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Back to school: Labor-market returns to higher vocational schooling

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ABSTRACT

This paper examines the labor-market returns to a new form of postsecondary vocational education: vocational master's degrees. We use individual fixed effects models on a matched sample of students and non-students from Finland to capture any time-invariant differences across individuals. We find that attendance in vocational master's programs leads to an earnings increase of more than seven percent five years after entry. The estimated effect remains positive even if selection on unobservables is twice as strong as selection on observables. Earnings gains are similar by gender and age, but they are marginally higher for those in the health sector than for those in the business or technology and trades sector.

1. Introduction

Vocational skills are valued in the labor market. Along with academic qualifications, the demand for work-oriented vocational skills is increasing (ILO, 2011). Policymakers have responded to the call to improve and enhance the content of vocational education and training. For example, the European Union's 2020 roadmap for vocational education and training, the Bruges Communiqué, treats practical work-oriented vocational skills and academic qualifications as being equally important (Brunello and Rocco, 2015).

This paper analyzes the labor-market returns to a new breed of postsecondary vocational education that combines the development of work-oriented vocational skills with the updating of academic knowledge. A deeper understanding of the connection between vocationally-oriented education and labor-market outcomes is central to education policies because a better match between skills and work promotes labor market inclusivity (OECD, 2017). Countries around the world are considering how to allocate resources between universities and vocational education providers in a way that best supports their citizens and economies.

Studies on the labor-market returns to postsecondary vocational education focus on bachelor's or lower-level programs. Recent evidence for the U.S. shows that community college degrees and diplomas in vocational fields lead to higher earnings and employment, particularly for women (see Jepsen et al., 2014; Belfield and Bailey, 2017, and the references therein). These programs are both vocationally and academically oriented and require up to two years of full-time study. In Europe, many vocational programs are of longer duration, of up to four years, and culminate in the receipt of a vocational bachelor's degree.[1]

Little, if anything, is known about the potential labor-market returns to master's degrees with a vocational focus, even though several European countries (such as Germany, Portugal, and Finland) offer such degrees. The growing literature on postgraduate education completed later in life focuses narrowly on academic degrees (Hällsten, 2012; Stenberg and Westerlund, 2016). Rapid technological change is occurring in occupations and industries such as manufacturing, where workers traditionally have vocational rather than academic qualifications. Lifelong learning, either in the form of on-the-job training or in terms of formal education, is vital for success in these jobs. For example, over 60% of U.S. workers were found to have received training or instruction at work in the last 12 months (Horrigan, 2016). An analysis of those who have prior working experience is especially policy relevant in the aftermath of the global economic crisis, as many unemployed have to decide whether to pursue additional formal schooling, and governments have

[1] Dearden et al. (2002) analyze a variety of academic and (lower-level) vocational qualifications in the UK and find that the wage premium associated with academic qualifications is typically higher than the premium associated with vocational qualifications at the same level. Böckerman, Haapanen, and Jepsen (2018) find sizable positive earnings and employment effects of obtaining vocational *bachelor's* degrees in Finland. See also Böckerman, Hämäläinen, and Uusitalo (2009).

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to decide whether to invest more resources in higher vocational education to improve the labor-market prospects of young people.

This paper produces the first estimates (as far as we are aware) of the labor-market returns to schooling in new vocational master's programs established in 2002. We examine returns to formal part-time education for prime-age workers (aged 25–55 years at entry). Using complete annual register data from Finland, we first create a matched comparison sample of individuals who would be eligible to attend vocational master's programs and have similar demographic characteristics, ability, and pre-enrollment labor-market experiences but who choose not to attend. For this matched sample of students and non-students, we estimate an individual fixed effects model to compare earnings before and after attending vocational master's programs. We estimate models of attendance and models of completion.

The results of the individual fixed effects models show that individuals who attend vocational master's programs—whether or not they complete a degree—have higher earnings than a matched comparison group who do not attend. By four to six years after entry, the earnings gains for attendees are more than seven percent of the average earnings in the year before entry. Over the same time period, the returns to degree completion are higher, at 10–11%. Returns are broadly similar between males and females and between younger and older students. Five to six years after entry, students of health programs have the highest returns, followed by those of technology and trades programs. Our estimates remain robust even if there is substantial selection into vocational master's programs. Because most European countries, like Finland, have vocational bachelor's programs that enroll large numbers of students, these findings demonstrate the potential earnings benefits of expanding vocational education further to the master's level.

2. Vocational master's programs in Finland

The Finnish government created polytechnics in 1991 to provide higher-level vocational education. Polytechnics are public institutions and form an integral part of the education system.[2] Funding for the polytechnics is provided by the state and local authorities. Polytechnics offer bachelor's degrees that take approximately 3.5–4 years of full-time study. By the end of 2001, around 61,000 students had completed these vocational bachelor's degrees in Finland, but they had very limited opportunities for acquiring further formal education in university master's programs. Starting in 2002, the government began a three-year trial period during which 20 polytechnics were allowed to run six different vocational master's programs ("*ylempi* AMK" in Finnish), with aggregate enrollment of 300 students per year. Licenses for these programs were issued by the Ministry of Education.

During the initial trial period, programs were offered only in business and administration, social welfare and health care, and technology and trades (such as construction). These were regarded as the fields that transform and internationalize most rapidly and therefore require lifelong learning and a continual upgrading of practical work-oriented skills. Programs covering other major fields were added later. There were 1312 applicants for vocational master's programs in 2002–2004 (ultimately, 900 applicants were accepted, and 706 students began in the vocational master's programs). During the first application round, the programs on entrepreneurship and business skills for small and medium-sized enterprises (SMEs), social work, and health promotion and preventative health care were the most popular.

The eligibility criteria for enrollment in a vocational master's program are the completion of a vocational bachelor's degree (or other applicable degree) and a minimum of three years of work experience in a relevant field prior to entry. During the initial trial period, the work experience had to be accumulated after the completion of the bachelor's degree. After 2005, part of the work experience could also be accumulated before the degree (minimum one year of work experience after the bachelor's degree). We account for work experience using a comprehensive set of register-based controls (e.g., employment and earnings history, and pre-treatment enrolment in education programs).

Because the trial period was deemed successful, vocational master's programs have expanded substantially.[3] For example, nearly 2000 new students entered these programs in 2008, and around 4300 students entered them in 2016. As a consequence of this expansion, master's degrees can be completed in two parallel sectors offering separate schooling tracks: universities engaged in academic research and vocationally-oriented polytechnics. Some subjects are offered in polytechnics but not in universities, and *vice versa*. Unlike a university master's degree, a vocational master's degree does not provide academic qualifications for studies in doctoral programs.

Finland's new vocational master's degree programs take from one to one and a half years of full-time study to complete (60–90 ECTS[4] credits; around 72–108 ECTS credits during the trial period). The programs are designed for completion in two to three years of part-time attendance. Unlike university education (or the vocational bachelor's degrees), the vocational master's degree programs are organized in a way that allows studying while working (Ministry of Education and Culture, 2012). Teaching modes include contact days, independent work, and the use of online learning environments. Most lectures are given on Fridays and Saturdays and in the evenings. A significant component of the degree is the completion of a thesis (30 ECTS credits), which is often a development project closely linked to the needs of the current employer (Ministry of Education and Culture, 2012). Echoing the earlier findings on UK students in similar programs (Pratt et al., 1999), few students start a vocational master's program with the explicit intention of moving to a new job. Instead, most students seek to improve their professional knowledge, skills, and understanding in their current employment (Pratt et al., 2004).

The central purpose of these programs is to offer further training in vocational skills that are relevant to the labor market.[5] Another aim is to provide sufficient knowledge and skills for demanding expert and managerial positions, and foster the continuous development of work-life tasks. Vocational master's programs have no fees or tuition, and students are entitled to (income-dependent) study grants.

