More skilled, better paid: labour-market returns to postsecondary vocational education

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Abstract:

Outside the U.S., relatively little is known about the labour-market returns to postsecondary vocational (or polytechnic) education. Yet, polytechnics in Europe are distinct from U.S. community colleges. This paper focuses on the labour-market returns to polytechnic attendance in Finland, where polytechnics are representative of many European countries. Using matching methods and longitudinal administrative data, we find that, compared to individuals with no postsecondary education, students who attend polytechnics have higher annual earnings of €3,300 to €3,700 and employment gains of 2.5 to 6.6 ten years after the entry decision. However, the returns vary by personal characteristics and field of study.

JEL classifications: J24, I26

1. Introduction

The worldwide economic crisis has dramatically altered the labour-market prospects of workers. Low-skilled workers are particularly vulnerable, as they have higher unemployment and lower wages than more educated workers (Blanchflower and Freeman, 2000). In 2012, the EU average employment rate for individuals with little or no postsecondary education was around 70%, compared with rates over 80% for individuals with postsecondary education.[1] Unemployment rates are also substantially higher for workers without postsecondary education. One potential opportunity for low-skill individuals to improve their labour-market prospects is to obtain additional vocational education.

Finland offers an excellent opportunity to study the labour-market returns to postsecondary vocational education. Polytechnics, also known as universities of applied sciences, offer postsecondary vocational education. The first polytechnics were created in 1991. They provide a high level of postsecondary vocational education for students by offering polytechnic bachelor's degrees that take approximately 3.5 to 4 years of full-time study (OECD 2003, p. 138). The length of study for polytechnics in Finland is typical of many European countries. In contrast, postsecondary vocational degrees in the U.S., usually offered by community colleges, require two years of full-time study. Furthermore, U.S. community colleges provide a very broad array of courses including non-degree options, vocational courses, and academic programmes providing the first two years of a bachelor's degree, so that these institutions are not directly comparable to European polytechnics offering degrees in a very narrow set of subjects.

[1] Information obtained from Eurostat website (http://ec.europa.eu/eurostat/web/lfs/data/main-tables [last accessed 23 October 2017]) for individuals aged 20 to 64. The comparison is between individuals with International Standard Classification of Education (ISCED) education levels 3 and 4, defined as 'Upper secondary and postsecondary non-tertiary education,' and levels 5 and 6, 'First and second stage of tertiary education.' Postsecondary vocational education studied in this paper is at level 5.

In this paper, we focus on the labour-market returns to attendance at Finnish polytechnics compared to no postsecondary attendance.[2] Using comprehensive administrative data, this paper contributes to a thin literature on the labour-market returns to postsecondary vocational education. In the preferred matching model, attendance in a polytechnic bachelor's programme corresponds with annual increases of €3,300 to €3,700 in earnings and 2.5 to 6.6 percentage points in employment when they are measured ten years after the entry decision. Returns for mature students are somewhat lower when we use a person-fixed effects model to compare the post-attendance earnings and employment of polytechnic entrants with their own pre-attendance earnings and employment. Consistent with most studies of postsecondary vocational education, our results apply to the short- and medium-run, as we have data for approximately 13 years after enrolment.

There is substantial heterogeneity in returns by sex, age, and field of study. Women generally have higher earnings and employment returns than men. In the medium run, older students have larger earnings gains but younger students have larger employment returns. In general, students studying health have higher earnings and employment gains compared to students studying business or technology.

2. Relationship to previous literature

The majority of studies on postsecondary vocational education focus on the returns to U.S. community colleges. These colleges offer associate's degrees in academic and vocational areas of study, and these degrees typically require two years of full-time study. Community colleges also offer long-term certificates (one year or more of full-time study, also known as diplomas) and short-term certificates, all in vocational areas. In studies using panel data to control for ability bias and the non-random selection of students into community college, associate's degrees and long-term certificates are associated with higher earnings and

[2] Specifically, we exclude individuals who attend universities from the comparison group. In other words, the treatment group contains individuals who attend only ISCED level 5, and the comparison group excludes individuals attending ISCED levels 5 and above.

employment, particularly for women (see Jepsen *et al.*, 2014; Stevens *et al.*, 2015; Belfield and Bailey, 2017, and the references therein).[3] Returns for short-term certificates are smaller and, in some cases, provide no discernible labour-market gains. Jacobson *et al.* (2005a, 2005b) and Bahr (2016b) also find positive effects of community college attendance without degree or certificate completion. Recent work in this area uses more flexible models and finds that the returns to community college are generally larger in the medium and long run compared to short-run returns (Bahr, 2016a; Jaggars and Xu, 2016; Minaya and Scott-Clayton, 2017).

However, U.S. community colleges have organizational differences from European universities of applied science such as those in Finland, Norway, the Netherlands, and elsewhere. U.S. community colleges provide courses and programmes in nearly every conceivable subject, and many of their vocational offerings are available on nights and weekends to facilitate part-time study. In fact, most community college students study part time and do not complete any sort of award (degree or certificate). In contrast, most European programmes like the one we study for Finland offer a limited number of subjects, where most students attend full time with the explicit objective of receiving a degree. For example, completion rates in Finland are approximately 70%, compared to around 30% for the U.S. (Jepsen *et al.*, 2014).[4]

There are few studies on the labour-market returns to postsecondary vocational education elsewhere in Europe. Riphahn *et al.* (2010) compare labour-market returns between polytechnics and universities in Germany, and, using OLS regressions on survey data, they find that universities have higher returns. Dearden *et al.* (2002), McIntosh (2006), and

[3] Studies using less rigorous controls for selection also tend to find positive effects of community college degrees on labour-market outcomes, although many of these studies combine the effects of academic and vocational degrees. Grubb (2002a, 2002b) and Belfield and Bailey (2011) provide thorough reviews on this literature.

[4] Although Shapiro *et al.* (2014) report a completion rate of nearly 40%, they do not distinguish among types of credential. In most states, the most common credential is a certificate that takes months rather than years to complete and is not comparable to anything offered in Finnish polytechnics.

Brunello and Rocco (2015a) find a similar pattern for other European countries. Schomburg and Teichler (2006) provide descriptive information on differences in employment and, in some cases, earnings from surveys in 12 countries, predominantly in Europe. Using much more sophisticated econometric methods, Verhaest and Baert (2015) find no evidence of a difference in early labour-market effects between postsecondary vocational and general postsecondary education in Belgium. Similarly, Brunello and Rocco (2015b) see little difference in long-run employment returns in the UK between the two sectors.

Because we run separate analyses on labour-market returns for older students, previous work on returns to adult education is also relevant. Albrecht *et al.* (2009) and Stenberg (2011) look at returns to adult education in Sweden. For example, Stenberg (2011) finds that a year of adult education increases earnings by 4.4%.[5] However, these studies are not directly comparable because they focus on education at the (upper) secondary-school level rather than at postsecondary vocational level. Stenberg and Westerlund (2016) look at long-run returns to attendance at postsecondary adult education in Sweden, but the estimated return is a combined effect of academic and vocational education. They find that a year of attendance at age 29–55 increases earnings approximately 5.5% for males and 10% for females. Similarly, Hällsten (2012) reports larger returns from academic postsecondary education for adult females than for adult males in Sweden.[6]

This paper contributes to a small literature on returns to postsecondary vocational education, where most of the research is on U.S. community colleges. As discussed, U.S community colleges and European postsecondary vocational institutions have substantial differences so that the returns to community colleges provide limited insight about the likely returns to European institutions. Therefore, results from Finland are much more representative of the returns to postsecondary vocational education in Europe.

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[5] Albrecht *et al.* (2009) calibrate an equilibrium search model using pre-program data and forecast impacts of a specific adult education initiative targeted at low-skill workers.

[6] The focus is on academic postsecondary due to incomplete data on postsecondary vocational education.

The current paper provides five substantial contributions relative to previous work on Finland (Hämäläinen and Uusitalo, 2008; Böckerman *et al.*, 2009). First, we look at medium-run returns over several years rather than studying the returns one or two years after graduation as in previous research. Second, we use propensity score matching on comprehensive registry data to identify a comparable set of workers with no postsecondary education. Third, we look at the returns to the established vocational system rather than studying the returns to the creation of a new polytechnic system. Fourth, we focus on returns to enrolling (regardless of completion status) given the likely endogenous decision on enrolees whether to complete rather than focusing on returns to completion. Fifth, we also examine returns for mature students returning to education after working compared to the focus of students aged 35 and under. The inclusion of older students with prior working experience is particularly policy-relevant in the aftermath of the global economic crisis, because many unemployed individuals have to decide whether to pursue additional education or not and the government has to decide whether to invest more resources in postsecondary vocational education.

