The effect of education on migration: Evidence from school reform

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ABSTRACT*

A polytechnic, higher 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. We implement instrumental variables estimators that exploit the exogenous variation in the regional availability of polytechnic education together with matriculation exam scores. Our IV results show that polytechnic graduates have a higher migration probability than those of vocational college graduates. However, a master's degree did not increase migration propensity in comparison with a polytechnic degree. We also find that an increase in the availability of polytechnic education did not reduce migration.

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

JEL classification: J10, J61, I20, R23

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1 Introduction

A 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, a geographically broader network of higher education was also regarded as a means to lessen the concentration of the workforce to the central regions. The number of graduates from polytechnics has risen rapidly. Today, the number of new polytechnic graduates exceeds the number of new university graduates.

The polytechnic reform has previously been evaluated by comparing the employment and earnings of graduates from the polytechnics with 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 in the field of business and administration 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 not known how the polytechnic education 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 prospects of economic growth in the peripheral regions weaken and the tax burden of those who remain rises. Consequently, regional disparities may increase substantially.

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1 Herein, the term 'brain drain' denotes the interregional transfer of resources in the form of human capital (i.e. migration of 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).

We first explore the effect of the polytechnic reform on the interregional migration of graduated high school students. 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. Although prior analyses of the effect of education on migration behaviour are extensive, to our knowledge only two very recent studies, by Machin, Pelkonen and Salvanes (2010) and Malamud and Wozniak (2010), have provided convincing evidence on the causality. In this paper, 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 particularly rich longitudinal data on individuals.

The 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, the IV estimates do not, however, 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.

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 3 describes the higher education system in Finland and the polytechnic reform. Section 4 introduces the data. Section 5 describes our empirical approach and reports the results. Section 6 concludes.

2 Why should migration propensity increase with the level of education?

Following the seminal work by Sjaastad (1962), migration is regarded as a means 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 education (see e.g. Jaeger et al., 2010; Faggian, McCann and Sheppard, 2007; Tunali, 2000).[2] Several explanations have been provided for this finding. The first one is the existence of a 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 employment information, and of using more sophisticated modes of information (Greenwood, 1975, p. 406). Hence, highly educated workers may have a better access to information about job prospects and living conditions in other regions. Therefore, a higher level of education may also moderate the income risks associated with migration.

Third, a 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 the 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 the 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. That having been said, unwillingness to

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[2] See also e.g. reviews by Greenwood (1975; 1997). Finnish migration has been studied recently e.g. by Ritsilä and Ovaskainen (2001), Pekkala and Tervo (2002), Hämäläinen and Böckerman (2004), Haapanen and Ritsilä (2007) and Jauhiainen (2008). However, the focus of these studies has not been on the causal impact of education on migration.

[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 better opportunities.

move for reasons of work may also result in extensive investment in education, if a 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 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 ability to finance the migration costs 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. There are, however, two very recent exceptions in the literature: Machin, Pelkonen and Salvanes (2010) and Malamud and Wozniak (2010). 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).[6] Malamud and Wozniak (2010) use the Vietnam War drafts in the US to identify the causal effect of college attainment on migration. Their 2SLS estimates imply that the additional years of higher education significantly increased the likelihood that affected men resided outside their birth states later in life. However, most of the 2SLS estimates are not significantly different from OLS.

In contrast to these recent studies, other analyses usually use simple statistical models that treat the level of education as exogenously determined. However, education and migration decisions are evidently co-determined by unobserved factors such as personality traits (including motivation). Indeed, the endogeneity of the education decision is taken for 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. In this paper, we apply an instrumental variables strategy to isolate the causal effect of education on migration. We take advantage of the polytechnic reform that exogenously altered the availability of higher education over time and space in Finland. The

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

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

[6] In contrast to Machin et al. (2010), our paper focuses on the effects at the upper tail of the education distribution.

matriculation exam scores from the general upper secondary school are used as additional instruments.