The Finnish polytechnics resemble *Fachhochschulen* in Austria, Germany, and Switzerland, *Hautes écoles* in Belgium and Switzerland, *Hogescholen* in the Netherlands, and *Escolas Politécnicas* in Portugal, which also offer both bachelor- and master-level qualifications with a vocational (professional) emphasis (OECD, 2014). The post-initial *Hoger Beroepsonderwijs* (HBO) in the Netherlands and the part-time professionally oriented master's degrees in Britain are also similar to those in Finnish polytechnics (Pratt et al., 2004: p. 42), but students in the Netherlands and Britain need to pay tuition and fees. Vocational master's degrees are currently not available in the U.S., Canada, or Australia. A unique feature of the Finnish vocational master's programs is that they combine adult education and lifelong learning with the structure of a formal degree program organized around and focused upon a research project in a work-related situation (Pratt et al., 2004: p. 23).

3. Data

In our empirical analysis, we utilize exceptionally rich register data on the population of Finland. The basic individual-level data originate

[2] See Böckerman et al. (2018) and the references therein for further information on vocational bachelor's degrees in Finland. Supplementary Online Appendix C (Fig. C1) provides an illustration of the Finnish education system before and after the second phase of the polytechnic reform in 2002.

[3] Due to the small number of entrants during the trial period, we cannot exploit this policy change.

[4] ECTS = European Credit Transfer and Accumulation System.

[5] On-the-job training programs do not lead to formal degrees, and they are offered only by the largest manufacturing firms in Finland. Administrative data do not record these types of on-the-job training programs.

from the Longitudinal Population Census Files and the Longitudinal Employment Statistics Files constructed by Statistics Finland. These two administrative datasets were updated in five-year intervals from 1970 to 1985 and annually from 1987 to 2014. The data cover all Finnish individuals under 70 years old during this period, with the exception of individuals who live or attend polytechnics in the Åland Islands, a small area with less than one percent of the population and many linguistic, cultural, and geographic differences from the rest of Finland. The data are further merged with the Registry of Completed Degrees, which maintains information on completed degrees since 1970, and the Registry of Student Population, which contains information on attendance at degree-leading educational programs since 1995. Finally, the data are linked to comprehensive data on all matriculation exam scores from academic high schools since 1967. Because individuals are matched based on their unique personal identifiers across time periods and data sources, these panel datasets provide a variety of reliable, register-based information on *all* the residents in the covered regions of Finland, including data on spouses and parents.

We limit the sample of potential entrants to vocational master's programs to people with vocational bachelor's degrees as their previous qualification by 2008, since over 95% of attendees have a vocational bachelor's degree. We also exclude the small number of students entering the vocational master's degree programs who are under 25 or over 55 to have a sufficient number of labor market observations before and after the treatment.[6] We also exclude the relatively few students who move abroad during the study period. After these exclusions, we are left with 176,963 vocational bachelor's recipients.

The sample is divided into treated and control groups. The treatment group consists of 7148 individuals who enter a (first) vocational master's program between 2002 and 2009. Entrants in 2010 or later are excluded because they do not have sufficient post-schooling earnings data with which to study the labor-market returns. Of the vocational master's students, 71% complete their studies by 2014. The vocational master's students are compared to 159,391 vocational bachelor's recipients with no attendance in vocational master's programs by 2014.[7]

The treatment and control groups contain a few individuals (around 5%) who attend universities. However, our main results are not sensitive to the inclusion or exclusion of the university students in the data (Table B1). In the analyses, all individuals are followed for a maximum of 10 years backward or until age 18 and a maximum of eight years[8] forward until 2014 or at age 64 (normal retirement age).

4. Method

Our preferred method utilizes two salient data features: the availability of data on entrants and non-entrants along with panel data for many years. We combine these two features by estimating fixed effects models on the matched sample of entrants and non-entrants. Because both matching and fixed effects models are common in labor economics, we provide only a brief overview of the methods here (see Imbens and Wooldridge, 2009, for details).

4.1. Matching model

We use detailed register data to identify a comparison group that has no vocational master's schooling but has a nearly identical likelihood of attending vocational master's programs based on pre-schooling characteristics such as demographics, earnings, and employment.[9] We use propensity score matching based on the two nearest neighbors, but our results are robust to using either coarsened exact matching or inverse probability weighting.[10] The comprehensive set of matching variables is presented in Table A2. In addition to measures of prior employment and earnings, these variables include measures of ability (measured in secondary school), bachelor's degree characteristics such as the field of study, family demographics, and parental education and occupation.[11] Although our preferred model also includes earnings during the year of attendance (as most of the earnings are obtained before the students enroll in September), we test the robustness of this inclusion by estimating alternate matching models that exclude earnings during the year of enrollment.

The matching method assumes that the selection between vocational master's students and individuals who do not attend is based on observables and is therefore captured by the propensity score. The selection-on-observables assumption has merit in this context given the entry requirement of at least three years of earnings prior to entering a vocational master's program. One key advantage of matching is that it allows us to test the covariate balance between the entrants and non-entrants after implementing the method. For each covariate, we report the standardized percentage bias as well as the variance ratio to compare the distribution of covariates between treatment groups, as recommended by Austin (2009); see Supplementary Online Appendix A (Table A3).

4.2. Individual fixed effects models on the matched sample

We estimate the individual fixed effects model using the combined sample of entrants and the matched comparison group of non-entrants. This model has been used extensively to study returns to schooling (Jacobson et al., 2005a, 2005b; Jepsen et al., 2014; Cellini and Chaudhary, 2014; Cellini and Turner, 2019; Jepsen et al., 2016).

The fixed effects model shown in Eq. (1) estimates the returns to attendance:

$$Y_{it} = \beta_{1t} Attend\,MA_i \times TIME_t + \beta_{0t} TIME_t + \alpha AGE_{it} + \tau YEAR_{it} + \eta_i + \varepsilon_{it}, \quad (1)$$

The dependent variables (Y_{it}) are annual measures of earnings and employment for individual i in time t. Our preferred earnings measure is total annual earnings measured in 2012 euros (using the consumer price index). Employment is measured as a dichotomous variable equal to one for individuals who are employed during the last week of each year.

To allow as much flexibility as possible, $TIME_t$ is a set of dichotomous variables for each year relative to enrollment (with the year before entry as the omitted year); we also include interaction terms be-

[6] See the Supplementary Online Appendix (Fig. C2) for the distribution of age at entry to vocational master's programs.

[7] In the results section, we show that the estimates are robust to expanding the control group by including individuals who are treated in the future (cf. Tables 2 and 4).

[8] We do not estimate the treatment effects for more than eight years after entry because of the low number of observations for these periods (few individuals started their studies in the 2002–2004 period).

[9] Because we match students separately for each year of entry, an individual in the comparison group can appear multiple times in the comparison group dataset. Overall, 159,391 control individuals generate 726,671 potential control observations that are matched with the 7148 treated individuals. Through propensity score matching, of the 12,666 matched control individuals, 953 (70, 4) are matched twice (three or four times) with the treated individuals.

[10] Specifically, we estimate the matching models using coarsened exact matching (Iacus et al., 2012). These CEM results are reported in Supplementary Online Appendix A (Table A1 and Fig. A1). The CEM and inverse probability weighted (IPW) fixed effects regression results are shown in Figs. B1 and B2 (see Appendix B). The results are qualitatively similar to our preferred matched fixed effects results based on nearest-neighbor matching. The only noticeable difference is that the CEM results show small positive employment effects in the long run, but these are likely the result of the utilization of fewer matching variables.

[11] Blundell et al. (2005) stress the importance of correcting for test score and family background differences to estimate the labor-market returns to education. In our specifications, we interact some variables with each other. For example, household characteristics are interacted by gender.

tween the treatment group (i.e., whether the individual has ever attended a vocational master's program) and the set of time indicators: $AttendMA_i \times TIME_t$.[12] These interaction terms are the main coefficients of interest because they capture the extra increase (or decrease) in earnings for individuals who attend vocational master's programs relative to the matched sample of workers who do not. Because the year before enrollment is the omitted year, the coefficients for each time period capture the gain (or loss) in earnings or employment relative to the year before the vocational master's program begins. AGE_{it} includes dummy variables for each year of age, measured in the year of observation, to allow for flexible age-earnings profiles. The model also includes a set of dichotomous variables for each calendar year ($YEAR_{it}$) in order to capture differences in macroeconomic conditions such as recessions. There are up to 19 observation-years for each individual, from 1992 to 2014. Standard errors are clustered at the person level to account for unobservable, within-person variation in outcomes.

