Clemens Noelke[1] and Daniel Horn[2]

Social Transformation and the Transition from Vocational Education to Work in Hungary: A Differences-in-Differences Approach

Abstract

The 'dual system' combining school-based vocational education with employer-provided training is often praised for effectively integrating young people into the labour market. While held up as model for other countries to emulate, it has proven difficult for countries that lack institutional foundations to elicit or maintain what is essentially voluntary provision of training places by employers. Whenever employers are unwilling to train, school-based training represents a viable alternative, but to date we know little about the relative effectiveness of school- vs. employer-provided training provision. This study exploits a rapid shift of training provision from employers to vocational schools that occurred during the Hungarian transformation from socialism to capitalism to analyse how these different ways of organizing training affect labour market entry of

[1] Center for Population and Development Studies, Harvard University, 9 Bow Street, Cambridge, MA 02138, USA, Corresponding author. Email: cnoelke@hsph.harvard.edu

[2] Institute of Economics of the Hungarian Academy of Sciences, and Department of Economics, Eötvös University, Budapest, Hungary.

vocational graduates. Our general expectation is that the substitution of employer-provided with school-provided training has resulted in higher unemployment and lower job quality, particularly upon leaving school. Results from Differences-in-Differences analyses indicate that the shift in training provision from employers to schools between 1994 and 2000 has increased male vocational school graduates' unemployment rate by 10 percentage points within the first two years after graduation. We find no effects of training organization on class position.

Introduction

This study examines how the partial withdrawal of employers from Hungarian vocational education and training (VET) has affected VET graduates' transition from school to work. Past research suggests that employer participation is important for VET to effectively integrate young people into the labour market (Müller and Shavit, 1998; Shavit and Müller, 2000; Gangl, 2001; Ryan, 2001; Breen, 2005; Iannelli and Raffe, 2007; Wolbers, 2007; Scherer, 2005). In particular, the provision of on-the-job training places appears to be crucial, because vocational students thereby get an opportunity to acquire up-to-date specific skills and secure a foothold in employment before schooling is completed. While employer involvement in VET is highly institutionalized in 'coordinated market economies' (Hall and Soskice, 2001) like Germany or Austria, this is generally not the case for post-socialist European countries or other 'liberal market economies', like the U.S. Even though VET programs still enrol a sizeable percentage of young people in several post-socialist Central and Eastern European (CEE) countries, VET students' access to on-the-job training has diminished considerably (Kogan, 2008).

Similar to the German dual system, Hungarian VET has traditionally combined classroom-based vocational education and employer-provided on-the-job training. However, in the course of transformation from socialism to capitalism employers withdrew in large numbers from training VET students and the importance of public vocational schools as training providers has increased. We exploit this institutional variation to analyse whether the substitution of employer-provided with school-provided training has caused VET graduates' early labour market outcomes to deteriorate.

Our study contributes to several active research fields in sociology. First, there has been a growing number of sociological studies trying to understand how socialist past and diverse transformation experiences have contributed to variation in school-to-work transitions and youth labour market performance in post-socialist countries (for example, Solga and Konietzka, 1999; Konietzka, 2001; Gerber, 2003; Diewald et al., 2006; Kogan et al., 2011; Kogan, 2012; Noelke et al., 2012). While prior work has analysed the transition from school to work in Hungary (Audas et al., 2005; Bukodi, 2006; Kogan and Unt, 2005; Bukodi and Robert, 2011), existing studies neither focus in detail on the changing situation of VET graduates nor try to directly measure the role of a specific institutional mechanism causing VET graduates outcomes to change.

Second, our study also contributes evidence on the effectiveness of employer- vs. school-provided training. For example, the German VET system offers both dual apprenticeship-type programs and fully school-based programs. To date, we still know little about the causal effects of these different modes of organizing VET. Given the difficulty of eliciting and maintaining employer cooperation in dual system VET, school-based training provision has been tried and may represent a viable alternative. If employers refuse to provide training, public schools may simply step in, as it happened not only in Hungary but also East Germany, where a decline in apprenticeship places has been in part compensated by establishing public training centres (Culpepper and Thelen, 2007).

Third, our analysis addresses methodological problems of previous studies on the transition from vocational education to work. Prior research has either compared outcomes of individuals, who enrolled in different VET programs within a given country

(for example, Baranowska, 2011; Matkovic, 2011; Parey, 2009), or outcomes of VET graduates across countries with different organization of VET training (for example, Müller and Shavit, 1998). Causal inference based on these comparisons is problematic because of unobserved heterogeneity at the level of individuals and countries. The research design and Differences-in-Differences estimator (for a recent applications in sociology, see Mooi-Reci and Mills, 2012) tries to address these issues.

Vocational Education and Training in Hungary

Upon completion of lower secondary education, students may enrol in vocational schools (*szakmunkásképző* or *szakiskola*), which offer dual system VET. Alternatively, students can continue in either upper secondary general school (*Gimnázium*) or upper secondary vocational school (*Teknikum* or *Szakközépiskola*), both of which qualify for admission to higher education.[1] VET students typically obtain school-based vocational and academic education during the first two years and receive (either school-based or employer provided) training in the last two years. Vocational schools mainly prepare for blue collar occupations, typically semi-skilled and skilled occupations in industry and agriculture, but also some semi-skilled service sector occupations. Completion of vocational school does not qualify for access to higher education. Therefore, most graduates enter the labour market directly after completion, usually at ages 17-18.