3 Higher education in Finland and the polytechnic reform

Compulsory comprehensive schooling for Finnish children begins at the age of seven and it lasts for nine years.[7] Roughly 50 per cent of the pupils continue to the general upper secondary school, which lasts for three years and ends with a matriculation examination. At the beginning of the 1990s, vocational schools and colleges were a diverse group of schools. Some took most of their 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.

Since the polytechnic education reform the higher education system has comprised two parallel sectors: universities[8] and polytechnics. The polytechnic degrees are bachelor-level higher education degrees with a vocational emphasis. These degrees take from 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.

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); see also Figure 2 below. 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 have gradually become permanent. Currently there are 27 multidisciplinary polytechnics in Finland. Unlike the university sector, the network of polytechnics covers the whole country.

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[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).

[9] The students who had started their studies before a particular vocational college transformed itself into a polytechnic continued their studies along 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.

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. Figure 2 illustrates the differences in the timing of the reform across regions; see Appendix, Figure A1, for the NUTS3 regional classification. These two figures clearly show regional differences in the availability of polytechnic (higher) education and the changes in it during the 1990s. Since the availability has been relatively constant thereafter, our analysis focuses on the 1990s and early 2000s.

--- Figure 1 around here ---

--- Figure 2 around here ---

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 means to equalize regional development, for example, by reducing brain drain from the less developed regions to the metropolitan areas.[11] 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.[12] First, the polytechnics reform increased the average level of education of young adults, which in turn may increase migration for the reasons discussed in the previous section. Second, the reform may have increased the propensity to move because fewer people were able to access education at their home municipality after vocational schools were converted into bigger polytechnic units. Third, incentives for school-to-school 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 previously, which may have reduced the need of some high school graduates to move in order to obtain higher education. If the reform affected the school-to-school migration, it is likely that it also had

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[11] The regional disparities in economic growth and unemployment rates have increased since the severe recession of the early 1990s; see e.g. Kangasharju and Pekkala (2004) and Tervo (2005).

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

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).

4 Data

The individual-level data are based on the Longitudinal Census File and the Longitudinal Employment Statistics File constructed by Statistics Finland. These two basic register files were updated annually from 1987 to 2004. By matching individuals' unique personal identifiers across the censuses, these panel data sets provide a variety of reliable register-based information on the residents of Finland.[13] Furthermore, register data on spouses and the region of residence are merged with the individual records.

The working sample comprises a 7 per cent random sample of the individuals who resided permanently in Finland in 2001.[14] The sample was further restricted to the individuals who had completed general upper secondary education ("lukio" in Finnish). The matriculation examination is a national compulsory final exam taken by all students who graduate from the general 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 general upper secondary education is required for tertiary-level studies. In the following analysis we focus on 18 to 20-year-old graduates from 1988 to 2001.[15] During this period, the availability of higher education made its dramatic rise; see Figure 1 and 2 above. We follow the educational qualifications and the migration behaviour over time until 2004, as illustrated by Figure 3. In the empirical analysis below, however, we treat the bachelor's degree as an intermediate phase of the master's degree, because it was uncommon to finish one's studies with a bachelor's degree from a Finnish university in the 1990s (i.e. before the Bologna process was adopted in 2005).

--- Figure 3 around here ---

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[13] That is, contrary to surveys, for example, the comprehensive register-based data contain very little measurement error due to their nature; cf. also Malamud and Wozniak (2010, p. 14).

[14] 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).

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

Throughout the analyses, the migration event is defined as long-distance migration between the 18 Finnish NUTS3 regions; see Appendix, Figure A1.[16] These migration flows allow us to examine the changes in the geographical distribution of human capital. Focusing on migration between the NUTS3 regions is also practical, because the location of the educational institution where an individual graduates is known at this regional level in the data. Furthermore, migration of shorter distances between municipalities or sub-regions most likely reflects housing market conditions rather than labour market prospects.

5 Empirical approach and results

5.1 Polytechnic reform and school-to-school migration

A significant proportion of high school graduates are likely to migrate in order to receive 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 ($t = 1, 2$) with simple linear (reduced-form OLS) regression:

$$m_{ijt} = Z_{ij}'\alpha + X_{ij}'\beta + \varepsilon_{ijt}, \quad t = 0, 1, 2 \tag{1}$$

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.[17] The availability of polytechnic education is measured as the number of new polytechnic 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 educational choices when we study the causal effect of education on school-to-work migration.