The primary goal of this paper is to estimate the returns (up to approximately 13 years after enrolment) on enrolling in vocational polytechnic education compared to not attending postsecondary education. Although previous literature finds positive returns, the size of the returns varies substantially across countries and studies. A secondary goal is to study heterogeneity in returns across several dimensions. For example, we look at returns between traditional-age versus older students. We test whether returns are highest for students entering in the early twenties (Jepsen *et al.*, 2012) or whether returns are similar across age (Jacobson *et al.*, 2005b). We also test the U.S. finding that returns to postsecondary vocational education are higher for the health sector (Belfield and Bailey, 2017).

3. Vocational polytechnic education in Finland

Vocational colleges were a diverse group of schools at the beginning of 1990s (OECD, 2003). The entry requirements and the length of education varied between 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 high school (upper secondary schooling) before entering vocational college.

The purpose of the polytechnic education reform was to raise the general educational standard and training of the population and to diversify higher education (OECD, 2003). Other objectives included pooling resources into larger units and making the Finnish education system more comparable to educational systems in other European countries.

The first 22 polytechnics, established under a temporary licence in 1991, were created by gradually merging 215 vocational colleges and vocational schools. The trial phase was judged a success and, since 1996, the temporary polytechnics gradually became permanent. In the 1990s, the number of polytechnic entrants increased rapidly to a level that substantially exceeds the number of university entrants (Böckerman and Haapanen, 2013). Currently there are around 129,000 students enrolled in 24 polytechnics.

Polytechnic degrees are Bachelor-level degrees with a vocational emphasis. These degrees are quite similar to the Bachelor of Arts (Hons) or Bachelor of Science (Hons) Degrees in the UK, the French Licence, the German Diplom Fachhochschule and the Dutch HBO Diploma. In Finland, the polytechnic degrees take 3.5 to 4 years to complete. The three largest fields are business and administration, social and health care (typically nursing), and technology and transport (typically engineers). Each year, 80–90% of all polytechnic degrees are awarded in these three fields. These institutions are much different from U.S. community colleges that offer at most an associate’s degree and cover a much more diverse range of fields of study. For example, the data in Stevens *et al.* (2015) contain 24 different fields of study, and roughly half of the students in their sample are studying one of the six most popular fields of study.

As a consequence of the polytechnic education reform, the higher education system in Finland comprises two parallel sectors, which are academic universities and vocationally-oriented polytechnics. Unlike academic universities, polytechnic schools are not engaged in academic research, and their students finish studies after getting a bachelor's degree.[7] Finland has a particularly high proportion of adults in tertiary education, as reported by Hällsten (2012). For example, approximately 9% of adults ages 30–34 attend tertiary education in Finland compared to roughly 4% in Germany or in the UK.

4. Data

The comprehensive individual-level data come from the Longitudinal Census File and the Longitudinal Employment Statistics File constructed by Statistics Finland. These two administrative data sets were updated on five-year intervals from 1970 to 1985 and annually from 1987 to 2014. The data contain *all* under 70-year-old individuals in Finland during this period. The data are further merged with the Registry of Completed Degrees, which has information on completed degrees since 1970, and the Registry of Student Population, which contains information on individuals' presence or absence at degree-leading educational programmes since 1995.[8] Because individuals are matched based on their unique personal identifiers across time periods and data sources, these panel data sets provide a variety of reliable, register-based information on all the residents of Finland.

In contrast to surveys, for example, the comprehensive, register-based data contain only a minimal amount of measurement error (Malamud and Wozniak, 2012). Furthermore, register data on spouses, parents, and the region of residence are linked to the individual

[7] Although universities offer bachelor's degrees as well, in practise these degrees serve as preparation for a master's degree. Polytechnics have recently been given the opportunity to provide master's level degrees, but the number of attendants in these programs is still low relative to number of polytechnic bachelors' students. A minimum of three-year work experience is also an entry requirement for the polytechnic master's programs.
[8] Information on the completed degrees and student population is available at ISCED level 3 and higher in Finland.

records. Through longitudinal linkages of the data, we are able to know, for example, spouse's employment status, parents' level of education, and unemployment rate in the municipality of residence.

A high-school or vocational school degree is required for entry to higher education. Therefore, the population sample is limited to individuals with upper secondary-level schooling (by 2003). We also exclude individuals who move abroad during the sample period as well as individuals attending polytechnics in the Åland Islands, a small isolated region with many differences such as language from the rest of Finland. Furthermore, we exclude individuals if they attend a university programme at or after the entry decision.[9] Thus, the comparison is between people who enter polytechnics (but not in combination with other educational programmes) and people who do not enter polytechnics or university (who choose to stay in or enter the labour market instead).

In the analysis, we are interested in the labour-market outcomes of individuals who are aged 19 to 50 when they initially enrol in polytechnics between 1997 and 2004. Of the 178,709 individuals who enter polytechnics, 74.7% receive a polytechnic bachelor's degree by 2014. The individuals are followed backward until 1987 or the year they turn 18, and forward until 2014 or age 64. On average, we follow them 5 years backwards and 13 years forwards.

5. Method

Throughout the analysis, we divide the sample into traditional-age students, age 19 to 24 at entry, and mature students, age 25 to 50 at entry. In addition to testing whether returns vary between the two groups, this separation also allows us to control for pre-polytechnic earnings among mature students. Because these individuals have considerable work histories

[9] One potential concern is we are conditioning on future outcomes (and thus have endogeneity concerns) by excluding individuals who later attend university. However, our results for the mature students hardly change when we do not condition on future postsecondary schooling; in addition, the results for traditional-age students remain qualitatively similar (i.e. positive and highly significant); see cf. Table 1 and Supplementary Appendix Table A17.

before making the decision to return to school, these work histories likely affect the amount of schooling as well as the labour-market returns to schooling.

5.1 Matching estimators

Our preferred method is a matching estimator where we compare polytechnic entrants to similar individuals who did not attend postsecondary education as of 2014. Carruthers and Sanford (2015) also use this technique for U.S. community colleges, although they have no characteristics other than earnings on which to match, and Stenberg and Westerlund (2016) apply it for Swedish tertiary adult education. By utilizing enrolment rather than completion as treatment, the treatment is not affected by the endogenous length of schooling or completion. As discussed in Stenberg and Westerlund (2016), the length of education is likely to be linked with costs in effort and indirect opportunity costs in the form of foregone earnings. Although our data include several ability measures introduced below, these opportunity costs are likely to make the length of treatment endogenous in an unpredictable way and thus limit the possibilities for estimating the returns to completion. Therefore, we focus on effects of attendance.

For each entrant and non-entrant, we calculate the propensity of entering a polytechnic as follows:

(1) $$Prob(POLYBA_i) = f\left(DEMOG_{i,-1}, Y_{i,-j}\right), \qquad j = 1, 2, 3, 4, 5, 6$$

where *Prob*(*POLYBA*) denotes the probability of entry (i.e. the propensity score), *DEMOG* denotes the demographics (as shown in Supplementary Appendix Table A2) prior to entry, and *Y* denotes earnings and employment in the three (for the age 19 to 24 cohort) or six (for the age 25 to 50 cohort) years *j* before enrolment. Squared prior earnings at time -1 and -2 capture non-linearities in the probability of entry. We estimate the function *f* as a probit, and we estimate separate models for traditional-age students and mature students.

To illustrate the matching algorithm more closely, consider a mature polytechnic entrant who started polytechnics in 2000. For this individual, the demographics are from

1999 and the earnings and employment information are from 1994 to 1999. We also calculate the corresponding entry probabilities in 2000 for individuals with no postsecondary attendance based on the prior demographic and labour-market information. The yearly data on each non-entrant can constitute up to eight different control observations (one for each entry year 1997 to 2004). Hence, in total we have around 6 million non-entry observations. For the younger group of non-entrants, we utilize all possible entry years when the individual is aged between 19 and 24, resulting in 784,464 control observations. For the older group of non-entrants (aged 25 to 50 at entry), we randomly select one year in the 1997–2004 window to serve as the reference year rather than allow a non-entrant to serve as a match at any year. This reduces the computation burden (to 1,038,314 control observations).

We use propensity score matching based on the nearest neighbour. Using the example from the previous paragraph, we compare the entrant in 2000 with the control individual with the most similar entry probability based on the prior demographic (from 1999) and labour-market information (from 1994–1999). We utilize exact matching on the calendar year. We match with replacement, so that an individual with no postsecondary attendance can be matched with more than one entrant. After matching, we compare the average earnings and employment development among entrant and non-entrant groups from six years before up to sixteen years after the entry decision.