Vocational schools were tightly linked to enterprises under socialism. Students received training in enterprise-based workshops or directly at workplaces. Under capitalism, employer-provided training is either organized by students themselves or

arranged for by their school. Those who do not (or do not want to) find a training place with an employer are trained within facilities run by the school, such as workshops or, for example, a school canteen. The distribution of training places across industries does not differ much across training sites (schools, employers) and, for the cohorts that we have data for (1995-8), changes little over time (see Figures A1 and A2, Appendix). For the 1995 cohort of VET labour market entrants, 54% of school-based training places were in industry, compared to 64% among employers (1995 cohort). The largest discrepancy concerns training places in agriculture, which comprise of 17% of training places within schools, but only 3.8% of employer-provided training places.

In the course of transformation, vocational schools have lost the support of different stakeholders. Young people themselves increasingly chose upper secondary tracks granting access to higher education instead of vocational schools. While 49% of young people aged 17-22 had obtained a vocational school degree in 1992, this number dropped to 25% in 2000 and stabilized at around 20% in the early 2000s (Hungarian Labour Force Survey, own calculations). The economic transformation crisis peaking in the early 1990s reduced employer training provision, both because firms were shedding rather than creating jobs and presumably also because increased job turnover shortened employment spells and therefore incentives to invest into specific skills (Becker, 1994).

While demographic and macroeconomic factors have certainly been influential, institutions have also been critical for the transformation of dual system VET. The socialist state has crowded out institutions that could maintain voluntary employer training provision under capitalism, especially independent bodies of collective worker and employer representation (Ost, 2000). The emergent neoliberal policy regime

emphasized market-based, decentralized solutions in key areas of educational and labour market policy (Bukodi and Robert, 2008; Horn, 2010). The socialist past and the transformation process have therefore created an environment that is hostile to the maintenance of institutionalized employer coordination in the provision of VET.

While dual systems in 'coordinated market economies' have largely survived economic crises and adapted to the changing skill requirements in the economy, the relative absence of institutionalized commitment to maintain VET has left the Hungarian VET sector vulnerable. On-the-job training provision for VET students diminished considerably starting in the 1990s. Figure 1 shows that the number of employer-provided training places available to VET students declined rapidly, while the number of places available in schools shows no clear trend. In consequence, the ratio of school- to employer-provided training places more than doubled from around 0.9:1 to around 2.1:1.

-- Figure 1 here --

Theory and Hypotheses

This study draws on the canonical work of Allmendinger (1989), Kerckhoff (2001) and Müller and Shavit (1998), who emphasize the importance of the education system for structuring the transition from school to work, and research in political economy that focuses on the determinants of employer involvement in VET provision (for example, Culpepper and Thelen, 2007). Following Shavit and Müller (2000) and others, we consider as dependent variables unemployment as a measure of the difficulty of finding a job and class position as measure of employment in routine vs. non-routine jobs.

From a human capital perspective (Becker, 1994), by moving training sites out of workplaces into schools, young people are at risk of acquiring obsolete vocational skills, particularly in a rapidly restructuring economy (Blossfeld, 1992; Gebel and Noelke, 2011). Industry-, occupation- and firm-specific skills derive their economic value from being up-to-date. If school-based vocational curricula were speedily updated to reflect shifts in labour demand, there should be few differences in the skill content of on-the-job and school-based training. However, because of rapid economic restructuring and a lacking institutional infrastructure to achieve employer vocational school coordination, we expect that the shift of training from employers to schools should increase the risk of skill obsolescence. With the value of their vocational skills eroding, young vocational graduates are expected to suffer from increased unemployment risks after leaving vocational school. And since obsolete vocational skills have no productive value to employers, young people should be more likely to work in an unskilled, routine occupation.

On-the-job training also matches young people to prospective employers, reducing information problems, search costs and unproductive turnover (Breen, 2005; Acemoglu and Pischke, 1998). On-the-job training provides an opportunity for employers to screen potential future employees, while students have the opportunity to assess whether a specific employer would be a good fit for them. Moving the site of training provisions from companies to schools implies that young people lack a bridge into employment. Young people (as well as employers) increasingly face search costs that prolong job search and increase the incidence and duration of search-related unemployment spells (Breen, 2005; Wolbers, 2007). The increase in search costs due to the substitution of

training places should therefore increase unemployment risks upon graduation, and may also force young vocational graduates to accept unskilled rather than skilled jobs.

Whether through human capital or matching mechanisms, training substitution should have the strongest impact on VET graduates immediately upon leaving school, because firm-provided training may lead to continuous employment after graduation in skilled occupations in the training firm. In contrast, school-trained VET graduates, unless they have found a job before graduation, will become unemployed when they graduate and search for jobs. With time spent on the labour market, the chance of a high quality match between employers' and individuals' preferences and skills should increase and young people also acquire experience from the jobs they obtain. Therefore, time spent on the labour market should become an increasingly important determinant of early career unemployment risks and job quality. We expect experience-unemployment profiles to steepen, as recent graduates suffer increasing disadvantages for their lack of experience. As they acquire experience, however, their unemployment risk diminishes. Similarly, the risk of working in an unskilled job should become more strongly dependent on labour force experience, with risks increasing immediately upon graduation.

