effects are homogenous, i.e., the causal effect of education on migration is same for all individuals, then an instrumental variables model could identify an average treatment effect for the sample of individuals (see e.g. Imbens and Angrist, 1994; Angrist and Krueger, 2001). This assumption is unlikely to hold in practise. However, under heterogenous treatment effects a local average treatment effect (LATE) can be identified. It is called local, because the treatment effect is identified for people (compliers) whose behaviour is being manipulated by the instrument. In our case, it estimates the treatment effect for individuals whose schooling choice is changed due to the polytechnic reform and matriculation scores.

To estimate the local average treatment effects, an additional technical assumption has to be made, which is known as “monotonicity”. This assumption means that the instrument only moves the endogenous variable in one direction. The results from Table

3 suggest that this is unlikely to prevail with our instruments.²¹ However, the monotonicity assumption is arguably valid in the pairwise comparisons of vocational and polytechnic graduates, and polytechnic and university graduates. Hence, the effect of the level of education (treatment) a relative to the level of education (treatment) b is estimated by putting aside the data for units exposed to other levels of education (see Imbens and Wooldridge 2009, p. 73; cf. Table 3).

We assume that our instrument – the relative number of regional polytechnic starting places – affects the likelihood of obtaining a polytechnic degree, but it does not directly affect migration after graduation from specialized education. If the migration propensity among the graduates is, for some reason, higher or lower in the regions where the relative number of first-year students is higher or lower for other reasons, our instrument is invalid and will produce biased estimates of the treatment effect (Moffitt 2005, p. 95). For example, if the set of factors that influences the number of polytechnic places (e.g. the local economy) also affect migration decisions, and these are not properly accounted for in the estimation, then our exogeneity assumption is questionable. In order to reduce this possibility, we control for several local factors such as regional unemployment besides adding a full set of regional dummies to all models.

Table 4 shows the estimation results that are obtained by using OLS, IV and LIML. The estimates based on the years of schooling are unlikely to be reliable for the reasons discussed above, but they are reported for comparison. In the second column the migration rates of the graduates from vocational colleges are compared with those from specialized secondary degrees. Strong rejection of the exogeneity of the educational dummy and the significance of the instrumental variables in the first-stage suggests that

²¹ That is, if we were to study the effect of the years of schooling on migration, and someone switches for example from university to polytechnic due to increased availability of polytechnic education, then the monotonicity assumption would be violated (i.e. negative effect for some, but positive effect for most people).

the OLS estimate (0.004) is biased.²² This conclusion is supported by the similarity of the IV and LIML estimates (0.091 and 0.092). Therefore, we conclude that a vocational college degree increases the migration probability by 9 percentage points relative to specialized upper secondary degree.

Table 4. The estimated effects of education on the migration propensity (sample of graduates)

Model	Full sample, using years of schooling	Vocational college vs. secondary degree	Polyt. vs. vocational college degree	Master's vs. polytechnic degree
OLS estimates	0.008*** (0.000)	0.004** (0.002)	0.013*** (0.003)	0.019*** (0.003)
IV estimates	0.012*** (0.001)	0.091*** (0.015)	0.063*** (0.020)	0.002 (0.007)
LIML estimates	0.012*** (0.001)	0.092*** (0.015)	0.063*** (0.020)	0.002 (0.007)
<i>Diagnostics for IV</i>				
Test for exogeneity of the educ. var. (F-test)	7.037 (p = 0.009)	34.822 (p < 0.001)	6.142 (p = 0.013)	6.822 (p = 0.009)
Overidentifying restrictions	0.202 (p = 0.904)	8.41992 (p = 0.015)	0.030 (p = 0.985)	0.683 (p = 0.711)
Average migration rate	0.075	0.062	0.073	0.093
Number of observations	110,927	64,865	55,698	46,062

Notes: Sample: Individuals are observed during the graduation year from specialized education and the following years. Dependent variable: NUTS3 migration during a year. * (**, ***) = statistically significant marginal effect at the 0.10 (0.05, 0.01) level. Robust standard errors are reported in parenthesis. OLS = Ordinary least squares, IV = instrumental variables. The instruments for the level of education are: availability of polytechnic education during matriculation, matriculation result and matriculation result not missing (see Table A1 for definitions). LIML = Limited information maximum likelihood. See Appendix, Table A1 for the set of control variables (incl. matriculation region and year dummies).

In the third column, which compares polytechnic graduates to vocational college graduates, the exogeneity of the educational dummy is also rejected by the F-statistic. Hence, the conclusions are based on the IV estimate, 0.063, which is considerably larger than OLS estimate (0.013). LIML estimate corresponds to the IV estimate. In the final column, graduates with master's degree are compared with polytechnic graduates. Exogeneity of the educational dummy is again rejected. The results from both IV and LIML show that university graduates with a master's degree and polytechnic graduates

²² The exogeneity test was conducted by adding the residual from the first-stage to the second

have similar migration propensity. Note that the test for the overidentifying restrictions can be interpreted as a test of heterogeneous treatment effects (Angrist, 1991), because under heterogeneous treatment effects the choice of the instruments affects the LATE being identified. Apart from the second column, there is very little evidence that our LATE estimates depend on which instruments are being used.