The matching algorithm assumes that the propensity score captures the differences between polytechnic entrants and individuals with no postsecondary attendance. In other words, the selection is a function of observable characteristics. The validity of this assumption is strengthened by the inclusion of nationally standardized matriculation test scores, which measure ability of individuals at the completion of high school[10] (typically at age 19), and the overall grade from individual subjects calculated at the completion from

[10] The matriculation examination is a national compulsory final exam taken by all students who graduate from high school.

comprehensive school (typically at age 16). The matching algorithm also benefits from the inclusion of prior earnings and employment among the observable characteristics. Matching estimators based on prior earnings are common in studies of job-training; for example, see Mueser *et al.* (2007). Note that we include a shorter period – three years – of pre-enrolment earnings and employment for traditional-age students (age 19 to 24 at entry) because of their limited labour-force attachment prior to polytechnic entry. Because most individuals in this age group enter polytechnics straight from school, pre-enrolment earnings may not be indicative of the future labour market earnings potential and therefore the identification of the effect of polytechnic attendance rests more on other matched observable characteristics (such as the scores from high school and comprehensive school).

Matching estimators use data on a large sample of individuals with no postsecondary attendance. Rather than comparing polytechnic entrants to the entire sample of individuals in the control group, we instead use the subset of individuals who are similar with respect to the likelihood of entering a polytechnic bachelor's programme. However, the main observable difference is that one group has entered the programme and the other group has not.

With the matched sample, we compare average labour-market outcomes between entrants and matched non-entrants. Specifically, we have administrative information on annual earnings from the Finnish tax authorities. Annual earnings are deflated to 2012 euros by using the consumer price index. Employment is a dichotomous variable equal to one for individuals who are employed during the last week of each year. Matching also allows us to investigate the extent to which the prior earnings and employment trends as well as other characteristics (such as ability) differ between individuals with or without any polytechnic education. In addition, by producing different matching estimators for each follow-up year after the enrolment decision, we allow the returns to vary over time as is done in the most recent work in the U.S. (such as Bahr, 2016a; Jaggars and Xu, 2016; Minaya and Scott-Clayton, 2017).

5.2 Person fixed-effects model

Because we have a detailed panel data set with pre-, during- and post-attendance earnings data, we also estimate the change in earnings and employment associated with polytechnic bachelor's degrees for mature students. Specifically, we compare the post-attendance earnings with the pre-attendance earnings for individuals who are aged 25 to 50 when they enter polytechnics. In terms of programme evaluation, this estimation technique resembles a treatment-on-the-treated model. The fixed effects model has been used extensively to study the returns to U.S. community colleges (Jacobson *et al.*, 2005a, 2005b; Jepsen *et al.*, 2014; Stevens *et al.*, 2015; Belfield and Bailey, 2017). Because this model assumes that the pre-attendance earnings are a valid counterfactual earnings estimate in the absence of polytechnic attendance, we only estimate this model for mature students aged 25 to 50 at entry.

Equation (2) describes the person fixed-effects model similar to that estimated in the U.S. community college literature:

(2) $$Y_{it} = \beta POSTATTENDANCE_{it} + \gamma ATTENDANCE_{it} + \eta_i + \omega_i t + \tau_t + \varepsilon_{it}$$

In this equation, *i* denotes a person and *t* denotes a year. The dependent variables (Y_{it}) are annual measures of earnings and employment. Although employment is dichotomous, it is estimated with linear probability models. Linear models for employment are common in the returns to schooling literature, as they are less sensitive to distributional assumptions (Wooldridge, 2001).

POSTATTENDANCE is a dichotomous variable equal to one in the post-attendance period, defined as not attending polytechnics at all since year *t*. For example, a person who finished attending a polytechnic in 2002 (regardless of receiving a degree or not) will have values of 0 from 1987 to 2002 and values of 1 from 2003 onwards. The variable accounts for any increase in earnings resulting from polytechnic school attendance regardless of degree received. In other words, this post-attendance variable equals one for all individuals, dropouts and completers, in post-attendance periods, and therefore captures the combined effects of attendance and completion on earnings. It also captures the overall increase in earnings across post-attendance periods. We make this choice for simplicity, as there is no consensus in the literature whether to allow for time-varying returns or not.[11] As mentioned previously, the model does not control for completion in order to avoid any assumptions about the exogeneity of the completion decision.

ATTENDANCE contains two dichotomous attendance variables. The first is equal to one for the years when the individual is attending polytechnic and zero otherwise. This variable accounts for the opportunity cost (in terms of earnings and employment) for students while they attend polytechnics. The second variable is equal to one for the years of attendance when the individual is absent from education (i.e. gap years from study) and zero otherwise. The earnings are likely to be higher during the years in the labour market compared to the years attending education. Inclusion of the attendance variables means that the *POSTATTENDANCE* variable estimates the change in the earnings relative to the earnings prior to the entry.[12]

The key feature of the model is the inclusion of the person fixed effects (η_i) and, in some specifications, person-specific time trends ($\omega_i t$). The person fixed effects control for time-invariant ability and other factors such as personality traits that affect earnings and are correlated with polytechnic attendance. Person-specific trends account for unobserved differences in motivation that may result in differences in earnings trajectories and degree completion. The fixed effects model uses variation between individuals as well as variation over time within individuals to estimate the value of the coefficients. Although each source of

[11] For example, Jaggar and Xu (2016) use a piecewise growth curve model, whereas Bahr (2016a) estimates returns for the time since credential and its square.
[12] Note that our descriptive analysis below does not reveal an Ashenfelter dip in earnings prior to entry (for the entrants).

variation has their weaknesses, together they provide a compelling technique for estimating the causal effect of education on earnings and employment.

The model also contains indicator variables for each calendar year and for the number of years prior to entry (except for the year before). The year before entry acts as a reference point in the analysis. Furthermore, we include the unemployment rate at the municipal (NUTS-5) level as an additional, time-varying control. We denote these sets of time effects as τ. The inclusion of the variables controls for differences in macroeconomic conditions such as the business cycle as well as for differences in age-schooling profiles. The last component (ε) is the unobservable component of earnings and employment. There are up to 28 years for each individual, from 1987 to 2014. Standard errors are clustered at the person level.

6. Results

6.1 Descriptive statistics

Supplementary Appendix Table A1 contains the descriptive statistics for the sample. The table reports results separately for entrants and for the full sample (i.e. matched and unmatched) of non-entrants, as well as separately by age category. The unit of analysis in the table is an individual. The top panel of the table contains the post-entry outcomes, the middle panel contains the pre-entry outcomes, the third panel contains demographic information, and the bottom panel contains household characteristics.

Ten years after the entry decision, average annual earnings are around €28,000 for entrants and €24,000 for non-entrants in the younger cohort. At the same time, employment percentages are 87.5% for entrants and 81.8% for non-entrants. For the older cohort, by ten years after the entry decision, average earnings are €33,100 for entrants and €31,200 for non-entrants. Average employment rates are 86.1% five years after the entry decision, compared to rates in year 10 of 87.9% for entrants and 83.5% for non-entrants. For comparison, according to Statistics Finland's Wage Structure Statistics, the average annual earnings of full-time wage and salary earners were €38,500 and the median earnings were €34,200 in 2012.

The second panel shows that entrants have worse pre-entry labour-market outcomes than the full sample of non-entrants for both age cohorts. This pattern suggests that the full sample of non-entrants is likely not a good control group for entrants due to different trends in labour-market outcomes. Thus, our matching analysis uses the subset of the comparison group with similar propensities to attend polytechnics.

The third panel provides demographic information on the sample, where all characteristics are measured prior to the initial polytechnic enrolment decision. Mature students are on average 33 years of age when they enter polytechnics. 54 to 62% of all polytechnic students are female compared with 41 to 49% of non-entrants. Entrants are drawn from the middle part of the distribution of the matriculation examination scores. The NUTS-5 regional unemployment rate is over 14%, illustrating the deep recession of the early 1990s.

Figures 1 and 2 provide detailed information on the profiles of annual earnings and employment for entrants and the full sample of non-entrants, where the x-axis shows the number of years relative to initial polytechnic enrolment. Year 0 is the year when the individual makes the enrolment decision. Year -1 is the year prior to enrolment, and year 1 is the year after enrolment.

For the younger cohort, earnings (Figure 1a) and employment (Figure 1b) increase dramatically around 4–5 years after the entry decision, consistent with large gains after leaving polytechnics. Because non-entrants have no postsecondary attendance during the period, they have more steady gains over time in both outcomes.