Review of Previous Research

Prior research has identified the effect of VET training provision by comparing VET graduates who received employer-provided training to "similar" VET graduates who enrolled in fully school-based VET programs. Studies on Western European countries suggest that employer-provided training lowers unemployment risks upon graduation, but

finds no effects on earnings (see Parey, 2009, and Online Appendix, for further information). Studies on Croatia (Matkovic, 2011) and Poland (Baranowska, 2011) find little or no evidence that employer-provided training leads to faster labour market entries or better job quality. Evidence from cross-nationally comparative studies are based on comparing differences in outcomes between VET graduates and other secondary school graduates across countries with different VET systems, and yield less conclusive results (see Online Appendix, for further information).

Causal inference in either type of study hinges on the assumption that conditional on measured controls, sorting into different VET programs (or secondary school types) is random. This assumption is most likely violated, since numerous individual characteristics relevant to both training choice and labour market outcomes are typically unobserved or poorly measured. The comparative studies, in addition, have to assume equivalence of educational degrees across countries (Schneider, 2010) and rule out unobserved confounders at the country level.

This study exploits the rapid substitution of employer- with school-provided training places that occurred in post-socialist Hungary during the 1990s. The rapid change obviates the need for cross-country comparison to obtain institutional variation in VET provision. By comparing vocational school graduation cohorts over time, we do not have to compare graduates from different secondary school types. The Differences-in-Differences estimator (Angrist and Pischke, 2009) allows us to control non-parametrically for unobserved time-constant and time-varying confounders.

Data and Methods

Data

From official school reports (KIR-Stat database [Közoktatási Információs Iroda]), collected by the Hungarian Ministry of Education in October around the beginning of the school year, we obtain information on the number of training places available at schools or employers at the county level for the period from 1993 to 1999. We calculate three indicators: the ratio of school- to employer-provided training places, the ratio of school-provided training places to total training places, and the ratio of employer-provided training places to total training places.[2] While we cannot use data after 1999 because of changes in survey design, we still capture the most dynamic period in terms of the rearrangement of training provision.

Data on labour market outcomes are obtained from the Hungarian Labour Force Survey (LFS), provided by the Hungarian Statistical Office and available since 1992. We restrict the sample to male vocational school graduates and define labour market entrant cohorts according to the year of obtaining the vocational school degree. From individual information on graduation years, we can identify individuals belonging to the same cohort across surveys, thereby generating a pseudo panel (Deaton, 1985) of labour market entrant cohorts. Using information on graduation years and counties in the LFS data, we merge the LFS with the training data, assigning each respondent county-by-cohort averages on the training indicator variables.

For the multivariate analysis, we restrict the sample to respondents who obtained their vocational school degree between 1994 and 2000. To capture graduates early in their

labour market career, we restrict the analytical sample to those who obtained a degree within 1 to 24 months before the month of survey and report not to be enrolled in education at the time of survey. We further restrict the sample to students aged 17 and 22 (dropping 2.6% of the sample) to focus only on those young people who make the typical transition after completing vocational school in regular time. Table A1 (Online Appendix) contains descriptive information for the observations used in the unemployment analyses. Individual respondents are nested within 20 counties, 7 (annual school-leaver) cohorts and 8 years (periods).

Our dependent variables are a dummy variable for unemployment (1=unemployed, 0=employed) and, as a measure of job quality and skill requirements, a dummy variable for employment in a routine occupation (1=employed in routine occupation, 0=employed in other occupation). Routine occupations are those belonging to class 9 in the European Socio-economic Classification (ESeC) (Harrison and Rose, 2006), a class schema derived from the Erikson-Goldthorpe-Portocarero scheme (Goldthorpe, 2007). Class 9 comprises of routine occupations that do not require extensive skills and can be monitored easily. Typical occupations include cleaners, labourers, assemblers, porters and messengers. We used three-digit ISCO-88 codes to derive the class schema. Unfortunately, information on respondents' occupation was available only from 1995 for Hungary, which is why we drop the 1994 cohort in the respective analyses. Data on respondents' wages was unavailable.

All models control for the natural log of respondents' age. Moreover, since 95% of respondents in the analytical sample are identified as children on the survey household roster, we can identify their parents within households and thereby control for

respondents' social background (parental education and employment status, umber of siblings) to control compositional differences across counties and cohorts. Further details on the construction of variables and descriptive statistics are included in the Online Appendix.

Identification and Estimation

We estimate variants of the following linear model:

(1) $Y_{icjt} = \beta_0 + \beta_1 TSG_i + \delta\ TRAIN_{cj} + \gamma_t + \delta_c + \mu_j + \varepsilon_{icjt}$.

Y_{icjt} is an outcome variable measured at the level of individuals i, nested in j counties, c cohorts and t years. $TRAIN_{cj}$ is the training indicator varying at cohort and county level (the ratio of school- to employer-provided training places for each cohort and county) and TSG_i is "time since graduation", a measure of potential labour force experience. γ_t is a vector of year fixed effects (year-specific dummy variables), with t=1,…,8, δ_c are cohort fixed effects, with c=1,…,7, and μ_j are county fixed effects with j=1,…,20. β_0 is a constant and ε_{icjt} is an idiosyncratic error term. We use the natural log transformation of time since graduation and training indicators in all models. To assess whether the effect of training provision causes the outcome variable to be more strongly dependent on time since graduation (potential labour force experience), we add an interaction between $TRAIN_{cj}$ and TSG_i. The Online Appendix provides additional background information and discusses differences between equation 1 and canonical examples of DD models.