VI. Conclusions

In this paper, we have examined the effects of the availability of education and the level of education on interregional migration in Finland. First, we explored the effect of the polytechnic education reform on the migration of the graduated high-school students. The results showed that an increase in the regional availability of polytechnic education did not, on average, affect much the level of out-migration of recent high school graduates. However, when we followed at the effect over time, decrease in the coefficient estimate was found. Namely, the effect of the availability of the polytechnic education on migration propensity is small positive close to high school graduation, but it turns small negative after few years.

Second, we also used the reform to identify the causal effect of education on the migration of young adults, who have graduated from specialized education after high school. To identify the causal effect of education on migration, we used instruments based on the availability of polytechnic education and the matriculation exam scores from general upper secondary school. Our IV estimates showed that vocational college degree increases migration probability by 9 percentage points relative to specialized upper secondary degree. Also, polytechnic graduates have 6 percentage points higher migration probability than those of vocational college graduates. However, master's degree did not increase migration propensity when compared to polytechnic degree.

Overall, our findings point out that the availability of polytechnic education did not reduce migration. One of the most important reasons for the creation of the polytechnic schools from regional policy perspective was to decrease brain drain from the less developed regions to the metropolitan areas. Although further analysis is still needed, our results point out that this aim has not been fulfilled.

Appendix

Table A1. *Description of covariates and their mean values for three samples*

Covariate	Description	(1)	(2)	(3)
<i>Dependent variables</i>				
Migrate	1 if the NUTS3 region of residence is different from previous year, 0 otherwise	0.078	0.074	0.075
Yrs of school.	Years of schooling (12, 13, 14.5, 15.5 or 17.5)	12.050	13.280	15.145
Secondary degree	1 if person has a specialized higher secondary level degree after matriculation (13) or nothing (12 years of schooling), 0 otherwise	0.991	0.687	0.231
Vocational college degree	1 if person has a vocational college degree (14.5 years), 0 otherwise	0.009	0.120	0.296
Polytechnic degree	1 if person has a polytechnic or bachelor degree (15.5 years), 0 otherwise	0.000	0.095	0.232
Master's degree	1 if person has a master's degree from a university (17.5 years), 0 otherwise	0.000	0.098	0.241
<i>Instrumental variables</i>				
Availability of polyt. education	Number of 1 st year polytechnic students divided by the hundreds of 19-24-year olds in the NUTS3 region during matriculation year (three year averages in parenthesis).	4.426 (4.955)	3.111 (3.711)	1.865 (2.501)
Matricul. result	General grade from matriculation exam. Range from 1 (worst grade) to 6 (best grade). 0 if grade is missing	3.904	3.786	3.567
Matr. result not missing	1 if matriculation result is not missing, 0 otherwise	0.926	0.892	0.856
<i>Control variables</i>				
Age	Age in years	18.156	18.157	18.143
Female	1 if female, 0 if male	0.576	0.576	0.661
Swedish	1 if person belongs to the Swedish minority, 0 otherwise	0.050	0.050	0.048
Married	1 if married or cohabiting, 0 otherwise	0.023	0.020	0.019
Sp. empl.	1 if spouse is employed, 0 otherwise	0.008	0.006	0.005
Sp. educ.	Spouse's level of education (0 if no spouse, 1 if comprehensive educ., ..., 5 if higher tertiary educ.)	0.038	0.033	0.030
Sp. income	Annual income of spouse, 10 000 €	0.014	0.013	0.013
Children	1 if children under 18 years in the family, 0 otherwise	0.002	0.002	0.002
Earnings	Annual earnings subject to state taxation, 10 000 €	0.162	0.161	0.158
Rural	1 if living in an rural municipality (based the degree of urbanisation and on the population of the largest urban settlement; see Statistics Finland 2001), 0 otherwise	0.236	0.240	0.271
Semiurban	1 if living in a semiurban municipality, 0 otherwise (see above; reference is "urban" municipality)	0.174	0.172	0.179
Unempl. Rate	Unemployment rate in travel-to-work area, %	14.568	13.396	12.153
Amenities	Percentage of the service sector workers in the NUTS4 region	5.700	5.597	5.412
Region of birth	1 if living in the region of birth, 0 otherwise	0.811	0.805	0.810
Number of observations		81,630	272,430	110,927

Notes: Control variables are measured on a year before an individual matriculates. Educational variables after matriculation refer to the first specialized degree. Sample includes: (1) Observations from the matriculation year and the following two years; (2) All possible observations after matriculation; (3) All possible observations after graduation from specialized education after matriculation.

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