The fixed effects approach assumes that the pre- and post-schooling earnings and employment patterns are similar between students who attended a vocational master's degree program and the matched comparison sample of those who did not, after controlling for the individual fixed effects (η_i). If a student receives a positive or negative shock that affects degree receipt/attendance and earnings patterns, the fixed effects model will not produce valid estimates. The last term in Eq. (1), ε_{it}, is the unobservable component of earnings and employment.

A salient data feature is that we have multiple cohorts of entrants (i.e., students who enter vocational master's programs over several years). Given this variation in entry times, coupled with the time effects for calendar year, coefficients β_{1t} capture the changes in labor-market outcomes net of differences in age-earnings profiles. These profiles are captured by the time fixed effects and the controls for age.

Studies on returns to vocational schooling attempt to estimate the returns to degrees as well as returns to attendance (e.g., Cellini and Chaudhary, 2014). We model returns to completion by including additional terms, $PostDegree_{it}$ and $PostDegree_{it} \times MA\_TIME_{it}$, to the baseline Eq. (1):

$$Y_{it} = \beta_{1t} AttendMA_i \times TIME_t + \beta_{0t} TIME_t + \lambda PostDegree_{it} + \gamma PostDegree_{it} \times MA\_TIME_{it} + \alpha AGE_{it} + \tau YEAR_{it} + \eta_i + \varepsilon_{it}, \quad (2)$$

where the dependent variables Y_{it} are the annual measures of earnings and employment, as before.

In Eq. (2), $PostDegree_{it}$ is a dichotomous variable equal to one for having a vocational master's degree (MA) at the beginning of year t, and MA_TIME_{it} is a set of dummy variables for years since graduation, with a total of six terms (two to seven years after graduation, as the first year is the omitted reference period). For example, a person who received a degree in 2007 will have $PostDegree_{it}$ values of 0 until 2007 and values of 1 from 2008 on. For individuals who do not receive a degree, $PostDegree_{it}$ has a value of 0 in all periods. The coefficient for $PostDegree_{it}$ captures the time-invariant returns to graduation, and the coefficients for the interaction terms between $PostDegree_{it}$ and MA_TIME_{it} capture the time-variant returns to degree completion. Similarly to Eq. (1), the coefficients for the interaction terms between $AttendMA_i$ and $TIME_t$ capture the additional returns to attendance, for both completers and dropouts.

For robustness, we also estimate two additional completion models. The first *excludes* the interaction terms between $PostDegree_{it}$ and MA_TIME_{it}, thereby assuming that there are no time-variant returns to graduation. In the second, we model the returns to completion by running separate regressions for completers (and their matched comparison group members) and dropouts (and their matched comparison group members). This latter specification allows the returns to degree completion to vary across time and allows for different pre-enrollment trends in earnings between completers and dropouts. Caution is required when interpreting the estimates of the completion models, as degree completion is endogenous.

In summary, the fixed effects methods combined with matching utilize the unique feature of the vocational master's programs requiring students to have at least three years of work experience in the field in which they plan to pursue post-graduate studies (see Section 2). Both the matching models and fixed effects models are based on the assumption that the pre-enrollment earnings and employment trends for vocational master's students are meaningful measures of their labor-market outcomes in the absence of further education. Due to the work-requirement of master's programs, we argue that these models are more appropriately used in a study of vocational master's programs than in previous studies of the returns to community colleges, for-profit colleges, and vocational bachelor's programs.

5. Results

5.1. Matching quality

Table 1 provides descriptive statistics for three samples: the set of vocational master's students (i.e., the treatment group), the entire population of vocational bachelor's recipients who do not pursue vocational master's degrees (i.e., the control group), and the subset of "non-students" who are matched with vocational master's students (i.e., the "matched control group"). Appendix Tables A3 and A4 present additional statistics on the matching quality.

Comparing Columns (1) and (2) reveals that vocational master's students display several differences from the population of vocational bachelor's recipients. For example, master's students have higher pre-enrollment earnings[13] and employment but fairly similar exam scores relative to the full population of bachelor's recipients. However, comparing Columns (1) and (4) reveals that, as expected, the subset of vocational bachelor's recipients matched with vocational master's students has characteristics in the pre-enrollment period similar to those of the master's students. Based on standardized differences in means and the overall covariate balance statistics reported at the bottom of Table 1, the covariates are well balanced between the matched entrants and non-entrants. Table A3 shows that the variance ratios of treated over matched non-treated are close to one, which shows good balance for continuous covariates.

Fig. 1 illustrates the pre- and post-treatment trends in earnings and employment for the matched control group and the treatment group.[14] Contrary to findings in the literature on displaced workers (Jacobson et al., 2005a, 2005b), we find no Ashenfelter dip in earnings prior to entry (for the entrants). This finding has two explanations. First, our data are measured on an annual basis, whereas the U.S. studies use quarterly data. Second, vocational master's students are almost always employed before and after entry to an educational program. Vocational master's students have higher post-treatment earnings than the matched sample of non-students. The post-treatment differences regarding employment are less pronounced. This observation is as expected, given the high pre-treatment employment levels, above 95%, for vocational master's students. Students show a small dip in employment rates during enrollment in master's programs.

[12] Jepsen et al. (2016) use a similar model to estimate returns to proprietary schooling in the U.S. using quarterly data, but they have data for students only. Therefore, they are unable to include interaction terms between the treatment group and time since enrollment. We have also suppressed an index y in $AttendMA_{iy}$ indicating the year when the individual decides to enter a vocational master's program.

[13] Earnings are in 2012 euros, adjusted by the consumer price index.

[14] See Supplementary Online Appendix A for the full matching results. Fig. C3 in Appendix C presents the development of earnings and employment before and after entry for the full control group and the treatment group.

Table 1
Descriptive statistics: treated vs. unmatched and matched control observations (Selected variables).

	(1) Entrants	(2) Non-entrants (Unmatched)	(3)	(4) Non-entrants (Matched)	(5)
	Mean	Mean	*p*-value[a]	Mean	*p*-value[a]
Earnings at $t = -3$	32.017	21.870	0.000	31.870	0.543
Earnings at $t = -2$	34.674	24.940	0.000	34.628	0.849
Earnings at $t = -1$	36.806	27.901	0.000	36.737	0.786
Earnings at $t = 0$	38.185	29.950	0.000	38.318	0.616
Employed at $t = -3$	0.956	0.780	0.000	0.956	0.935
Employed at $t = -2$	0.969	0.840	0.000	0.969	0.943
Employed at $t = -1$	0.975	0.885	0.000	0.975	1.000
No tenure	0.027	0.110	0.000	0.027	0.959
Tenure 1 year	0.229	0.270	0.000	0.226	0.697
Tenure 2 years	0.210	0.199	0.025	0.208	0.734
Tenure 3 years	0.186	0.141	0.000	0.190	0.556
Tenure 4 years	0.137	0.098	0.000	0.137	0.913
Age in years	36.614	32.802	0.000	36.700	0.490
Female	0.631	0.610	0.000	0.631	0.952
Finnish speaker	0.963	0.954	0.000	0.962	0.878
Living in Helsinki region	0.292	0.323	0.000	0.287	0.568
Not living in the region of birth	0.445	0.427	0.002	0.446	0.866
Enrolled in any education, $t = -1$	0.066	0.068	0.607	0.063	0.424
Enrolled in university education, $t = -1$	0.017	0.008	0.000	0.018	0.655
BA degree from business	0.257	0.285	0.000	0.254	0.708
BA degree from tech. and trades	0.259	0.273	0.010	0.260	0.947
BA degree from health care	0.347	0.283	0.000	0.345	0.854
BA degree from other fields	0.137	0.159	0.000	0.141	0.522
Years from BA degree to entry	5.562	4.475	0.000	5.609	0.252
Comprehensive school grade (4–10)[b]	7.965	7.944	0.035	7.967	0.848
Graduated from academic high school	0.701	0.734	0.000	0.705	0.602
Exam score in native language					
Not written or failed	0.289	0.259	0.000	0.285	0.624
1	0.029	0.035	0.006	0.028	0.822
2	0.103	0.107	0.258	0.100	0.524
3	0.262	0.285	0.000	0.267	0.501
4	0.227	0.223	0.398	0.230	0.750
5	0.090	0.091	0.873	0.090	0.942
Married	0.812	0.735	0.000	0.811	0.889
Has child	0.302	0.316	0.010	0.302	1.000
Unempl. rate	0.098	0.103	0.000	0.098	0.977
Overall covariate balance[c]					
LR-test of the joint insignificance of variables		8357.1 ($p < 0.001$)		57.66 ($p > 0.999$)	
Mean [median] absolute bias		11.5 [3.6]		0.6 [0.6]	
Rubin's B ("bias")		114.4		13.0	
Rubin's *R* ("ratio of variances")		0.48		0.98	
Number of observations	7148	726,671		13,771	