δ estimates the effect of changing the opportunities for training provision for all VET graduates no matter what type of training they received, picking up the individual level

returns to different types of training, general equilibrium effects, for example due to job competition on the labour market, (Imbens and Wooldridge, 2009; Gangl, 2010) and time-varying effects, such as exit from the labour force of discouraged workers.[3] δ does not estimate by how much individual i's unemployment probability would be reduced, if he or she participated in firm- rather than school-based training.[4] Instead, we obtain an estimate of the total effect of changing the structure of training provision on all individuals exposed to that change.[5]

Our key identifying assumption is that differences in training opportunities, i.e. in $TRAIN_{cj}$, across cohorts are as good as random, i.e. unrelated to unobserved factors causing both differences in training provision and differences in outcomes.[6] Because we compare cohorts with different training opportunities, we already make use of fixed effects in our baseline specification (equation 1) to control for unobserved factors specific to cohorts, counties and calendar years that may be confounded with variable training opportunities across cohorts. This a powerful strategy to deal with endogeneity of $TRAIN_{cj}$, unobserved confounders or selection on unobservables, i.e. factors associated with both training choice and labour market outcomes, which are a key threat to causal inference (Imbens and Wooldridge, 2009; Gangl, 2010).[7]

Because of the county, period and cohort fixed effects included in equation 1, we need not worry about unobserved time-constant confounders specific to counties, time-varying confounders such as the national business cycle affecting all counties/cohorts equally, changes in economic restructuring that proceed in the same manner across counties/cohorts, reforms of vocational schools that change the organization of schools for different cohorts in the same way, change in the composition of VET graduates that

affects all counties equally. However, biases may result from unobserved changes that occur at different speeds across cohorts or countries (or occur affect certain cohorts or counties), which may induce a noncausal association between $TRAIN_{cj}$ and Y_{icjt}. For example, if labour demand declines in some counties but not others, this would cause both a reduction in firm-based training and increased unemployment among vocational graduates in these counties. To address these and other biases, we perform three specification checks.

First, we control for county-specific linear trends in the outcome variable (Angrist and Pischke, 2009). To the extent that time-varying unobserved confounders, such as gradual changes in the composition of vocational graduates or training firms, evolve smoothly with the county-specific linear trends, these trends account for such confounding. Rather than identifying the effect of changes in training provision around county-specific means (equation 1), the resulting model identifies the effect of non-linear changes in training provisions around county-specific trends.[8]

Second, since individuals observed in the same county and calendar year can belong to two different cohorts, we can adopt a more flexible specification for county and period shocks by replacing the γ_t and μ_j in equations 1 with 160 county-by-year dummies. In this differences-in-differences-in-differences specification, we identify the effect of reform no longer by comparing all 140 cohorts, but by comparing two cohorts observed within the same county and year. We can to rule out as confounders whatever county-specific annual shocks occurred that equally impacted members of the two cohorts we observe within each county-by-year cell. This specification should be powerful in removing county-specific shocks or non-linear trends in labour demand.

Third, to test whether cohorts observed within the same county and year differ, we replace the cohort fixed effects δ_c and county fixed effects μ_j in equation 1 with 140 county-by-cohort dummies. Since the cohort-by-county dummy variables are perfectly collinear with the main effect of the training indicator variable, this effect is no longer identified. However, we can still estimate the interaction term between training provision and time since graduation. In this case, we identify the effect of reform by comparing outcomes of individuals within the same cohort with different levels of labour force experience.

All analyses were performed separately gender. To be able to compare coefficient estimates across different model specifications and interpret interaction effects in an intuitive manner, we report estimates from OLS linear probability models (Mood, 2010). We also graph simulated probabilities from logistic regressions using the CLARIFY ado (King et al., 2000; Tomz et al., 2003). Both approaches yielded consistent results. Standard errors are adjusted for clustering of observations within the 140 county-by-cohort cells. All analyses were conducted in Stata 11.

Results

Figure 2 shows trends in the main outcome variables over cohorts calculated from the respective analysis samples. Our observation period is marked by a recovery on the youth labour market. From peak levels observed in the early 1990s in the midst of transformation crisis, male vocational school graduates unemployment rates decline until 1997. Macroeconomic recovery in the second half of the 1990s could certainly be strong

enough to mask a weakening of vocational graduates' labour market outcomes due to the substitution of employer with school-provided training places. The goal of the multivariate analyses is to account for such macroeconomic and other time-varying factors in order to partial out the independent effect of training substitution. We also observe a steady increase of the percentage employed in the lowest occupational category, which points to a weakening of vocational graduates' employment opportunities despite macroeconomic recovery.

-- Figure 2 here --

In the following, we focus on the results for male vocational school graduates, who turned out to be more strongly affected by training substitution than women. This is consistent with prior research that has shown that apprenticeship programs tend to be particularly effective for non-college bound young men (Bonnal et al., 2002; Lynch, 1992; Ryan, 2001). Moreover, in the Hungarian context, men are overrepresented in Hungarian VET by a factor of 2:1 and disproportionately enrol in programs where on-the-job training had been prevalent, such crafts and manufacturing.