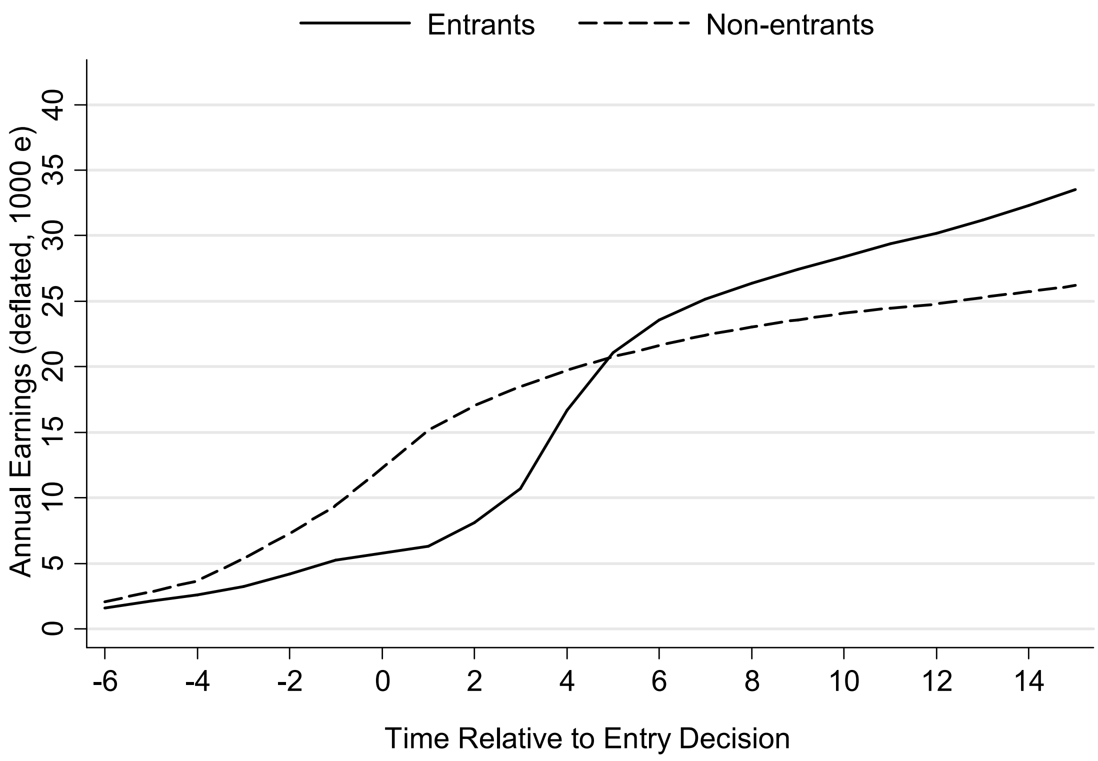

Fig. 1a Annual earnings by treatment status, aged 19 to 24 at entry

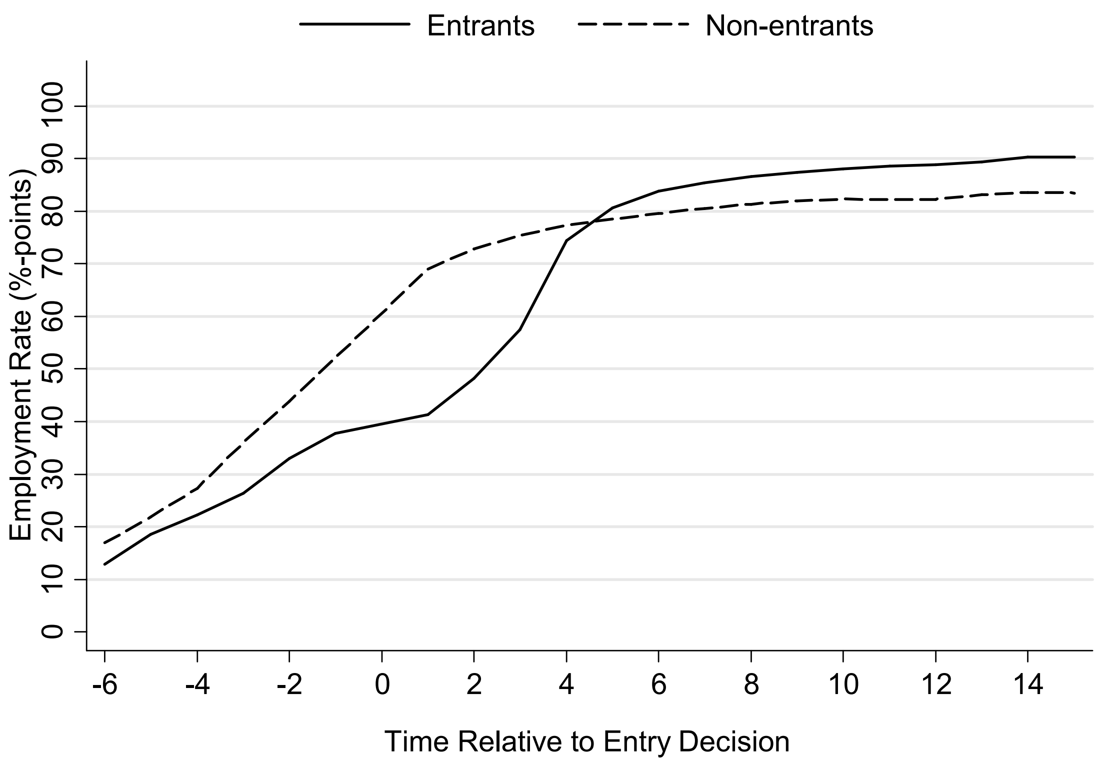

Fig. 1b Annual employment by treatment status, aged 19 to 24 at entry

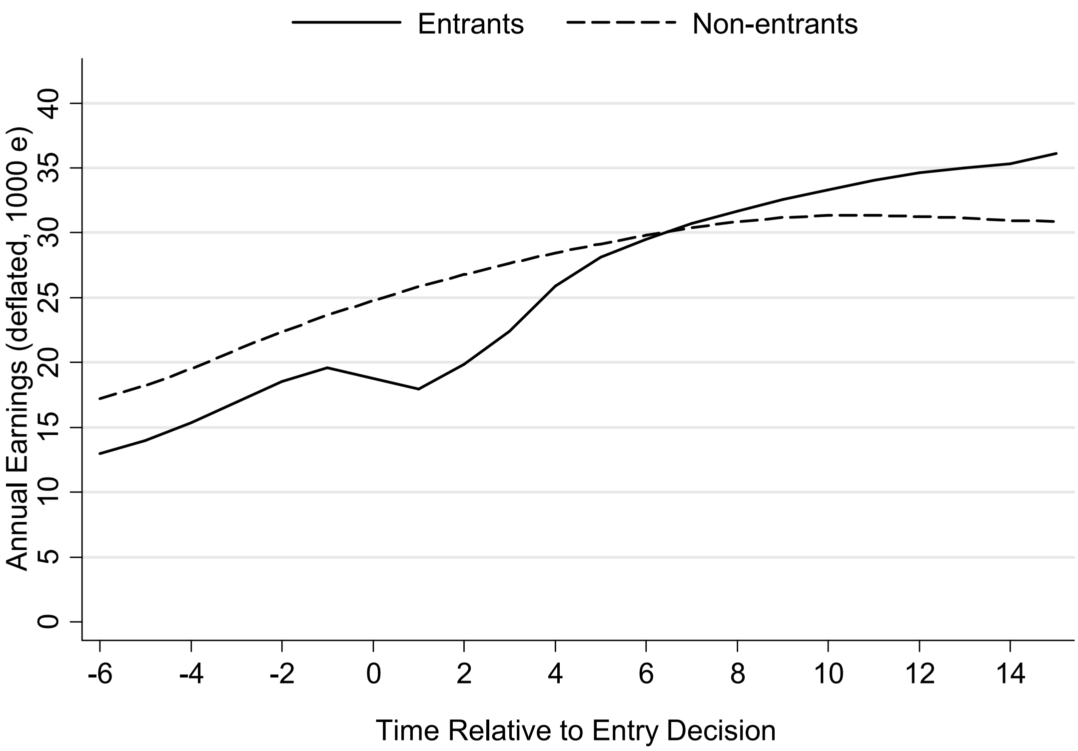

Fig. 2a Annual earnings by treatment status, aged 25 to 50 at entry

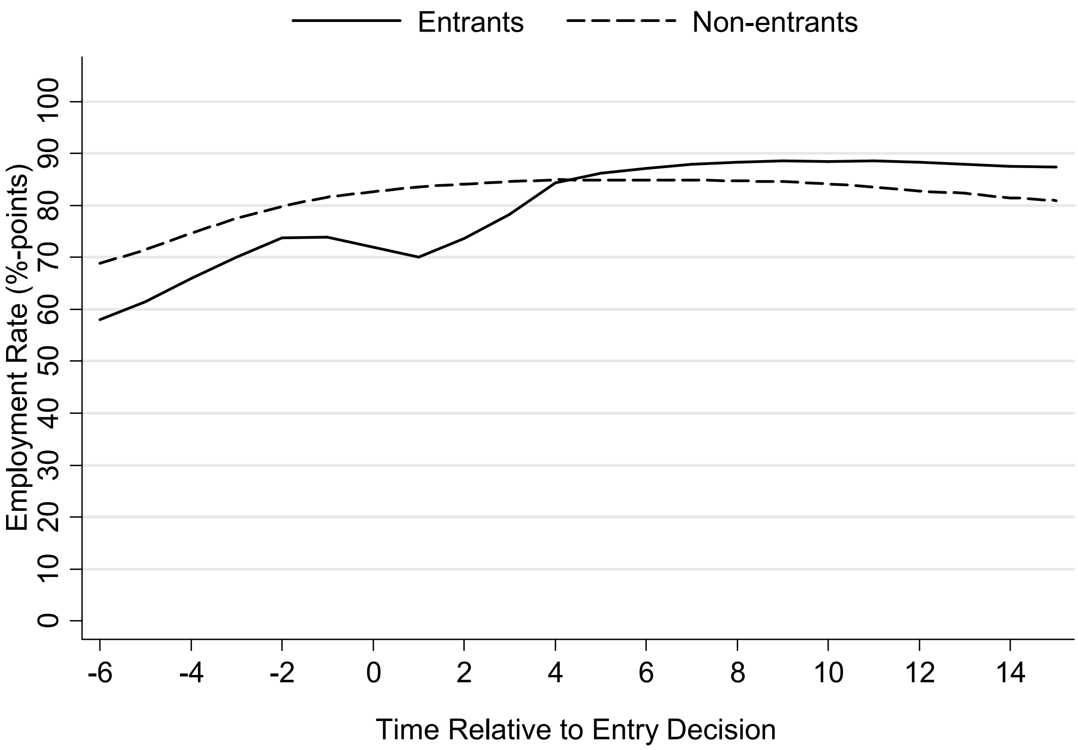

Fig. 2b Annual employment by treatment status, aged 25 to 50 at entry

For the older cohort, the patterns for average earnings (Figure 2a) and employment (Figure 2b) are similar. Entrants have a decline around the time they enter polytechnics, and then they have an improvement in both outcomes soon after entry. In contrast, non-entrants have a more gradual increase in earnings and employment, corresponding to the pattern for non-entrants in the younger cohort.

6.2 Matching estimator results

First, we look at the results using the matching estimators, where the comparison group for entrants is the subset of individuals who have the most similar propensity to enter a polytechnic but have no postsecondary attendance. Supplementary Appendix Table A2 contains the results for the probit model estimating the likelihood of entering a polytechnic, with separate models for traditional-age and mature students. For mature students, a poor labour-market history significantly increases the likelihood of entering a polytechnic.[13]

As shown in Table A3 and A4, all covariates are balanced between the matched entrants and the non-entrants, based on the standardized differences in means and the variance ratios.[14] In other words, the matched sample is similar with respect to observable characteristics as well as with respect to the propensity of entering a polytechnic in a particular year. Supplementary Appendix Figures A1 and A2 confirm that we have sufficient common support for each entry year in the samples of traditional-age students and mature students given the large size of the control population.