Notes: Earnings are measured in 1000 euro (adjusted to 2012 euros). See Tables A2–A4 for complete list of matching variables and their descriptive statistics. The variables include tenure (0–10), number of degree-leading education programs attended, study loan, exam score in English language and mathematics, spouse's and parents' characteristics, NUTS-4 region of residence, occupation, industry, and entry year. [a] *p*-value tests for the significance of difference in means between non-entrants and entrants. [b] Conditional on the availability of the school grade. [c] Statistics are based on the full matching model reported in Table A2; According to Rubin (2001), $B < 25$ and $0.5 < R < 2$ indicate sufficiently balanced samples.

5.2. Fixed effects regression results on the matched sample

Fig. 2 and Table 2 present the estimated returns to attendance from the fixed effects model. The top panel of the figure and the first columns of the table report the results where the dependent variable is total annual earnings. In the bottom panel of the figure and the last two columns of the table, the dependent variable is annual employment. We report the gain (or loss) in earnings associated with attending a master's program relative to the time period one year prior to entry in the master's program, the time period omitted from the regressions. In addition to these interaction terms between time and attendance, the model also contains dummy variables for the time period relative to attendance to control for overall trends in earnings for the combined sample of attendees (treatment group) and the matched control group.

Annual earnings for program attendees are €2700–€2900 higher than for the control group four to six years after entry compared to the year before entry. By seven years after entry, the return is over €3000.[15] In percentage terms, attendees have a 7.3–7.8% increase in earnings (from €36,800 the year prior to entry) four to six years after initial enrollment.[16] By contrast, the earnings differentials between attendees and the matched control group are small and not statistically different from zero in all the pre-enrollment time periods.

To provide additional insight into the quantitative size of the total returns to education, we have calculated the discounted cumulated gains based on the estimates reported in Table 2. Following Koedel and Podgursky (2016), we use a 4% discount rate in the calculations. As

[15] When we estimate a fixed effects model with a single post-schooling period, as is done in many U.S. studies, the coefficient is around €2000 (results available from the authors upon request).

[16] An estimation of the fixed effects models with log earnings as the dependent variable (dropping the small number of zero annual earnings) also resulted in a 7–8% gain in earnings (see Appendix Table B2).

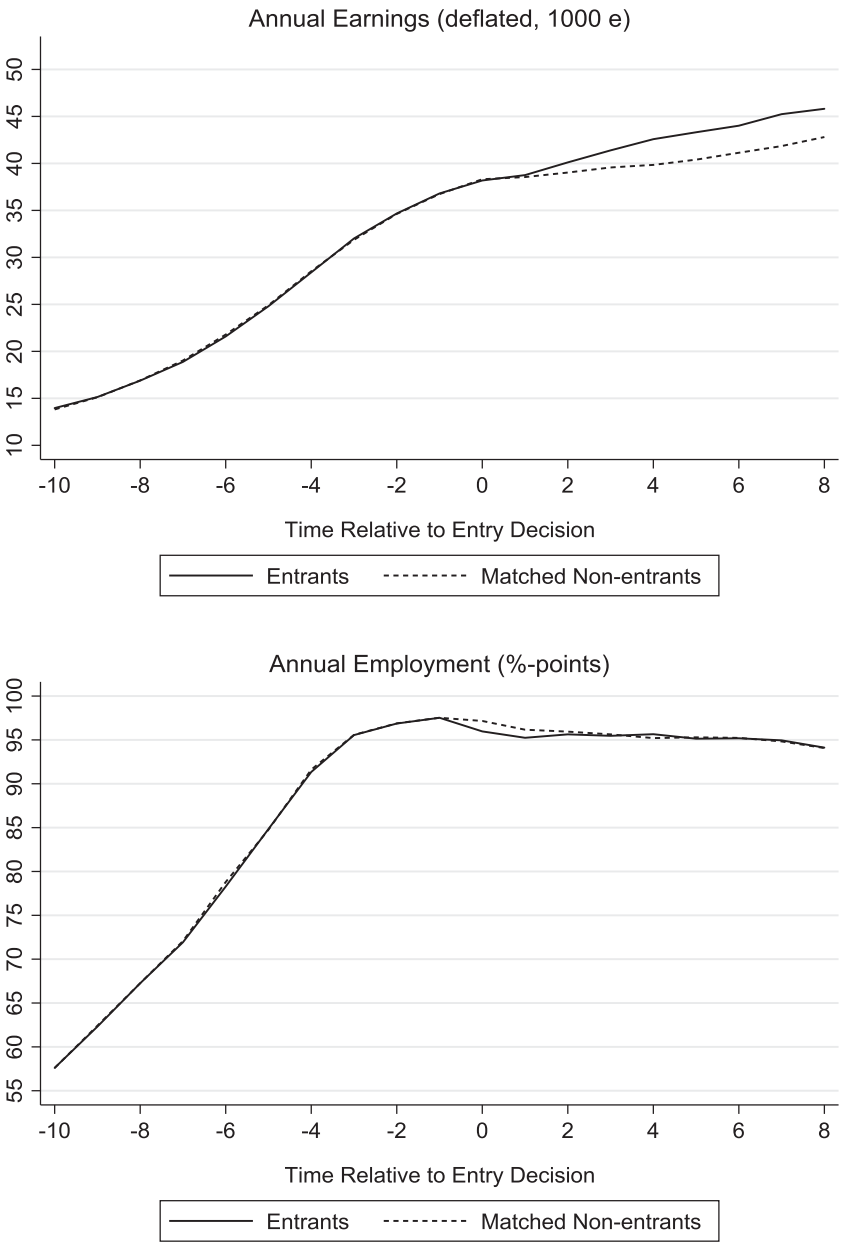

Fig. 1. Development of labor-market outcomes for the treated and matched control group.
Notes: A probit model is used to estimate the propensity scores (see Table A2 for results). Individuals are followed backwards until age 18 (or older).

reported in the Supplementary Online Appendix B, the total gains from this tuition-free education are about €14,000 over the period 0 to 8 years after initial enrollment (see Table B3). The return per year-attended is around €4800 because the students, on average, attend vocational master's programs for 2.94 years (mostly part-time).

We find no significant differences in employment between master's students and the matched control group. At the 95% confidence interval (two-sided tests), we can rule out positive employment effects larger than one percentage point in years four to six. These insignificant employment effects are to be expected given the average employment rate of almost 0.98 in the year before enrollment (see Table 1, Columns 1 and 3). As before, the employment differences between the treated and control groups are insignificant in the pre-enrollment period, where program attendance could not have had a causal impact.

To assess the role of observables, we have estimated matched regression models with different sets of control variables. The results reported in Appendix Table B4 show that the estimates remain intact when we gradually exclude fixed effects as well as age and year dummies from the regression models after matching. The results are also similar when we expand the set of matching variables with two (insignificant) covariates that measure the pre-treatment earnings trends between years −5 and −1 in an individual's region of residence and his/her industry (see Appendix Table B5).