Table 1 reports results from linear probability OLS regression models where the dependent variable is a dummy variable for unemployment (upper panel) and a dummy variable for employment in a routine occupation (lower panel). The baseline specification M1 (equation 1) shows that the substitution of employer- with school-based training provision has had a positive effect on vocational graduates' unemployment risk significant at the 5% level ($p=0.016$). Controlling for county-level linear trends (M2), the training coefficient drops only marginally in size. Controlling for county-by-year fixed

effects (M3, equation 3), the effect increases in size. Neither county-specific linear trends nor county-by-year specific shocks reduce the effect size more than marginally compared to the baseline specification (M1), which make us more confident that the training variable is not endogenous to either type of unobserved, time-varying confounder. That statistical significance drops is likely caused by restricting the variation in the training indicator that is used to estimate the effect of training substitution.

Allowing for an interaction between training provision and time on the labour market (time since graduation) provides for a more realistic model: The impact of training substitution should be strongest upon leaving school and then dissipate, as young VET graduates spend more time on the labour market. Consistent with our expectations, M1i provides strong evidence in support of this interaction. The unemployment-reducing effect of experience is more pronounced if a greater fraction of graduates has received training in schools rather than enterprises. The interaction effect is barely changed by the inclusion of county-specific trends (M2i), county-by-year fixed effects (M3i) and county-by-cohort fixed effects (M4i).

-- Table 1 here --

The interaction effect is also not affected by dropping whichever year, cohort or county. The interaction is also unaffected by retaining only respondents for which we have full social background information. If we move the cluster level, over which standard errors are calculated, from the county-by-cohort up to the county level (effectively assuming only 20 independent observations for the purposes of calculating standard errors), standard errors increase but the interaction effects retain significance at

the 5% level and also remains statistically significant when dropping any year, cohort and county from the sample. For women, however, we find no significant effect of the training indicator, or its interaction with experience, on unemployment or class position (see Online Appendix, Table A2).

As a further test for the endogeneity of the training indicator, the two leftmost columns of Table 2 report results from a placebo test. Instead of VET graduates, we use a sample of upper secondary (gymnasium and tehnikum) graduates, specified in the same manner as for VET graduates, and assess whether their unemployment risks have also been affected by training substitution, which theoretically they should not be. However, if the training indicator captures unobserved macroeconomic shocks that have an impact on training provision and the youth labour market and that our control variables were unable to account for, we would expect the training indicator to also predict the unemployment rate of upper secondary graduates. Using the baseline specifications (M1, M1i in Table 1), we find no effect of training provision on upper secondary graduates' unemployment probability. We obtain the same result using the other specifications (see Online Appendix, Table A3).

-- Table 2 here --

Figures 3 and 4 illustrate the interaction between training indicator and time since graduation. We have re-estimated the specification M1i in Table 1 using logistic regression and simulate predicted unemployment probabilities for different levels of the training variable and time since graduation. To generate Figure 3, we simulated the mean effect of decreasing the training indicator variable from its average value for the 1994

cohorts to the average value for the 2000 cohort at different values of time since graduation. The effect of training substitution is strongest in the first month after leaving school, where it increases unemployment probability by 21 percentage points (90% confidence interval: 0.10, 0.32), and declines thereafter. 24 months after graduation, the effect is still 6 percentage points (-.002, .130) and no longer statistically significant at the 10% level. Averaging over the entire 24 months period, training substitution increased male VET graduates' unemployment by a total of 10 percentage points (90% c.i.: 0.03; 0.17).

-- Figure 3 here --

Figure 4 illustrates that potential labour force experience has become a more important predictor of unemployment. The more VET graduates have received training in schools rather than enterprises, the steeper the slope of the unemployment-experience profile. The negative effect of additional months of labour force experience on unemployment is particularly strong in the months after leaving school. Over time, the unemployment risks of VET graduates trained in schools vs. enterprises become more similar, as VET graduates predominantly trained in schools acquire more relevant skills and better information about available jobs.

-- Figure 4 here --

To further explore the underlying mechanisms, we use two alternate training indicators: the percentage of school-provided training places (of all training places) and the percentage of employer-provided training places (see Table 2). As we would expect, school-based training raises unemployment, and increases the unemployment-reducing

effect of time since graduation, as young people's unemployment risks become more dependent on labour force experience. Also conforming to expectations, employer-provided training lowers VET graduates unemployment, and flattens their unemployment-experience profiles.[9]

The Online Appendix contains additional results for male vocational graduates (Table A2). Repeating the unemployment analyses, but including individuals who report to be enrolled in school changes, yields similar results. Repeating the analyses using employment probability (1=employed, 0=not employed) as the dependent variable also produces the expected patterns, essentially mirroring the results for unemployment with respect to the interaction effect.[10] While the unemployment analyses may suffer from bias due to selective withdrawal of individuals from the labour force, this does not affect the employment analyses. We find no effect of training provision on being neither in education nor employment. We also find no effects on temporary employment status (results available on request).[11]

The lower panel of Table 1 reports regression results with employment in routine occupations (=1, employment in other occupation=0) as dependent variable. We observe no statistically significant effects. Repeating these analyses with occupational status (measured by the International Socioeconomic Index; Ganzeboom et al., 1992) as the dependent variable did not yield different conclusions. That we fail to find an effect on job quality might reflect the short post-graduation observation span or the measures of job quality used. However, it also remains a possibility that extant research finding an association (Shavit and Müller, 2000; Arum and Shavit, 1995) has suffered from bias due to, for example, unobserved demand side factors. The organization of production and

demand for the products intensive in VET graduates labour is most likely a critical determinant of the number, skill content and quality of jobs available to VET graduates. Therefore, one plausible interpretation of our results is that demand side (and other) factors, but not training organization, are critical for the quality of jobs, while training organization matters for unemployment risks and the dynamics of labour market integration.