Figures 3 and 4 illustrate our preferred estimates of the returns to attending polytechnics. They show the average treatment effect on the treated between entrants and the matched sample of non-entrants, as well as the 95%, two-sided confidence interval based on standard errors that allow for heterogeneity. As in earlier figures, the x-axis measures time in years relative to the entry decision, the year in which entrants start attending polytechnics.

[13] Regarding employment history, our sample of mature students has some resemblance to displaced workers studied in Jacobson *et al.* (2005a, 2005b).
[14] The reported matching results are estimated using the psmatch2 package in Stata 14.

Table 1 also shows the effects for selected years; full results are available in Supplementary Appendix Table A5.

Figures 3 and 4 show that, as expected, there are few differences in average earnings for the pre-entry period. Soon after entry, entrants have markedly lower earnings due to their polytechnic attendance compared to no attendance for the non-entrants, an effect known as 'lock-in effect' in the job training literature. Thereafter, the earnings gains increase steadily over time for both cohorts. For the younger cohort (Figure 3a), the average annual earnings of entrants are €1,300 more than that of matched non-entrants for five years after entry. In percentages, the average earnings of the entrants are around 6.7% higher than that of the matched non-entrants. The corresponding increase in earnings is €3,300 (13.3%) for ten years after entry (see also Table 1). For the older cohort (Figure 4a), the gain in average annual earnings of entrants is around €2,000 five years after entry, around 7.6%. Ten years after entry, the gain is over €3,700, around 12.7%.

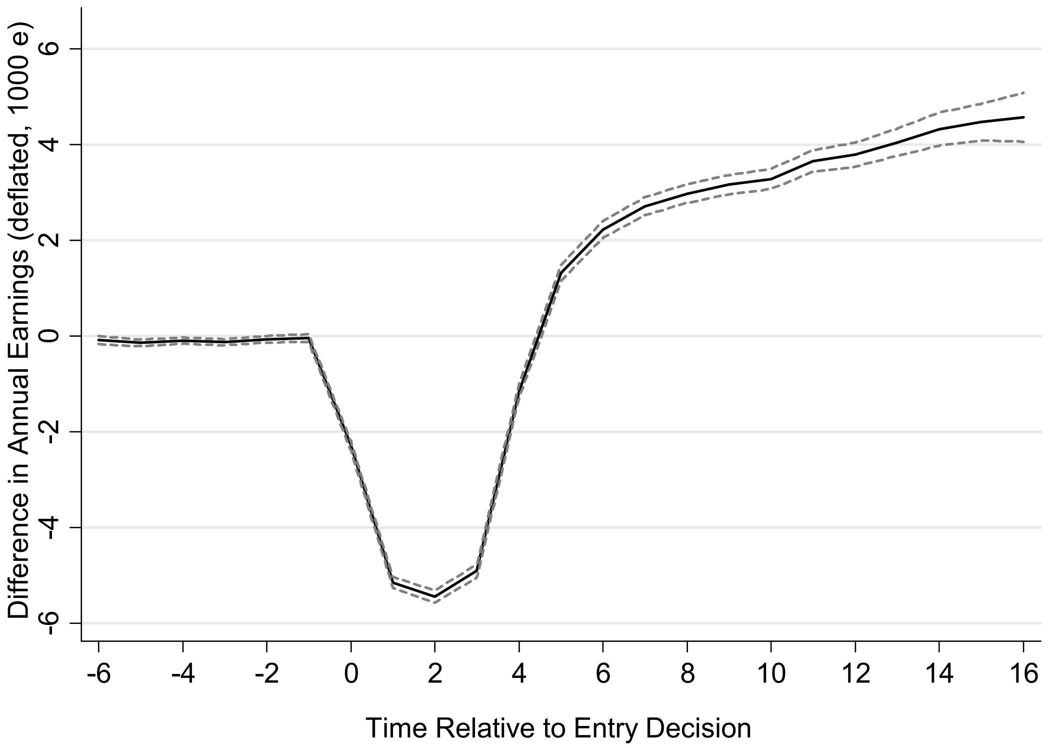

Fig. 3a Difference in earnings development between the matched polytechnic entrants and non-entrants, aged 19 to 24 at entry (Notes: Treatment effect on the treated is reported. Dashed lines indicate 95% confidence intervals.)

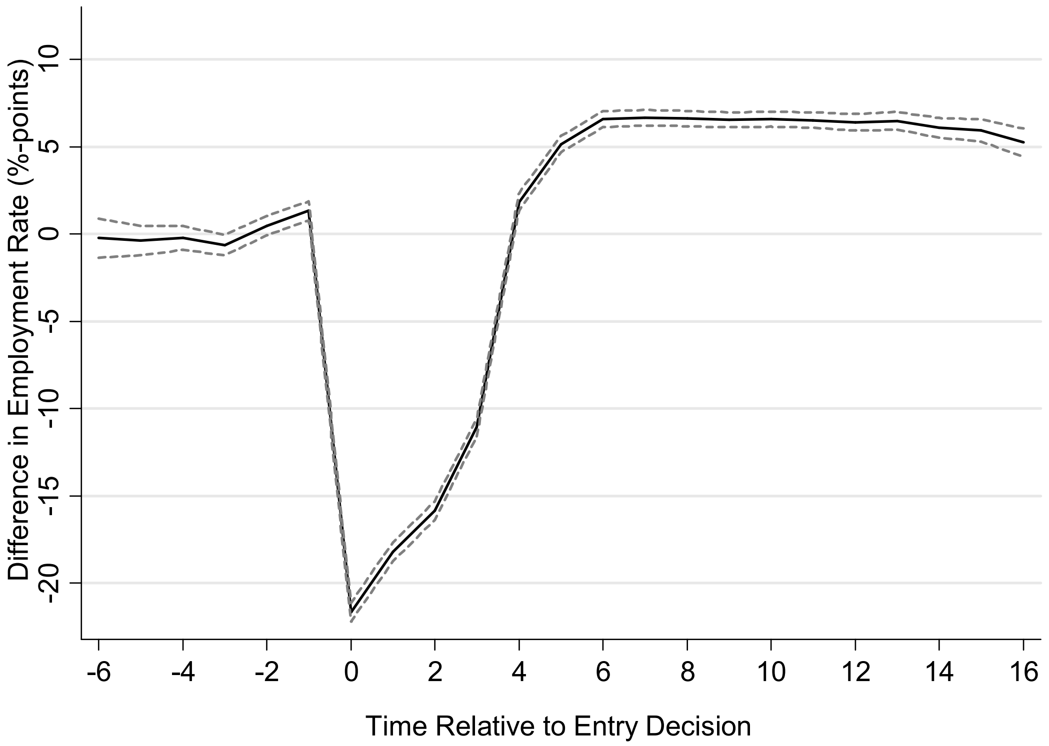

Fig. 3b Difference in employment development between the matched polytechnic entrants and non-entrants, aged 19 to 24 at entry (Notes: Treatment effect on the treated is reported. Dashed lines indicate 95% confidence intervals.)