Analyses based on Oster's (2019) method show that the matched individual fixed effects results for earnings are robust to substantial selection on unobservables (see Table 3). The method can be used to evaluate the value of δ, the ratio of selection on unobservables versus observables, for which the effect of interest is zero (see Column 1).[17] Our results reveal that, for four to six years after enrollment, the unobservables would need to be around 2.0–2.6 times as important as the observables in order to produce a zero treatment effect of vocational master's program

[17] Following Oster (2019) and Dahlen (2016), we assume that R_{max}, the unknown overall R-squared value of a hypothetical model, which controls for the full set of observables and unobservables, is min{1, 1.3*(R^2 in the extended model)}. R_{max} is not set to 1 because earnings cannot be fully explained even if the exhaustive set of controls were included, for example, due to idiosyncratic variation in earnings.

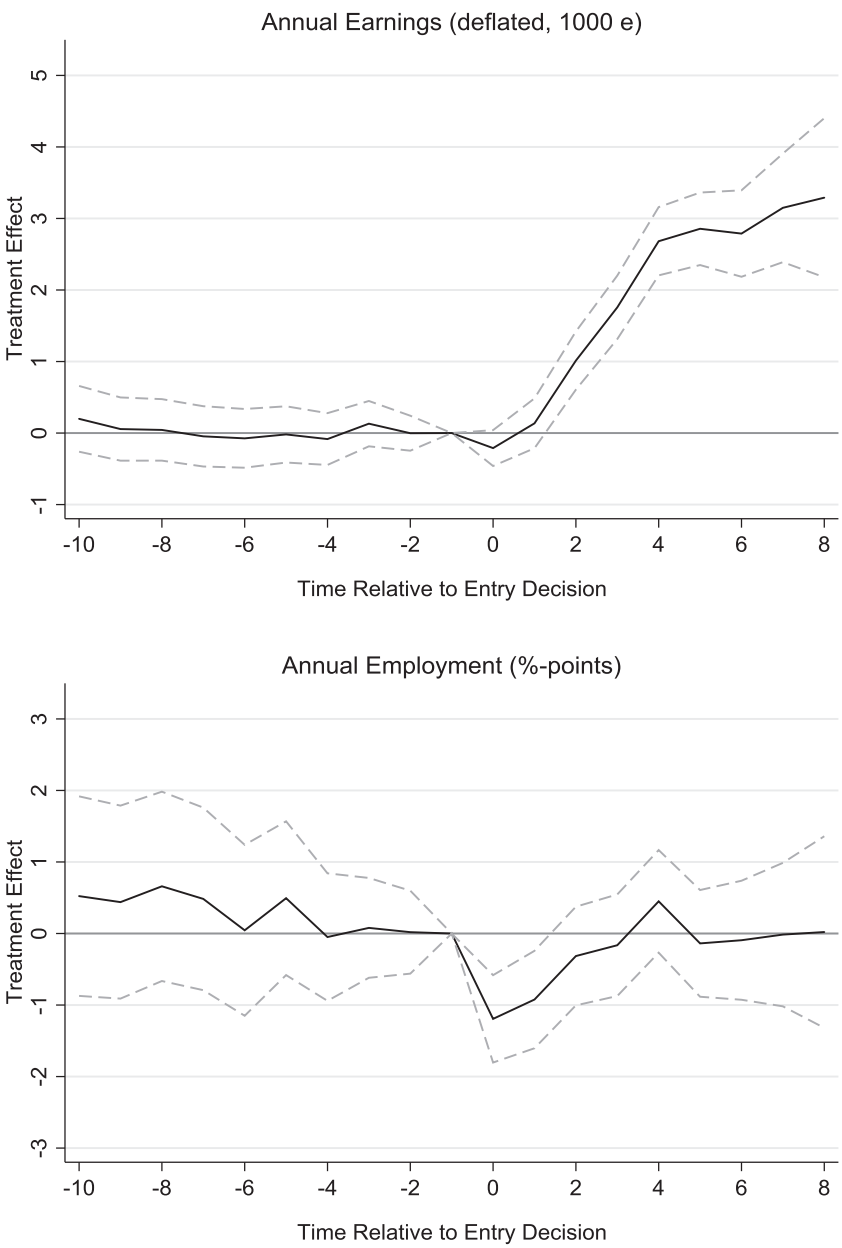

Fig. 2. Fixed effects results by time relative to entry, attendance model (with 95% confidence intervals).
Notes: The matched fixed effects regressions also include controls for time relative to entry (not interacted with attendance status), dummy variables for calendar year, and age in years, as listed in Eq. (1). Reference year is $t = -1$. Dashed lines indicate 95% confidence intervals.

attendance on earnings (i.e., $\beta_{1t} = 0$). Altonji et al. (2005) argue that the value of $\delta = 1$ (i.e., equal selection on observables and unobservables) constitutes a reasonable cutoff for a robust result. Alternatively, the method can be used to estimate the bounds for estimated effects while assuming that $\delta = 1$ (see Column 2). In all robustness checks at $t > 1$, we can clearly reject the hypothesis that the effect of attending vocational master's programs is zero. Unless selection on unobservables is more than twice as great as selection on observables (i.e., $\delta > 2$), our results are robust to the selection of students into vocational master's programs.

A potential concern with the results is that we condition on future treatment by excluding from the control group vocational bachelor's degree recipients who do not attend vocational master's programs in the entry year but do attend vocational master's programs in later years. Table 4 reports the results from the fixed effects model where we no longer exclude these future treated students from the control group. The table is identical in format to Table 2.

The results between Tables 4 and 2 are remarkably similar. The notable difference is that the returns four to eight years after attendance are slightly lower, by 100–350 euros, once we expand the control group to include future students.

We have also run placebo regressions where we have replaced our outcome variables of interest with pseudo outcomes that should not be affected by the treatment (Athey and Imbens, 2017). We use the mother's total annual earnings and employment as pseudo outcomes, for which we should obtain estimates that are close to zero. Using longitudinal linkages in population census data, the mother's earnings and employment are defined as in the baseline models for the offspring. We use the mother's outcomes because mother–children links are more complete than are father–children links and because mortality is higher among men at younger ages. We find no significant effects on pseudo outcomes in the post-treatment periods (see Table B6).

The primary advantage of the above models (based on Eq. (1)) is that they make no assumptions about the endogeneity of program completion. The primary disadvantage is that the returns to attendance that are measured combine the returns for dropouts with the returns for completers. Table 5 contains the results of our completion model specified in

Table 2
Fixed effect returns to program attendance (Matched sample).

	Annual earnings		Annual employment	
	Coeff.	Std. Err.	Coeff.	Std. Err.
Attendees – entry year	−0.210	0.128	−0.01193***	0.00312
Attendees – 1 year after entry	0.136	0.178	−0.00923***	0.00347
Attendees – 2 years after entry	1.013***	0.207	−0.00315	0.00352
Attendees – 3 years after entry	1.757***	0.226	−0.00164	0.00362
Attendees – 4 years after entry	2.682***	0.243	0.00450	0.00366
Attendees – 5 years after entry	2.856***	0.259	−0.00138	0.00381
Attendees – 6 years after entry	2.789***	0.308	−0.00094	0.00424
Attendees – 7 years after entry	3.149***	0.387	−0.00015	0.00512
Attendees – 8 years after entry	3.291***	0.567	0.00021	0.00683
Attendees – 2 years before entry	−0.002	0.125	0.00019	0.00296
Attendees – 3 years before entry	0.131	0.162	0.00079	0.00356
Attendees – 4 years before entry	−0.084	0.185	−0.00049	0.00455
Attendees – 5 years before entry	−0.019	0.201	0.00494	0.00549
Attendees – 6 years before entry	−0.074	0.209	0.00045	0.00610
Attendees – 7 years before entry	−0.046	0.215	0.00484	0.00651
Attendees - 8 years before entry	0.044	0.219	0.00660	0.00675
Attendees – 9 years before entry	0.056	0.226	0.00439	0.00688
Attendees – 10 years before entry	0.199	0.235	0.00523	0.00712
Number of observations	364,957		364,957	
Number of individuals	19,323		19,323	
Adjusted R-squared	0.689		0.349	

Notes: *= significant at 10%; **= significant at 5%; ***= significant at 1% (all two-sided tests). The regressions also include controls for time relative to entry (not interacted with treatment status), dummy variables for calendar year, and age in years, as listed in Eq. (1). Estimations are based on samples of attendants and matched non-attendants. Annual earnings are measured in 1000 euro (adjusted to 2012 euros).