Discussion

In the course of economic liberalization, employers withdrew in large numbers from providing training places to vocational students in the Hungarian dual system. Our analyses indicate that the substitution of employer-provided with school-provided training places between 1994 and 2000 has increased male VET graduates' unemployment rate by 10 percentage points within the first two years after graduation. We found no evidence linking the training shift to changes in class positions. While concerns about time-varying confounding remain, our results have proven remarkably robust to demanding specification checks for this type of confounding.

These results suggest that economic liberalization in Hungary has made the transition from vocational education to work more difficult by breaking linkages from schools to employers that perform a critical matching function. The growing role of markets has led to more search-related unemployment and turnover due to diminished flow of information between vocational schools and employers. The absence of an effect on quality of employment (skilled vs. unskilled) may be taken as further evidence that it is

the matching rather than the skilling function of employer-provided training that makes dual system VET effective (Acemoglu and Pischke, 1998; Breen, 2005).

This case study also illustrates the contingency and importance of employer involvement in VET at a time where the dual system is, once again, portrayed as a model to emulate for other countries.[12] The Hungarian case, and the experience of post-socialist Central European countries more generally, illustrate the challenges in building and maintaining dual system VET: Without the historically grown institutions facilitating voluntary employer involvement in VET, employers participation is difficult to elicit, and as the Hungarian case illustrates, employer exit in droves during periods of economic crisis. This suggests that reformers in countries without strong institutional foundations for voluntary employer involvement in VET face tough constraints that may severely constrain their reform attempts, and might consider innovative strategies that do not rely on employers providing training places for vocational skill formation.

Is school-provided vocational training an alternative? Our and other research clearly indicates that declining employer involvement leads to higher unemployment upon graduation. Our results also indicate that after two years, more than two thirds of the initial adverse effect on unemployment has dissipated. The absence of effects on class position (and temporary contract status) suggests equivalent outcomes of school- and employer-provided training. However, before we can draw definite conclusion whether or not, or under which conditions employer- and school-provided training yield equivalent or divergent outcomes, more research is clearly in order.

Future research on the transition from school to work would benefit from a more refined understanding of different modes of training organization and the importance of employer involvement. Too little attention has been paid to the internal heterogeneity of dual system VET. The underlying logics of employer training provisions as well as the effectiveness of on-the-job training as such may differ considerably across occupations. Moreover, in the absence of formal institutions undergirding employer involvement in VET, policy-makers might encourage local informal coordination between vocational education providers and employers to ensure that vocational curricula are aligned to current labour demand and to create local school to work networks for VET students (Deil-Amen and Rosenbaum, 2004). Gender segregation in VET enrolment and gender differences in VET outcomes also merit further exploration (Jacob et al., 2009).

References

Acemoglu, D. and Pischke, J.-S. (1998). Why Do Firms Train? Theory And Evidence, *Quarterly Journal of Economics*, **113**, 78–118.

Allmendinger, J. (1989). Educational Systems and Labor Market Outcomes, *European Sociological Review*, **5**, 231–250.

Angrist, J. D. and Pischke, J.-S. (2009). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton and Oxford: Princeton University Press.

Arum, R. and Shavit, Y. (1995). Secondary Vocational Education and the Transition from School to Work, *Sociology of Education*, **68**, 187–204.

Audas, R., Berde, E. and Dolton, P. (2005). Youth Unemployment and Labour Market Transitions in Hungary, *Education Economics*, **13**, 1–25.

Baranowska, A. (2011). Does Horizontal Differentiation Make Any Difference? Heterogeneity of Educational Degrees and Labor Market Entry in Poland. In Kogan, I., Noelke, C., and Gebel, M. (Eds.), *Making the Transition: Education and Labor Market Entry in Central and Eastern Europe*. Palo Alto: Stanford University Press, pp. 216–240.

Becker, G. S. (1994). *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*. Chicago and London: University of Chicago Press.

Blossfeld, H.-P. (1992). Is the German Dual System a Model for a Modern Vocational Training System?, *International Journal of Comparative Sociology*, **33**, 168 – 181.

Bonnal, L., Mendes, S. and Sofer, C. (2002). School-to-Work Transition: Apprenticeship Versus Vocational School in France, *International Journal of Manpower*, **23**, 426–442.

Breen, R. (2005). Explaining Cross-National Variation in Youth Unemployment: Market and Institutional Factors, *European Sociological Review*, **21**, 125–34.

Bukodi, E. (2006). *Increasing Labor Market Insecurities Among Young People in Hungary? Labor Market Entry Process Since the Early 1980s*. University of Bamberg: FlexCAREER Working Paper No. 9.