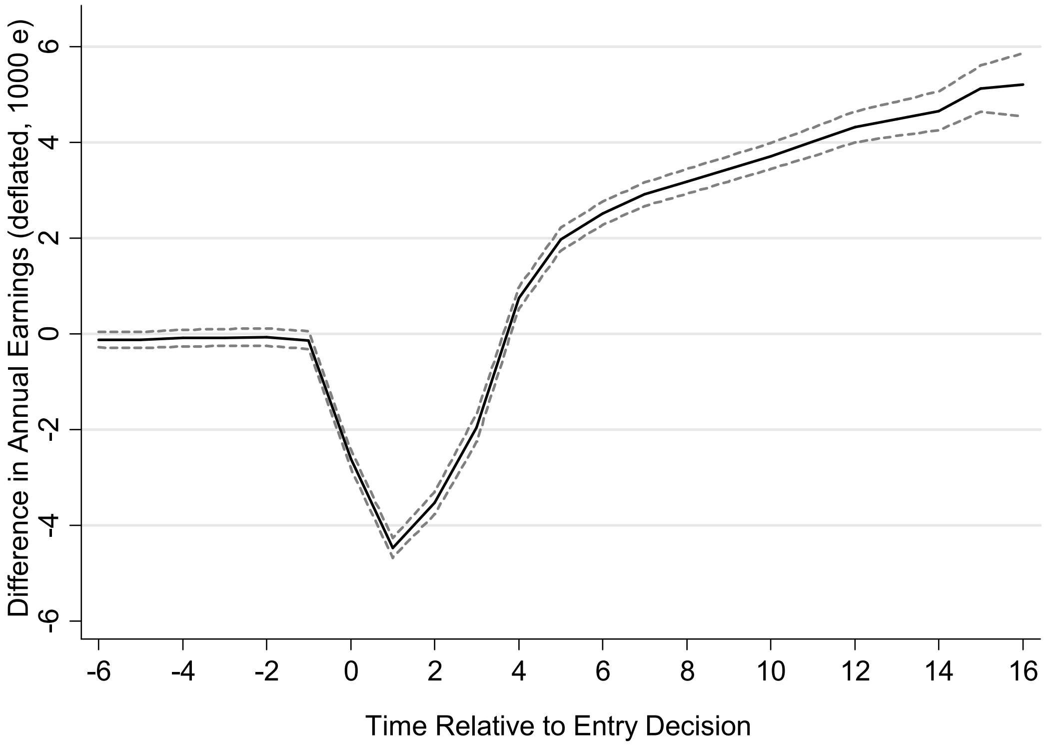

Fig. 4a Difference in earnings development between the matched polytechnic entrants and non-entrants, aged 25 to 50 at entry (Notes: Treatment effect on the treated is reported. Dashed lines indicate 95% confidence intervals.)

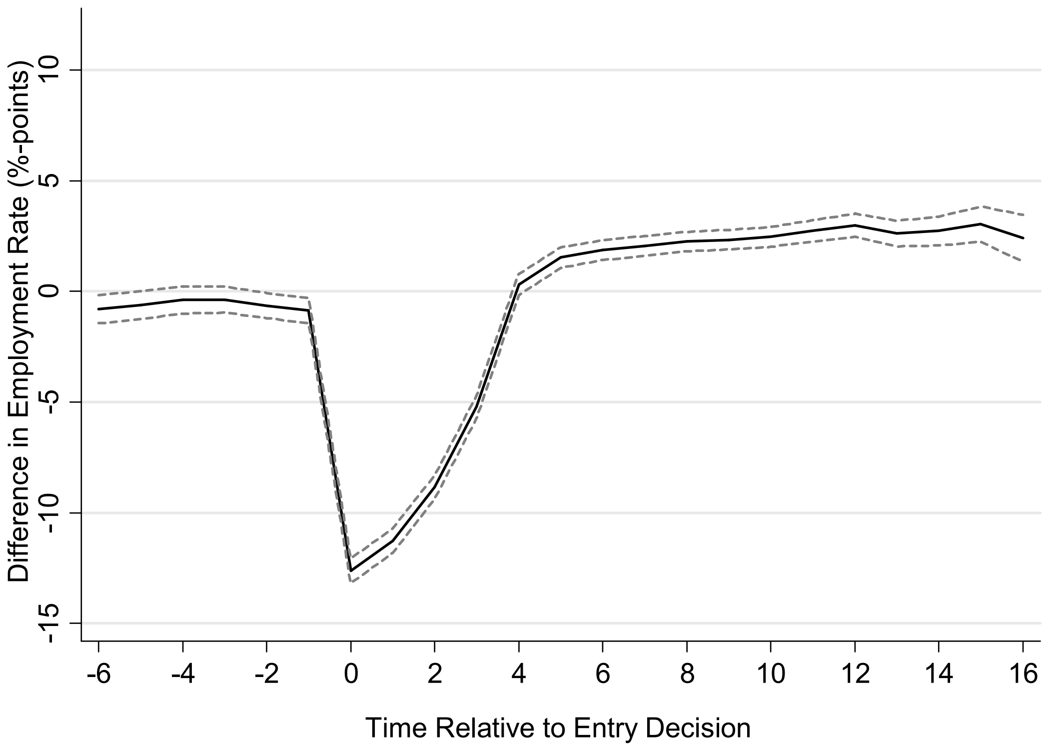

Fig. 4b Difference in employment development between the matched polytechnic entrants and non-entrants, aged 25 to 50 at entry (Notes: Treatment effect on the treated is reported. Dashed lines indicate 95% confidence intervals.)

Table 1 Earnings and employment results for matching estimators (entrants vs. non-entrants)

Number of Years after Match (i.e. after Polytechnic Entry Decision)	Earnings (1) Diff.	 (2) Std. Err.	Employment (3) Diff.	 (4) Std. Err.	$N^{Treated}$
Panel A: Aged 19 to 24 at Entry					
Year of Entry (t = 0)	-2.292***	0.050	-0.217***	0.003	127,802
5 Years After Entry (t = 5)	1.320***	0.085	0.051***	0.002	126,686
10 Years After Entry (t = 10)	3.287***	0.107	0.066***	0.002	125,275
Panel B: Aged 25 to 50 at Entry					
Year of Entry (t = 0)	-2.606***	0.099	-0.126***	0.003	50,887
5 Years After Entry (t = 5)	1.982***	0.123	0.015***	0.002	50,466
10 Years After Entry (t = 10)	3.719***	0.139	0.025***	0.002	49,940

Notes: $N^{Treated}$ = Number of treated individuals. Average treatment effects on the treated are reported. The results are based on propensity score matching on nearest neighbour on common support. A probit model is used to estimate the propensity scores (see results in Supplementary Appendix Table A2). Statistical significance in two-sided tests are denoted by * for the 10% level, ** for the 5% level, and *** for the 1% level. *Source*: Authors' calculations.

As with earnings, the pattern of results for employment shows a similar trend between entrants and non-entrants before the entry decision, followed by noticeably lower employment among entrants immediately after entry, with higher employment of entrants relative to non-entrants after entrants complete their studies. For the younger cohort, the gain in employment is five percentage points five years after entry and nearly seven percentage points ten years after entry. For the older cohort, the post-attendance gains in employment are much more modest, with the medium-run effect of less than three percentage points.