All the control variables, X_{ij}, relate to the year before an individual graduates from high school, so that the consequences of migration are not confused with the causes of migration.[18] Concerning personal characteristics, we control for gender, age and annual earnings subject to state taxation. Household characte-

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[16] The small region of Itä-Uusimaa is combined with Uusimaa in the analyses, because of their close proximity and similarity. It is also the only region that does not currently have its own polytechnic; see Appendix, Figure A1 for a map of the NUTS3 regions of Finland.

[17] Matriculation scores are used in this reduced-form regression because they are likely to affect the schooling choices (Hämäläinen and Uusitalo, 2008), and hence indirectly migration decisions.

[18] This decision also assures that our instrument does not affect the (future) values of control variables and hence bias the results.

ristics comprise marital status, having children, and a 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 the individual matriculates from his or her region of birth, which captures otherwise unobserved differences in migration behaviour; 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 matriculation year and the following two years.[19] The first row gives the estimation results of simple bivariate models that do not control for any other factors. A positive estimate from the linear probability and probit model is unlikely to provide a 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. A more reliable estimate is obtained after other relevant covariates have been controlled for. The average marginal effects[20] 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. The estimated average marginal effect is very close to zero and is insignificant. The linear probability model shows a small, positive, but significant, marginal effect on the migration propensity.[21]

--- Table 1 around here ---

To explore the long-run effects of the polytechnic reform on the migration probability of the matriculated students, we also study the effect over a longer 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 ii) the matriculation year and the

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19 The individual fixed effects model is not estimated because it does not allow us to identify time-invariant covariates (e.g. coefficient of the availability of polytechnic education).

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

21 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.

following two years (i.e. as an average over three years). Again, several model specifications are reported (Table 2). The results from the four specifications (A–D) correspond to those reported in Table 1. The effect of the polytechnic reform on migration also seems to be negligible in the long-run. This conclusion does not depend on whether the availability is measured only during the matriculation year or also two years after.

--- Table 2 around here ---

5.2 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 the student's region during the matriculation year as well as the matriculation exam scores.[22]

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

$$s_{ijt} = Z'_{ij}\gamma + X'_{ij}\delta + \mu_{ijt}, \quad t = 0, 1, 2, \ldots, \tau_i \tag{2}$$

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 matriculation. The educational outcome is measured as the levels of education and the years of schooling. To compute the years of schooling, the level of education (up to the first specialized degree) 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. They 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

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[22] For 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 availability must have no influence on migration other than through the first-stage channel; see equations (2) and (3) below.

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 a vocational college degree is reduced relative to completing a specialized secondary degree as the 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 a vocational college degree (0.017). We do not, however, find that the reform reduced the probability of obtaining a master's degree relative to a 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 around here ---

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

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

where the dependent variable, m_{ijt}, is 1 if the 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 (constituting the so-called exclusion restriction). In practice, 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 was the 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 practice. 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.[23] 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 graduates is, for some reason, higher or lower in those 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 affects migration decisions, and if 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 first estimates based on the years of schooling are unlikely to be reliable for the reasons discussed earlier, but they are reported for comparison. In the second column the migration rates of the graduates from vocational colleges are compared with those with 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 the OLS estimate (0.004) is biased.[24] This conclusion is supported by the similarity of the IV and LIML estimates (0.090 and 0.091). Therefore, we conclude that a vocational college degree increases the migration probability approximately by 9 percentage points relative to a specialized upper secondary degree.

--- Table 4 around here ---

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[23] 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 the increased availability of polytechnic education, then the monotonicity assumption would be violated (i.e. negative effect for some, but a positive effect for most people).

[24] The exogeneity test was conducted by adding the residual from the first-stage to the second stage, and testing its significance robustly; see Cameron and Trivedi (2005, p. 276) for details.