Bukodi, E. and Robert, P. (2008). Hungary. In Kogan, I., Gebel, M., and Noelke, C. (Eds.), *Europe Enlarged: A Handbook of Education, Labour and Welfare Regimes in Central and Eastern Europe*. Bristol: Policy Press, pp. 183–211.

Bukodi, E. and Robert, P. (2011). Education and Labour Market Entry in Transition: The Case of Hungary. In Kogan, I., Noelke, C., and Gebel, M. (Eds.), *Making the Transition: Education and Labor Market Entry in Central and Eastern Europe*. Palo Alto: Stanford University Press, pp. 189–215.

Culpepper, P. and Thelen, K. (2007). Institutions and Collective Actors in the Provision of Training: Historical and Cross-National Comparisons. In Mayer, K. U. and Solga, H. (Eds.), *Skill Formation: Interdisciplinary and Cross-National Perspectives*. New York: Cambridge University Press, pp. 21–49.

Deaton, A. (1985). Panel Data from Time Series of Cross-Sections, *Journal of Econometrics*, **30**, 109–126.

Deil-Amen, R. and Rosenbaum, J. E. (2004). Charter Building and Labor Market Contacts in Two-Year Colleges, *Sociology of Education*, **77**, 245–265.

Diewald, M., Goedicke, A. and Mayer, K. U. (2006). *After the Fall of the Wall: Life Courses in the Transformation of East Germany*. Palo Alto: Stanford University Press.

Frankfurter Allgemeine Zeitung (2013). Duales System Ausbildung made in Germany, *FAZ.NET* (26 February 2013).

Gangl, M. (2001). European Patterns of Labour Market Entry. A Dichotomy of Occupationalized Vs. Non-occupationalized Systems?, *European Societies*, **3**, 471–494.

Gangl, M. (2010). Causal Inference in Sociological Research, *Annual Review of Sociology*, **36**, 21–47.

Ganzeboom, H. B. G., De Graaf, P. M. and Treiman, D. J. (1992). A Standard International Socio-economic Index of Occupational Status, *Social Science Research*, **21**, 1–56.

Gebel, M. and Noelke, C. (2011). The Transition from School to Work in Central and Eastern Europe: Theory and Methodology. In Kogan, I., Noelke, C., and Gebel, M. (Eds.), *Making the Transition: Education and Labor Market Entry in Central and Eastern Europe*. Palo Alto: Stanford University Press, pp. 29–57.

Gerber, T. P. (2003). Loosening Links? School-to-Work Transitions and Institutional Change in Russia Since 1970, *Social Forces*, **82**, 241–276.

Goldthorpe, J. H. (2007). Class and the Differentiation of Employment Contracts. In *On Sociology. Volume Two.* Palo Alto: Stanford University Press, pp. 101–124.

Hall, P. A. and Soskice, D. (eds) (2001). *Varieties of Capitalism: The Institutional Foundations of Comparative Advantage*. Oxford: Oxford University Press.

Harrison, E. and Rose, D. (2006). *The European Socio-economic Classification (ESeC) User Guide.* Colchester: Institute for Social and Economic Research, University of Essex.

Hernán, M. A. and Hernández-Díaz, S. (2012). Beyond the Intention-to-treat in Comparative Effectiveness Research, *Clinical Trials*, **9**, 48–55.

Horn, D. (2010). *The Political Background of Structural Changes in the Educational System of Hungary, 1985-1994*. Central European University: Institute for Policy Studies Working Paper.

Iannelli, C. and Raffe, D. (2007). Vocational Upper-Secondary Education and the Transition from School, *European Sociological Review*, **23**, 49–63.

Imbens, G. W. and Wooldridge, J. M. (2009). Recent Developments in the Econometrics of Program Evaluation, *Journal of Economic Literature*, **47**, 5–86.

Jacob, M., Kleinert, C. and Kühhirt, M. (2009). *Trends in Gender Disparities at the School to Work Transition in Germany: Comparing the Labor Market Entry of Young Men and Women Between 1984 and 2005*. MZES Discussion Paper No. 127.

Kerckhoff, A. C. (2001). Education and Social Stratification Processes in Comparative Perspective, *Sociology of Education*, **74**, pp. 3–18.

King, G., Tomz, M. and Wittenberg, J. (2000). Making the Most of Statistical Analyses: Improving Interpretation and Presentation, *American Journal of Political Science*, **44**, 347–361.

Kogan, I. (2008). Educational Systems of Central and Eastern European Countries. In Kogan, I., Gebel, M., and Noelke, C. (Eds.), *Europe Enlarged: A Handbook of Education, Labour and Welfare Regimes in Central and Eastern Europe*. Bristol: Policy Press, pp. 7–34.

Kogan, I. (2012). Tertiary Education Landscape and Labour Market Chances of the

Highly Educated in Central and Eastern Europe, *European Sociological Review*, **28**, 701–703.

Kogan, I., Noelke, C. and Gebel, M. (eds) (2011). *Making the Transition: Education and Labor Market Entry in Central and Eastern Europe*. Palo Alto: Stanford University Press.

Kogan, I. and Unt, M. (2005). Transition from School to Work in Transition Economies, *European Societies*, **7**, 219–253.