Table 3
Fixed effects earnings results (Matched sample): robustness to omitted variable bias.

	Annual earnings		
Treatment variable	(1) $\tilde{\delta}$ for $\beta = 0$ given R_{max}	(2) Identified set given $\delta = 1$ and R_{max}	(3) Extended controls move coefficient away from zero
Attendees – entry year	8.064	[−0.346, −0.210]	Yes
Attendees – 1 year after entry	1.023	[0.006, 0.136]	No
Attendees – 2 years after entry	1.881	[0.893, 1.013]	No
Attendees – 3 years after entry	1.988	[1.644, 1.757]	No
Attendees – 4 years after entry	2.046	[2.582, 2.682]	No
Attendees – 5 years after entry	2.047	[2.748, 2.856]	No
Attendees – 6 years after entry	2.602	[2.655, 2.789]	No
Attendees – 7 years after entry	3.133	[2.868, 3.149]	No
Attendees – 8 years after entry	8.148	[3.291, 3.444]	Yes
$R_{max} = 0.919$			

Notes: The Oster analysis is based on a matched sample estimated with propensity score matching on two nearest neighbors as reported in Tables A2 and A3. The number of observations is 364,957 (full sample). Results are computed using Oster's (2019) Stata package psacalc, and areg. Baseline models include only (fully observed) controls for time dummy variables relative to entry (except for the year before) and these time dummies interacted with treatment status. Extended models include the full set of controls, as in Table 2: individual fixed effects, age and year fixed effects, time dummy variables relative to entry (except for the year before), and these time dummies interacted with treatment status.

Eq. (2).[18] As in Table 2, the table contains the results for annual earnings (first two columns) and annual employment (second two columns).

In this model, the completion of a master's degree is associated with an increase in annual earnings of around €1500, or approximately four percent of average earnings in the comparison time period one year before enrollment. By contrast, the completion of a degree has an insignificant effect on employment (almost zero). In both models, most of the time-variant returns to master's degrees are not statistically different from zero, even at the 10% level. In other words, we find that completers have higher earnings than dropouts, but this difference does not vary significantly over time. As with attendance, we find no evidence that completing a master's degree affects employment. Our alternative models of completion, shown in Appendix Tables B7 and B8, support these conclusions.

5.3. Results for specific subgroups

Next, we investigate whether the returns to vocational master's programs differ across key demographic characteristics, fields of study, or job mobility. For simplicity, we present only the results from the attendance model where the dependent variable is annual earnings, and we estimate separate regressions for each subgroup. Table 6 contains the coefficients and standard errors for the post-enrollment returns for attendees (versus the relevant matched comparison group) by age,

[18] See Supplementary Appendix Table C1 for descriptive statistics on the samples of completers and dropouts.

Table 4
Fixed effect returns to program attendance (Matched sample): including future attendees in the control group.

	Annual earnings		Annual employment	
Variable	Coeff.	Std. err.	Coeff.	Std. err.
Attendees – entry year	0.025	0.128	0.00630**	0.00316
Attendees – 1 year after entry	0.185	0.174	0.00663*	0.00347
Attendees – 2 years after entry	1.095***	0.204	0.00162	0.00351
Attendees – 3 years after entry	1.710***	0.224	0.00048	0.00362
Attendees – 4 years after entry	2.463***	0.242	0.00596	0.00365
Attendees – 5 years after entry	2.725***	0.258	0.00047	0.00379
Attendees – 6 years after entry	2.536***	0.311	0.00263	0.00426
Attendees – 7 years after entry	2.905***	0.390	0.00461	0.00513
Attendees – 8 years after entry	2.957***	0.575	0.00376	0.00665
Attendees – 2 years before entry	0.014	0.124	0.00274	0.00296
Attendees – 3 years before entry	0.113	0.159	0.00196	0.00356
Attendees – 4 years before entry	0.031	0.186	0.00115	0.00455
Attendees – 5 years before entry	0.064	0.199	0.00091	0.00546
Attendees – 6 years before entry	0.014	0.209	0.00312	0.00608
Attendees – 7 years before entry	0.027	0.215	0.00156	0.00649
Attendees – 8 years before entry	0.063	0.219	0.00183	0.00672
Attendees – 9 years before entry	0.160	0.225	0.00147	0.00686
Attendees – 10 years before entry	0.186	0.235	0.00675	0.00706
Number of observations	366,586		366,586	
Number of individuals	19,569		19,569	
Adjusted R-squared	0.689		0.347	

Notes: *= significant at 10%; **= significant at 5%; ***= significant at 1% (all two-sided tests). The regressions also include controls for time relative to entry (not interacted with treatment status), dummy variables for calendar year, and age in years as listed in Eq. (1). Estimations are based on sample of attendants and matched non-attendants. Annual earnings are measured in 1000 euro (adjusted to 2012 euros). In this robustness check, non-attendants include also those individuals who are treated, i.e. attend vocational master's programs, in the future ($t > 0$; cf. results in Table 2).

Table 5
Fixed effect returns to Master's degree (Matched sample).

	Annual earnings		Annual employment	
	Coeff.	Std. err.	Coeff.	Std. err.
Master's degree	1.489***	0.249	0.00168	0.00364
× 1 year after graduation (ref.)				
× 2 years after graduation	0.065	0.185	−0.00234	0.00322
× 3 years after graduation	0.116	0.289	−0.00125	0.00425
× 4 years after graduation	0.776*	0.408	0.00374	0.00538
× 5 years after graduation	0.585	0.591	0.00594	0.00700
× 6 years after graduation	0.705	0.857	0.00388	0.01007
× 7 years after graduation	0.758	1.543	−0.03931*	0.02338
Attendees – entry year	−0.210	0.128	−0.01193***	0.00312
Attendees – 1 year after entry	0.136	0.178	−0.00923***	0.00347
Attendees – 2 years after entry	0.866***	0.210	−0.00331	0.00355
Attendees – 3 years after entry	1.203***	0.251	−0.00203	0.00393
Attendees – 4 years after entry	1.822***	0.304	0.00431	0.00437
Attendees – 5 years after entry	1.767***	0.360	−0.00206	0.00496
Attendees – 6 years after entry	1.478***	0.455	−0.00319	0.00574
Attendees – 7 years after entry	1.735***	0.585	−0.00373	0.00704
Attendees – 8 years after entry	1.793**	0.871	0.00013	0.00926
Attendees – 2 years before entry	−0.002	0.125	0.00019	0.00296
Attendees – 3 years before entry	0.131	0.162	0.00079	0.00356
Attendees – 4 years before entry	−0.084	0.185	−0.00050	0.00455
Attendees – 5 years before entry	−0.019	0.201	0.00494	0.00549
Attendees – 6 years before entry	−0.074	0.209	0.00045	0.00610
Attendees – 7 years before entry	−0.046	0.215	0.00484	0.00651
Attendees – 8 years before entry	0.045	0.219	0.00660	0.00675
Attendees – 9 years before entry	0.055	0.226	0.00439	0.00688
Attendees – 10 years before entry	0.200	0.235	0.00523	0.00712
Number of observations	364,957		364,957	
Number of individuals	19,323		19,323	
Adjusted R-squared	0.689		0.349	

Notes: *= significant at 10%; **= significant at 5%; ***= significant at 1% (all two-sided tests). The regressions also include controls for time relative to entry (not interacted with treatment status), dummy variables for calendar year, and age in years as listed in Eq. (2). Estimations are based on the sample of attendants and matched non-attendants. Annual earnings are measured in 1000 euro (adjusted to 2012 euros).

Table 6
Fixed effect earnings returns to program attendance by demographic group (Matched sample).