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, 0.085, which is considerably larger than the OLS estimate (0.006). The LIML estimate corresponds to the IV estimate. In the final column, university graduates with a 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, everything else being equal, graduates with master's degrees and polytechnic graduates have very similar migration propensities. Note that the test for the overidentifying restrictions can be interpreted as a test of heterogenous treatment effects (Angrist, 1991), because under heterogenous treatment effects the choice of the instruments affects the LATE being identified. Apart from the second column, there is very little evidence that the LATE estimates depend on which instruments are being used.

6 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 graduated high-school students. The results showed that an increase in the regional availability of polytechnic education did not, on average, greatly affect the level of out-migration of recent high school graduates. The conclusion did not change when migration propensities were followed over a longer period.

Second, we also used the reform to identify the causal effect of education on the migration of young adults who had 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 the general upper secondary school. The IV estimates showed that a vocational college degree increases migration probability by 9 percentage points relative to a specialized upper secondary degree. Also, polytechnic graduates have an 8.5 percentage points higher migration probability than that of vocational college graduates. However, a master's degree did not increase migration propensity in comparison with a 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 a regional policy perspective was to decrease brain drain from the less developed regions to the metropolitan areas. The results point out that this aim has not been fulfilled.

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TABLES

Table 1 The estimated marginal effects of the availability of polytechnic education on 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 parentheses 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.

Table 2 The estimated marginal effects of the availability of polytechnic education on 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

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.

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	0.004 (0.013)	-0.014*** (0.005)	0.021*** (0.005)	0.001 (0.003)
Matriculation results	0.620*** (0.012)	0.058*** (0.006)	0.035*** (0.005)	0.164*** (0.007)
Matriculation results not missing	-2.740*** (0.118)	-0.237*** (0.047)	-0.156*** (0.038)	-0.815*** (0.051)
Diagnostics				
Joint significance of the instruments (F-test)	884,834 (p < 0.001)	34.315 (p < 0.001)	20.063 (p < 0.001)	183.868 (p < 0.001)
Number of observations	102,583	63,861	46,453	38,722

Notes: Sample: Individuals are observed during the graduation year from specialized education and the following years. Dependent variable: Years of schooling or the level of education (binary variable). * (**, ***) = statistically significant marginal effect at the 0.10 (0.05, 0.01) level. Robust standard errors are reported in parentheses 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).

Table 4 The estimated effects of education on 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*** (0.001)	0.004** (0.002)	0.006* (0.003)	0.026*** (0.004)
IV estimates	0.012*** (0.001)	0.090*** (0.022)	0.085** (0.036)	-0.001 (0.010)
LIML estimates	0.012*** (0.001)	0.091*** (0.022)	0.085** (0.036)	-0.001 (0.010)
Diagnostics for IV				
Test for exogeneity of the educ. var. (F-test)	7. 608 (p = 0.006)	21.767 (p < 0.001)	5.250 (p = 0.023)	9.413 (p = 0.002)
Overidentifying restrictions	0.318 (p = 0.853)	8.401 (p = 0.015)	0.152 (p = 0.927)	0.601 (p = 0.740)
Average migration rate	0.075	0.062	0.072	0.096
Number of observations	102,583	63,861	46,453	38,722

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 parentheses. 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).