Thus, the results show a difference in effects by age cohort. The younger cohort has a larger employment gain than the older cohort, but the older cohort has a larger earnings gain. Possible explanations are that earnings have lower variation at younger ages because entry-level jobs have actual wages close to binding minimum wages stipulated in collective agreements, but employment outcomes can vary sizably. In contrast to the U.S., where mature students often return to school in response to involuntary job loss (Jepsen *et al.*, 2014), mature students in Finnish polytechnics return voluntarily so that both entrants and non-entrants have high employment rates throughout the study period (Figure 2b).

To provide an economic insight into the total medium-run returns to education, we have also calculated discounted cumulated gains based on the matching estimates. Following Koedel and Podgursky (2016), we use a 4% discount rate in the calculations. As reported in Supplementary Appendix Table A11, the total gains are €8,500 for the traditional-age students and €18,200 for the mature students over the period 0–16. The rate of return per year attended is also higher for the mature students because they, on average, attend polytechnic education for a shorter time than the traditional-age students (3.7 years vs. 4.6 years).

6.3 Sensitivity analysis

We have checked the sensitivity of our findings to alternative matching estimators. Instead of our preferred estimator of nearest neighbour matching with replacement, we estimated several alternative matching models:[15] (A) two nearest neighbours, (B) four nearest neighbours, (C) one nearest neighbour with a trimmed sample of 2%,[16] (D) one nearest neighbour with a trimmed sample of 5%, (E) caliper (radius) matching with a caliper of 0.0001, and (F) an Epanechnikov kernel matching estimator with bandwidth of 0.06. With the exception of the kernel estimator for mature students' earnings, the results are similar using the different estimators. For example, five years after entry, the estimated difference in earnings for ages 19 to 24 (Supplementary Appendix Table A6) is between €1,304 and €1,409, compared to the increase of €1,320 for the preferred estimator in Table 1. For mature students, the kernel estimator for five years after entry is €1,278 (Supplementary Appendix Table A7) compared to the preferred estimate of €1,982 in Table 1. However, the estimates for ten years after are more similar between the kernel estimator (€3,248) and the preferred nearest neighbour estimator (€3,719). Finally, our findings are not sensitive to the set of covariates that is used in the matching models (Panels G–I of Tables A6–A7).

[15] The results are also qualitatively similar when we ran the person fixed-effects models on the matched sample of mature entrants and non-entrants: earnings and employment returns are negative during education and positive after exiting education; see Supplementary Appendix Table A18.
[16] This trimming drops 2% of the treatment observations at which the propensity score density of the non-entrant observations is the lowest.

6.4 Returns by demographic groups

Now we turn to our secondary goal of exploring differences in returns across demographic groups (and, later, fields of study). Table 2 shows the earnings returns to polytechnic attendance by sex, as most U.S. studies provide separate returns by gender. The top two panels (A–B) are for the younger cohort, and the bottom two panels (C–D) are for the older cohort. Within each panel, we report the average treatment effect on the treated for three time periods, the year in which students enter polytechnics, five years after entry, and ten years after entry (full results are available in the Supplementary Appendix Tables A12–A13). The first two columns contain the coefficient and standard error for the annual earnings model, and the next two columns contain the coefficient and standard error for the annual employment model. The final column reports the sample size for each estimate. Each panel and outcome are from a separate model, such as earnings among men ages 25 to 50 at entry.

For the younger cohort, male entrants have higher earnings of nearly €2,300 after ten years. The gap between entrants and non-entrants is even larger in later years. In contrast, female entrants have higher earnings that peak at a difference of approximately €5,800 after six years, compared with a difference of around €5,000 in years 9 to 13. For employment, the pattern is similar for women: large initial employment gains for entrants that level off at a slightly lower level. For men, the employment gains are relatively constant around 2.5 to 3.5 percentage points starting nine years after the entry decision. Additional analyses on the young entrants show that completion rates are substantially higher for women (82.2%) than men (65.0%), which partially explains the larger initial gains for the former.

Table 2 Earnings and employment results by sex and age at entry

Number of Years after Match (i.e. after Polytechnic Entry Decision)	Earnings (1) Diff.	Earnings (2) Std. Err.	Employment (3) Diff.	Employment (4) Std. Err.	$N^{Treated}$
Panel A: Males Aged 19–24					
Year of Entry (t = 0)	-2.879***	0.072	-0.268***	0.004	58,996
5 Years After Entry (t = 5)	-2.991***	0.122	-0.035***	0.003	58,619
10 Years After Entry (t = 10)	2.256***	0.151	0.028***	0.003	58,112
Panel B: Females Aged 19–24					
Year of Entry (t = 0)	-2.135***	0.070	-0.200***	0.004	68,804
5 Years After Entry (t = 5)	5.433***	0.109	0.126***	0.004	68,065
10 Years After Entry (t = 10)	4.921***	0.133	0.103***	0.004	67,161
Panel C: Males Aged 25–50					
Year of Entry (t = 0)	-3.130***	0.183	-0.142***	0.005	19,199
5 Years After Entry (t = 5)	0.615***	0.235	-0.008**	0.004	19,032
10 Years After Entry (t = 10)	3.887***	0.267	0.025***	0.004	18,773
Panel D: Females Aged 25–50					
Year of Entry (t = 0)	-2.277***	0.110	-0.113***	0.004	31,673
5 Years After Entry (t = 5)	2.813***	0.128	0.033***	0.003	31,421
10 Years After Entry (t = 10)	3.798***	0.147	0.035***	0.003	31,154

Notes: $N^{Treated}$ = Number of treated individuals. Average treatment effects on the treated are reported. The results are based on propensity score matching on nearest neighbour on common support. A probit model is used to estimate the propensity scores. Statistical significance in two-sided tests are denoted by * for the 10% level, ** for the 5% level, and *** for the 1% level. *Source*: Authors' calculations.

For the older cohort, the gap in earnings between entrants and non-entrants grows steadily over time for both men and women.[17] For example, five years after entry, male entrants have higher earnings of €600 compared with non-entrants, but female entrants have higher earnings of €2,800 compared with non-entrants. By ten years after entry, the earnings gains of male and female entrants are €3,900 and €3,800, respectively. This pattern of results for mature students is in contrast with the noticeably higher returns for women in U.S. community colleges (Jepsen *et al.*, 2014; Carruthers and Sanford, 2015). By ten years after entry, entrants have higher employment probabilities of 2.5 percentage points for men and 3.5 percentage points for women.

[17] Completion rates are also substantially higher for women than for men (75.5% vs. 58.4%) among the mature students.

Table 3 provides the results using more detailed age categories to see how if at all the overall returns vary by age. In the short run, i.e. five years after entry, the largest earnings returns are for the oldest cohort (€2,400), but the largest employment returns are for the youngest cohort (6.1 percentage points). Similarly, the largest employment returns ten years after entry are also for the youngest cohort, with an increase of 7.0 percentage points compared with 2.8% for the 25 to 34 year old cohort. Ten years after entry, the largest earnings returns of €4,200 are again for the oldest cohort. In comparison, the medium-run returns for the youngest cohort are slightly above €3,000. Thus, the results for Finland are not always consistent with the U.S. finding where younger students generally have higher returns (Jepsen *et al.*, 2014).

Table 3 Earnings and employment results by age at entry

	Earnings		Employment		
Number of Years after Match	(1)	(2)	(3)	(4)	
(i.e. after Polytechnic Entry Decision)	Diff.	Std. Err.	Diff.	Std. Err.	$N^{Treated}$
Panel A: Aged 19–21					
Year of Entry (t = 0)	-2.054***	0.055	-0.217***	0.004	92,432
5 Years After Entry (t = 5)	1.544***	0.105	0.061***	0.003	91,662
10 Years After Entry (t = 10)	3.057***	0.135	0.070***	0.003	90,639
Panel B: Aged 22–24					
Year of Entry (t = 0)	-3.728***	0.079	-0.252***	0.004	35,365
5 Years After Entry (t = 5)	0.685***	0.125	0.023***	0.003	35,019
10 Years After Entry (t = 10)	3.203***	0.159	0.046***	0.003	34,631
Panel C: Aged 25–34					
Year of Entry (t = 0)	-2.889***	0.120	-0.148***	0.004	30,342
5 Years After Entry (t = 5)	1.664***	0.151	0.019***	0.003	30,083
10 Years After Entry (t = 10)	3.335***	0.180	0.028***	0.003	29,772
Panel D: Aged 35–50					
Year of Entry (t = 0)	-2.167***	0.161	-0.082***	0.004	20,529
5 Years After Entry (t = 5)	2.377***	0.185	0.018***	0.003	20,369
10 Years After Entry (t = 10)	4.226***	0.212	0.029***	0.003	20,155

Notes: $N^{Treated}$ = Number of treated individuals. Average treatment effects on the treated are reported. The results are based on propensity score matching on nearest neighbour on common support. A probit model is used to estimate the propensity scores. Statistical significance in two-sided tests are denoted by * for the 10% level, ** for the 5% level, and *** for the 1% level. *Source*: Authors' calculations.