	Age at entry		Gender		Region		Entry year	
	25–34	35–55	Females	Males	Helsinki	Other areas	2002–2005	2006–2009
Attendees – entry year	0.086	−0.064	0.018	−0.032	−0.043	0.085	−0.119	0.082
	(0.182)	(0.179)	(0.164)	(0.201)	(0.257)	(0.149)	(0.275)	(0.143)
Attendees – 1 year after entry	0.726***	−0.314	0.424*	0.102	0.361	0.205	0.760*	0.348*
	(0.256)	(0.242)	(0.223)	(0.277)	(0.355)	(0.198)	(0.396)	(0.194)
Attendees – 2 years after entry	1.579***	0.947***	1.394***	0.781**	1.674***	0.941***	1.130**	1.296***
	(0.310)	(0.276)	(0.252)	(0.342)	(0.417)	(0.231)	(0.485)	(0.225)
Attendees – 3 years after entry	2.185***	1.832***	2.225***	1.433***	2.574***	1.608***	2.148***	2.083***
	(0.340)	(0.303)	(0.278)	(0.381)	(0.465)	(0.254)	(0.558)	(0.247)
Attendees – 4 years after entry	2.807***	2.501***	2.900***	2.454***	3.024***	2.364***	2.641***	2.795***
	(0.367)	(0.329)	(0.292)	(0.418)	(0.504)	(0.270)	(0.600)	(0.264)
Attendees – 5 years after entry	3.343***	2.920***	2.900***	2.543***	2.918***	2.762***	3.047***	3.139***
	(0.392)	(0.343)	(0.309)	(0.454)	(0.561)	(0.287)	(0.656)	(0.281)
Attendees – 6 years after entry	3.298***	3.258***	3.143***	2.811***	2.627***	3.256***	3.305***	3.432***
	(0.476)	(0.405)	(0.353)	(0.571)	(0.691)	(0.333)	(0.701)	(0.344)
Attendees – 7 years after entry	3.478***	3.951***	3.359***	3.272***	2.746***	3.089***	3.617***	3.746***
	(0.575)	(0.521)	(0.429)	(0.704)	(0.842)	(0.410)	(0.749)	(0.453)
Attendees – 8 years after entry	4.217***	3.895***	3.744***	4.170***	3.101**	3.020***	2.968***	4.602***
	(0.931)	(0.652)	(0.545)	(1.186)	(1.368)	(0.527)	(0.777)	(0.833)
Number of observations	179,358	185,100	230,250	134,337	107,119	258,865	58,174	306,741
Number of individuals	9886	9722	12,287	7146	5769	13,819	3019	16,692
Adjusted R-squared	0.661	0.689	0.628	0.730	0.670	0.696	0.704	0.686
Mean $t = -1$ earnings for treated (€1000)	34.046	39.458	31.934	45.144	40.091	35.454	34.829	37.144

Notes: *= significant at 10%; **= significant at 5%; ***= significant at 1% (all two-sided tests). Standard errors are in parentheses. Each column contains the results from a separate regression. The regressions also include controls for time relative to entry (not interacted with treatment status), dummy variables for calendar year, and age in years as listed in Eq. (1). The dependent variable is annual earnings in 1000 euro (adjusted to 2012 euros). The estimated pre-treatment effects $t = -10, \ldots, -2$ are all insignificant and are reported in the Appendix (see Table B9).

gender, region, and year of entry. As before, the reference time period is the year before entry.

The table shows modest differences in returns by demographic group. For age, the two cohorts have statistically indistinguishable returns starting in year two. For example, five years after, the returns for the younger cohort are around €3300, compared to €2900 for the older cohort; these earnings gains are 8.2% for the younger cohort and 6.3% for the older cohort.

For gender, females have higher gains than males except in year eight, although none of the gains is statistically different between men and women. In year five, the returns are €2900 for women and €2500 for men. Because women in our sample have lower earnings than men, the percentage increase is higher for women: 9.1% versus 5.4%.

In all years, we cannot reject the hypothesis that the earnings gains are equal between the Helsinki metropolitan region and other regions in Finland. Gains are slightly higher in Helsinki in the first five years after entry, but they are larger in other regions in years six and seven. Five years after entry, the gains are €2900 (or 7.5%) for Helsinki and €2800 (or 6.7%) elsewhere in the country.

Regarding entry year, the earlier and later cohorts have similar earnings gains. For instance, students entering master's programs between 2002 and 2005 have earnings €3000 higher five years after entry, compared with €3100 for students entering master's programs between 2006 and 2009. In both cohorts, the gain is approximately 7.5% of average earnings the year before entry. The first trial years involved only a small number of students, making it difficult to draw precise earnings projections. Another concern with the estimates for the early years is that, with a new program, employers and attendees may learn about the labor-market value of degrees only gradually.

Next, we separate returns by field of study (see Table 7).[19] The three main fields of study in vocational master's programs are (1) health care and welfare, (2) business and administration, and (3) technology and trades. Table 7 presents the returns to attendance, where the sample is split into these three fields. Short-run gains from the program are noticeably high for business students; from year six onwards, however, the highest gains are for health, although the differences by field of study are often statistically insignificant. By four to five years after entry, the earnings gains are around €3500–€3600 for health, €2500–€2900 for technology and trades, and €2400–€2600 for business. In percentage terms, the earnings increase is highest in health (around 12%) because, on average, their prior earnings are the lowest (€30,000), followed by business (€37,700) and technology and trades (€45,700).

Because nearly everybody worked throughout the sample period, we can also study whether the results are robust to change in employer. We utilize information on the employer a year prior to entry (at $t = -1$) and three years after the entry ($t = 3$).[20] The employer code can be matched for 93% of the attendants, of whom around half (51%) change their employer between the two measurement points. To estimate the heterogeneity of the returns to education, we separate the sample by job-change status under the strong assumption that the decision to change jobs is exogenous.

Fig. 3 illustrates the estimates reported in the Supplementary Online Appendix B (see Table B10). The pattern of coefficients, steep growth until year 4 or 5 followed by slower growth, is similar for the two groups, but the coefficients are larger for the job-switch sample. However, we cannot reject the hypothesis that the earnings gains are the same between those who switch jobs and those who do not. Job switchers may receive a larger increase in earnings from switching jobs, consistent with the standard theory of employee turnover and earnings (Ehrenberg and Smith, 2009). However, Fig. 3 suggests that attendees receive higher earnings regardless of whether they switch employers. Thus, the similarity of results between switchers and stayers provides little if any support for the notion that the decision to return to school—such as returning

[19] Master's degrees are usually completed in the same field as the bachelor's degrees.

[20] We choose $t = -1$ as the starting point for job changes because $t = -1$ is our reference year for pre-schooling attributes in general. We choose $t = 3$ as the end point for job changes because the decision to change jobs can be lengthy. Furthermore, the choice of $t = 3$ also produces roughly equal numbers of stayers and movers.

Table 7
Fixed effect earnings returns to program attendance by education field (Matched sample).

	Health	Business	Tech. and trades
Attendees – entry year	0.037	0.248	−0.062
	(0.192)	(0.281)	(0.254)
Attendees – 1 year after entry	0.183	0.817**	0.099
	(0.264)	(0.381)	(0.340)
Attendees – 2 years after entry	1.497***	1.824***	1.133***
	(0.294)	(0.449)	(0.416)
Attendees – 3 years after entry	2.573***	1.987***	1.569***
	(0.320)	(0.496)	(0.461)
Attendees – 4 years after entry	3.481***	2.558***	2.476***
	(0.340)	(0.526)	(0.501)
Attendees – 5 years after entry	3.646***	2.438***	2.947***
	(0.355)	(0.558)	(0.529)
Attendees – 6 years after entry	4.093***	1.877***	1.716***
	(0.411)	(0.646)	(0.642)
Attendees – 7 years after entry	4.654***	2.390***	2.150***
	(0.502)	(0.756)	(0.782)
Attendees – 8 years after entry	5.436***	3.611***	3.174***
	(0.621)	(0.997)	(1.011)
Attendees – 2 years before entry	−0.074	0.016	−0.272
	(0.195)	(0.264)	(0.247)
Attendees – 3 years before entry	0.230	0.213	−0.554
	(0.244)	(0.338)	(0.454)
Attendees – 4 years before entry	0.103	−0.081	0.011
	(0.283)	(0.380)	(0.366)
Attendees – 5 years before entry	0.251	−0.193	0.035
	(0.307)	(0.403)	(0.396)
Attendees – 6 years before entry	0.104	−0.007	−0.035
	(0.313)	(0.419)	(0.424)
Attendees – 7 years before entry	0.280	−0.006	−0.284
	(0.318)	(0.430)	(0.437)
Attendees – 8 years before entry	0.228	0.164	−0.462
	(0.312)	(0.443)	(0.488)
Attendees – 9 years before entry	0.196	−0.137	−0.075
	(0.315)	(0.458)	(0.452)
Attendees – 10 years before entry	0.129	−0.223	−0.246
	(0.322)	(0.475)	(0.487)
Number of observations	126,023	101,045	93,105
Number of individuals	6710	5453	4992
Adjusted R-squared	0.619	0.673	0.710
Mean $t = -1$ earnings for treated (€1000)	30.018	37.650	45.671

Notes: *= significant at 10%; **= significant at 5%; ***= significant at 1% (all two-sided tests). Standard errors are in parentheses. Each column contains the results from a separate regression. The regressions also include controls for time relative to entry (not interacted with treatment status), dummy variables for calendar year, and age in years as listed in Eq. (1). The dependent variable is annual earnings in 1000 euro (adjusted to 2012 euros).

to school after receiving a promotion—is driven solely by recent or perceived future promotions among stayers.