FIGURES

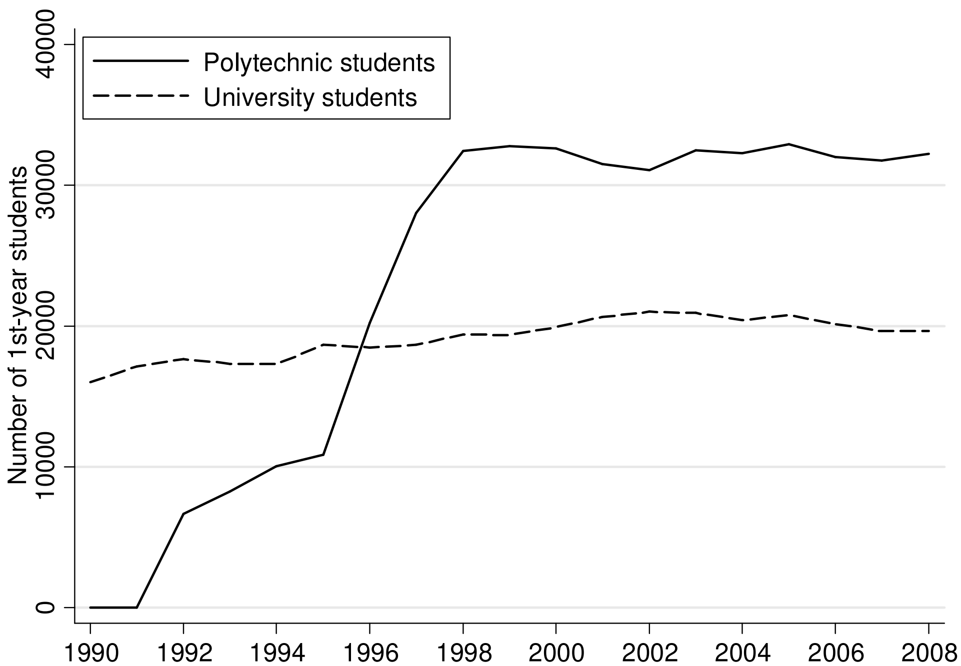

Figure 1 New polytechnic and university students in Finland 1990–2008. Source: AMKOTA and KOTA databases

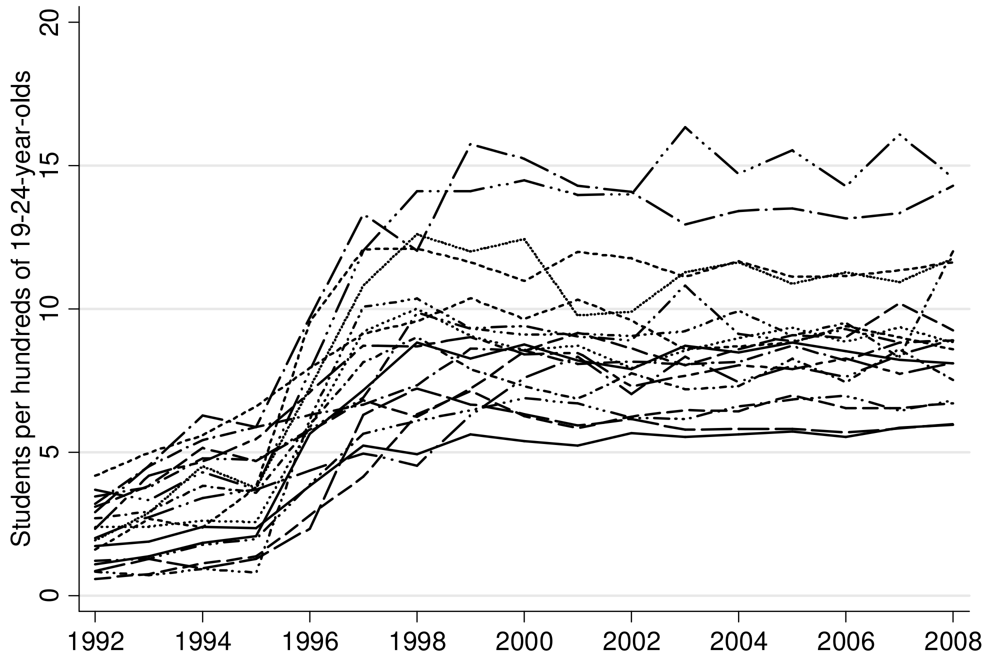

Figure 2 First-year polytechnic students per 19-24-year-olds in 1992–2008 (lines represent NUTS3 regions). Source: AMKOTA database & Statistics Finland, Population statistics