Supplementary Appendix Table A8 compares results between students who are from the Helsinki metropolitan area (using NUTS-3 as the level of region) and the rest of Finland.[18] For students aged 19–24, employment and earnings effects are larger for students originating from the Helsinki metropolitan area versus the rest of Finland. For the older cohort, earnings effects are smaller for students from Helsinki. Hence, there is no clear pattern by region.

6.5 Returns by field of study

Our final matching analysis investigates whether, as in the U.S., health is the field of study with the highest returns. In Supplementary Appendix Tables A9–A10, we present the returns to polytechnic bachelor's degrees by the field of study for the younger and older cohorts, respectively. We divide fields of study into three main areas: business, technology, and health. The subject area of technology and transport is the most popular, with 55,031 students, or 31% of all entrants. Business, administration, and social sciences is the next most popular, with 48,369 students, or 27%. Of the polytechnic entrants, 42,785 study in the field of health (23%). The dependent variable is earnings in the first two columns and employment in the second two columns. As always, each panel and outcome is from a separate model.

The earnings and employment returns vary substantially by field of study. For the younger cohort (Table A9), health has the largest employment returns, at 14.8 percentage points after five years and 12.5 percentage points after ten years.[19] Health also has large earnings gains in five years of €6,600, in contrast to a more modest earnings gain of nearly €4,400 after ten years. Business has the largest earnings returns after ten years at €5,400, as well as having sizable short-run earnings returns (€3,100). Employment returns are also large

[18] Region of residence is measured during a year prior to entry because the region of study is potentially endogenous to the choice of attendance.

[19] The medium-run employment effects are largest for health also when we estimated the matching models separately for men and women; see Supplementary Appendix Figures A3–A4 for graphical illustration. The difference is most notable for mature students.

in business (8.8 to 10.3 percentage points). On the other hand, technology has the lowest returns of the three field of studies, and the effects are negative five years after entry.

For the older cohort (Table A10), the earnings and employment patterns are similar, although the size of the effects is different. Health is again the field with the highest employment gains (7.4 to 8.4 percentage points) and the highest short-run earnings gains (€3,900). Technology and health have equally large medium-run earnings gains of nearly €5,000, and business has increases in earnings as much as €3,500. In contrast to the younger cohort, however, business has little if any effect on employment for the older cohort. In sum, health does well in improving employment and earnings (consistent with results from the U.S., as summarized in Belfield and Bailey, 2017).

6.6 Fixed effects regression results

To look more in depth at returns for mature students, we supplement our preferred matching analysis with person fixed-effects models for two outcomes, annual earnings and annual employment. The results from this model are in Table 4. For each outcome, the first specification (columns (1) and (3)) is the basic specification with person-specific fixed effects,[20] whereas the second specification (columns (2) and (4)) also includes person-specific time trends ($\omega_i t$ in equation (2)) as estimated in some specifications in Jacobson *et al.* (2005a) and elsewhere.

In the combined sample for men and women (Panel A), polytechnic attendance (with or without a degree) is associated with an average annual increase in earnings of €2,200 for the basic specification and €2,300 for the person-specific time trends model. These earnings increases are slightly lower than those from the preferred matching model. In the basic specification (column 3), the employment effect is 4.5 percentage points, whereas it is much

[20] Supplementary analyses based on Oster's (2017) method show that the person fixed-effects results are robust to omitted variable bias (see Table A19). Our analyses imply that the unobservables would need to be 1.74 (5.21) times as important as the observables in order to produce zero treatment effect of polytechnic attendance on earnings (employment).

lower at 2.1 percentage points in the person time-trends specification (column 4). In comparison, the employment effect is around 2.5 percentage points in the preferred matching model. Hence, the results are broadly comparable between the fixed-effects and matching approaches.[21]

Table 4 Fixed effects earnings and employment results, students aged 25 to 50 at entry

	Earnings		Employment	
	(1)	(2)	(3)	(4)
Panel A: Full sample (N=1,314,418)				
Post attendance	2.163***	2.318***	0.045***	0.021***
	(0.101)	(0.085)	(0.002)	(0.002)
Attendance	-3.905***	-3.922***	-0.079***	-0.097***
	(0.062)	(0.054)	(0.002)	(0.002)
Adjusted R-squared	0.603	0.750	0.299	0.401
Panel B: Males (N=490,272)				
Post attendance	2.158***	1.759***	0.028***	-0.004
	(0.192)	(0.156)	(0.004)	(0.004)
Attendance	-4.066***	-4.411***	-0.081***	-0.107***
	(0.115)	(0.099)	(0.003)	(0.003)
Adjusted R-squared	0.615	0.780	0.323	0.443
Panel C: Females (N=824,146)				
Post attendance	2.583***	2.783***	0.055***	0.037***
	(0.115)	(0.101)	(0.003)	(0.003)
Attendance	-3.720***	-3.615***	-0.079***	-0.092***
	(0.071)	(0.064)	(0.002)	(0.002)
Adjusted R-squared	0.580	0.709	0.285	0.378
Person fixed-effects	Yes	Yes	Yes	Yes
Person time-trends	No	Yes	No	Yes

Notes: N = number of observations. All models also include the following control variables: NUTS-5 unemployment rate, calendar year dummy variables, absent from education, and dummy variables for each year prior to entry (except for the year before). Statistical significance in two-sided tests are denoted by * for the 10% level, ** for the 5% level, and *** for the 1% level. *Source*: Authors' calculations.

[21] We have also estimated fixed-effects models that compare completers to dropouts from polytechnic education. They show marked positive earnings and employment effects. These results are available in Supplementary Appendix Table A20.

The second and third panels (B–C) provide the results separately for men and women, respectively. The earnings results correspond to our short-run results from matching models: women benefit more from attending polytechnics than men. When we include person-specific time trends in the specification in column (4), only women seem to benefit from the polytechnic education. The estimated employment effect for men is essentially zero, which is contrary to our expectations.

7. **Discussion**

The main aim of this paper is to estimate the returns to attendance at polytechnics in Finland. As expected, postsecondary vocational attendance is associated with higher earnings and employment in the short and medium run compared to a matched sample of individuals who did not attend postsecondary education. For the younger cohort, the increase in annual earnings is €1,300 for five years after entry and €3,300 for ten years after entry. The gain in employment is 5.1 to 6.6 percentage points. For the older cohort, the gain in earnings is nearly €2,000 five years after entry and over €3,700 ten years after entry. The post-attendance gains in employment are modest (1.5 to 2.5 percentage points).

Another goal is to explore variation in earnings by other demographic characteristics such as age at entry and sex. As in the U.S., women in Finland usually have higher returns to postsecondary vocational education. With respect to field of study, health is related to sizeable increases in employment and short-run earnings (as is usually found in the U.S.). Business also has considerable increases in earnings and, for the younger cohort, employment, too.

Our overall results are broadly comparable with other studies of postsecondary vocational education. Despite longer enrolment in Finland, studies from the U.S. tend to find larger returns for associate's degrees than we do for Finnish polytechnic attendance.[22] Even

[22] The U.S. results also generally find larger returns than our earlier work on returns to the completion of polytechnic degrees in Finland (Böckerman *et al.*, 2015).

the results for attendance from Jacobson *et al.* (2005a) are larger than our results for attendance. Conversely, our medium-term returns are generally larger than the returns for the first two years of the new polytechnic system found in Böckerman *et al.* (2009). Our results for mature students are similar in size to the results in Stenberg and Westerlund (2016) for adult education in Sweden. In addition, the results in Hällsten (2012) for degrees received are similar to the findings for degree receipt in Finland reported in Böckerman *et al.* (2015).

We provide much-needed information on the labour-market returns to postsecondary vocational education in Europe. The majority of evidence comes from U.S. community colleges, but the U.S. system is much different from the system in most European countries. Although our paper focuses on one country, the postsecondary vocational system in Finland is representative of many European countries. Students earn polytechnic bachelor's degrees after approximately three and a half to four years of full-time attendance, as in other countries such as Norway and the HBO diploma from universities of applied science in the Netherlands. Given the dire labour-market prospects for individuals with no postsecondary education in Europe, particularly among younger individuals, a better understanding of the labour-market returns to postsecondary vocational education is needed (Bell and Blanchflower, 2011). Results from the U.S. are not very informative for Europe given the pronounced differences in education systems and labour markets, as illustrated by the generally smaller returns compared to U.S. results. More research on Europe and elsewhere is warranted, particularly for long-run outcomes that we do not have data to study.

Supplementary material

The data used in this paper are confidential, but the Stata do-files have been uploaded online as supplementary material and are available online at the OUP website. The online appendix is also available here.

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