Our final analysis examines whether vocational master's programs help their students obtain better job titles. Although direct information on promotions is not available, data on occupations allow us to rank occupations into three job titles: managers, professionals, and other occupational categories.[21] We calculate the percentage of individuals in each job title at different points in time relative to enrollment, separately for master's entrants and the matched sample of non-entrants.

In our supplementary analysis (see Appendix Table B11), three empirical patterns stand out. First, upward mobility in occupational hierarchy is more likely among entrants than matched non-entrants during the six-year follow-up period. Second, downward mobility is similar in both groups. Third, entrants seem to move to better positions (relative to non-entrants) gradually over time, arguably as opportunities for professional (and managerial) tasks emerge. Because upward mobility is greater than downward mobility among the entrants than matched non-entrants, this analysis suggests that vocational education has not led to an increase in the proportion of workers with vocational master's education in "non-professional" tasks (cf. Gottschalk and Hansen, 2003). A comprehensive analysis of the occupational changes is necessary to enable stronger (and more causal) inferences to be drawn about changes in occupational hierarchy.

6. Discussion

This paper provides the literature's first estimates of labor-market returns to vocational master's programs, a new and growing sector of higher vocational education. We use matching methods on complete population data to identify a sample of individuals who did not attend these programs but have similar demographic characteristics and labor-market histories, and we run an individual fixed effects model to account for any time-invariant differences across individuals.

Attendance in vocational master's programs is associated with higher earnings of more than seven percent four to six years after entry. As employment was around 95% in the pre-enrollment period, it is not surprising that we find no significant effects of program attendance on employment. Under the assumption that completion is exogenous after controlling for individual and time fixed effects, we find particularly

[21] These occupational levels are based on standard ISCO classifications. Of the vocational master's students, 7.2% are managers, 33.4% are professionals, and 59.4% belong to other occupational categories.

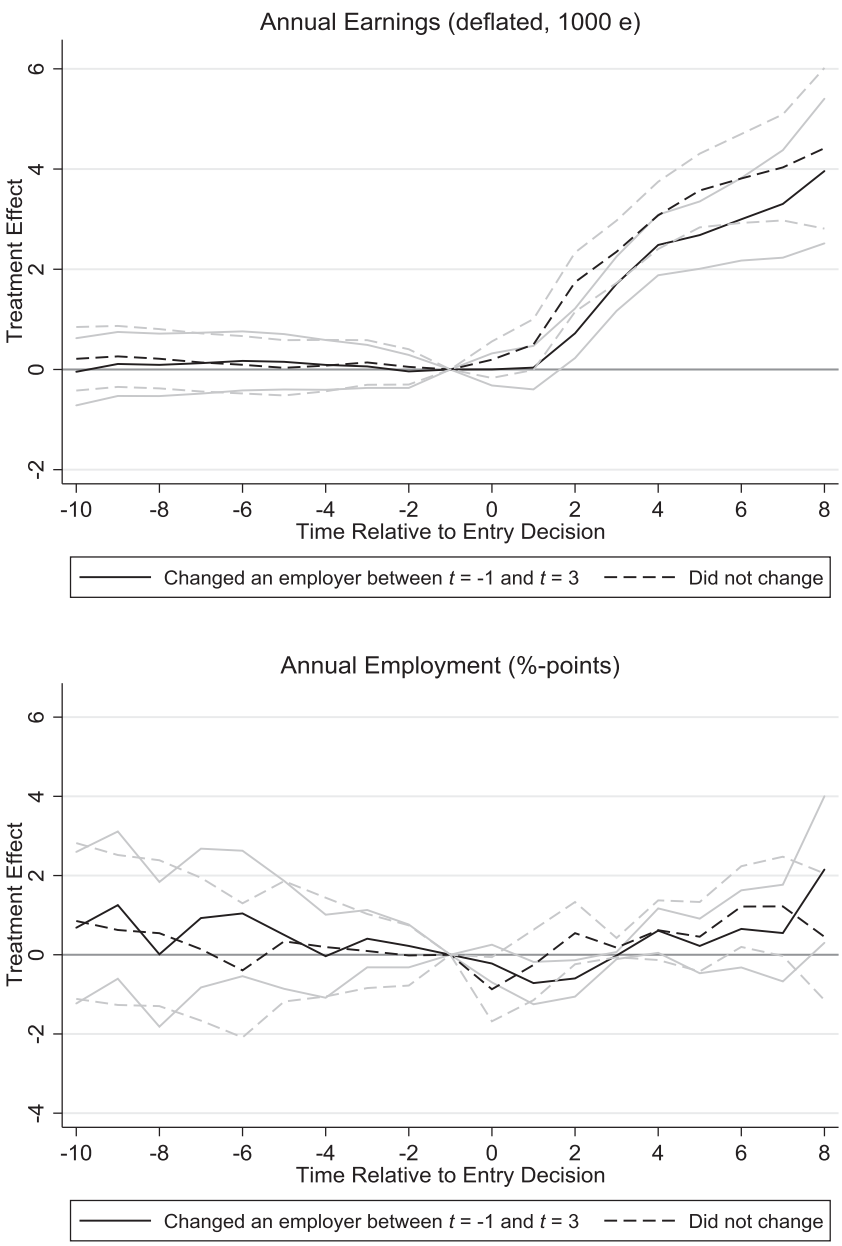

Fig. 3. Fixed effects results by employer change, attendance model (with 95% confidence intervals).
Notes: The matched fixed effects regressions also include controls for time relative to entry (not interacted with attendance status), dummy variables for calendar year, and age in years as listed in Eq. (1). The reference year is $t = -1$. Estimates are conditional on being employed in $t = -1$ and $t = 3$. The comparison group has the same employer-change status as the treated group. Gray lines indicate 95% confidence intervals.

sizable earnings returns to the completion of a vocational master's degree. We observe few statistically significant differences in returns to attendance across demographic groups or fields of study, although point estimates suggest higher returns for those in the health field.

Despite the combination of matching estimators and fixed effects regression, concerns may persist about the nonrandom decision of individuals to attend vocational master's programs. However, unless selection on unobservables is more than twice as large as selection on observables (based on the methods in Oster, 2019), our results demonstrate a positive earnings return to attending a vocational master's program.

We are not aware of any prior work on returns to these degrees. Although our results are from one country (Finland), other countries such as Austria, Germany, and Switzerland offer similar programs. Because individuals with vocational bachelor's degrees rarely have access to academic master's programs, these vocational master's degrees offer the best opportunity for them to obtain formal post-graduate education. Finland's experience suggests that vocational master's programs substantially improve earnings. However, these master's programs have not been designed for those who are unemployed: almost all the entrants work before and after program entry. Finally, although we show that workers clearly benefit from these programs in terms of discounted future earnings, future research should also focus on obtaining measures of the cost to government of these educational programs in order to compare the benefits of vocational master's programs to their costs. These cost estimates would inform policymakers about how to allocate funding and other resources between universities and vocational education providers in order to best support work-related skills.

Declaration of Competing Interest

None.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.labeco.2019.101758.

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