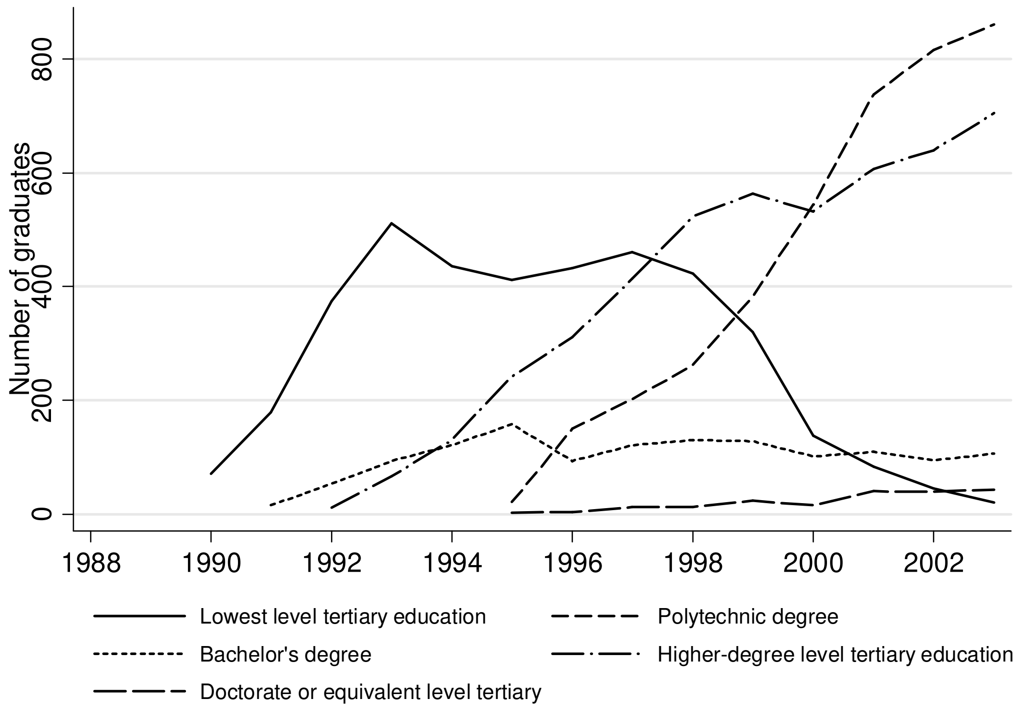

Figure 3 Number of graduates from specialized education (only 1988–2001 matriculated who graduate at an age under 35). Source: own sample data

APPENDIX

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

Covariate	Description	(1)	(2)	(3)
Dependent variables				
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	14.900
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	0.710	0.306
Vocational college degree	1 if person has a vocational college degree (14.5 years), 0 otherwise	0.009	0.121	0.316
Polytechnic degree	1 if person has a polytechnic degree (15.5 years), 0 otherwise	0.000	0.051	0.136
Bachelor's degree	1 if person has a bachelor's degree from a university (15.5 years), 0 otherwise	0.000	0.032	0.015
Master's degree	1 if person has a master's degree from a university (17.5 years), 0 otherwise	0.000	0.091	0.241
Instrumental variables				
Availability of polyt. education	Number of 1st year polytechnic students divided by the hundreds of 19-24-year olds in the NUTS3 region during matriculation year (three year averages in parentheses).	4.426 (4.955)	3.111 (3.711)	1.929 (2.573)
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	3.575
Matr. result not missing	1 if matriculation result is not missing, 0 otherwise	0.926	0.892	0.860
Control variables				
Age	Age in years	18.156	18.157	19.144
Female	1 if female, 0 if male	0.576	0.576	0.668
Swedish	1 if person belongs to the Swedish minority, 0 otherwise	0.050	0.050	0.046
Married	1 if married or cohabiting, 0 otherwise	0.023	0.020	0.020
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	0.032
Sp. income	Annual income of spouse, 10 000 €	0.014	0.013	0.014
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	0.157
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	0.178
Unempl. Rate	Unemployment rate in travel-to-work area, %	14.568	13.396	12.304
Amenities	Percentage of the service sector workers in the NUTS4 region	56.995	55.965	54.196
Region of birth	1 if living in the region of birth, 0 otherwise	0.811	0.805	0.811
Number of observations		81,630	272,430	102,583

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.

Figure A1 Capital Helsinki and NUTS3 regions in Finland. Note: Itä-Uusimaa is merged with Uusimaa in the analysis and Åland ("Ahvenanmaa" in Finnish) is excluded from it