Konietzka, D. (2001). Hat Sich Das Duale System in Den Neuen Ländern Erfolgreich Etabliert? [Has the Dual System of Vocational Training Been Successfully Established in East Germany?], *Kölner Zeitschrift für Soziologie und Sozialpsychologie*, **53**, 50–75.

Lynch, L. M. (1992). Private-Sector Training and the Earnings of Young Workers, *The American Economic Review*, **82**, 299–312.

Matkovic, T. (2011). Screens and Credentials: Education and Labor Market Entry in Croatia in the Early 2000s. In Kogan, I., Noelke, C., and Gebel, M. (Eds.), *Making the Transition: Education and Labor Market Entry in Central and Eastern Europe*. Palo Alto: Stanford University Press, pp. 110–140.

Mood, C. (2010). Logistic Regression: Why We Cannot Do What We Think We Can Do, and What We Can Do About It, *European Sociological Review*, **26**, 67 –82.

Mooi-Reci, I. and Mills, M. (2012). The Gendered Consequences of Unemployment Insurance Reforms, *Social Forces*, **91**, 583–608.

Müller, W. and Shavit, Y. (1998). The Institutional Embeddedness of the Stratification Process: A Comparative Study of Qualifications and Occupations in Thirteen Countries. In Shavit, Y. and Müller, W. (Eds.), *From School to Work: A Comparative Study of Educational Qualifications and Occupational Destinations*. Oxford: Clarendon Press, pp. 1–48.

New York Times (2013). Text: Obama's 2013 State of the Union Address, *The New York Times* (12 February 2013).

Noelke, C., Gebel, M. and Kogan, I. (2012). Uniform Inequalities: Institutional Differentiation and the Transition from Higher Education to Work in Post-socialist Central and Eastern Europe, *European Sociological Review*, **28**, 704–716.

Ost, D. (2000). Illusory Corporatism in Eastern Europe: Neoliberal Tripartism and Postcommunist Class Identities, *Politics & Society*, **28**, 503–530.

Parey, M. (2009). Vocational Schooling Versus Apprenticeship Training - Evidence from Vacancy Data, *Unpublished manuscript*.

Ryan, P. (2001). The School-to-Work Transition: A Cross-National Perspective, *Journal of Economic Literature*, **39**, 34–92.

Scherer, S. (2005). Patterns of Labour Market Entry: Long Wait or Career Instability? An Empirical Comparison of Italy, Great Britain and West Germany, *European Sociological Review*, **21**, 427–440.

Schneider, S. L. (2010). Nominal Comparability Is Not Enough: (In-)equivalence of Construct Validity of Cross-national Measures of Educational Attainment in the European Social Survey, *Research in Social Stratification and Mobility*, **28**, 343–357.

Shavit, Y. and Müller, W. (2000). Vocational Secondary Education: Where Diversion and Where Safety Net?, *European Societies*, **21**, 29–50.

Solga, H. and Konietzka, D. (1999). Occupational Matching and Social Stratification, *European Sociological Review*, **15**, 25 –47.

Tomz, M., Wittenberg, J. and King, G. (2003). CLARIFY: Software for Interpreting and Presenting Statistical Results, *Journal of Statistical Software*, **8**.

Wolbers, M. H. J. (2007). Patterns of Labour Market Entry: A Comparative Perspective on School-to-Work Transitions in 11 European Countries, *Acta Sociologica*, **50**, 189–210.

Table 1. OLS estimates ("cluster robust" standard errors) of the effect of the ratio of school-provided to employer-provided training places and time since graduation on male VET graduates' labor market outcomes 1-24 months after graduation, 1994-2000 graduation cohorts.

	M1	M2	M3	M1i	M2i	M3i	M4i
Unemployment probability							
ln(time since graduation)	-0.11***	-0.11***	-0.11***	-0.10***	-0.09***	-0.09***	-0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ln(school-/employer-provided places)	0.11*	0.10	0.16	0.28***	0.25**	0.30**	
	(0.05)	(0.09)	(0.09)	(0.07)	(0.10)	(0.10)	
· ln(time since graduation)				-0.06**	-0.07***	-0.08***	-0.06**
				(0.02)	(0.02)	(0.02)	(0.02)
N	5584	5584	5584	5584	5584	5584	5584
R^2	0.12	0.13	0.17	0.12	0.13	0.18	0.18
Probability of employment in routine vs. other occupation							
ln(time since graduation)	0.00	0.01	0.01	0.00	0.00	0.01	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ln(school-/employer-provided places)	0.02	0.15	-0.03	0.02	0.11	-0.02	
	(0.06)	(0.12)	(0.13)	(0.11)	(0.13)	(0.15)	
· ln(time since graduation)				0.00	0.01	-0.01	-0.01
				(0.03)	(0.03)	(0.03)	(0.03)
N	4005	4005	4005	4005	4005	4005	4005
R^2	0.05	0.06	0.14	0.05	0.06	0.14	0.15
Social background	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	No	Yes	Yes	No	No
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	No
Year FE	Yes	Yes	No	Yes	Yes	No	Yes
County-specific trends	No	Yes	No	No	Yes	No	No
County-by-year FE	No	No	Yes	No	No	Yes	No
County-by-cohort FE	No	No	No	No	No	No	Yes

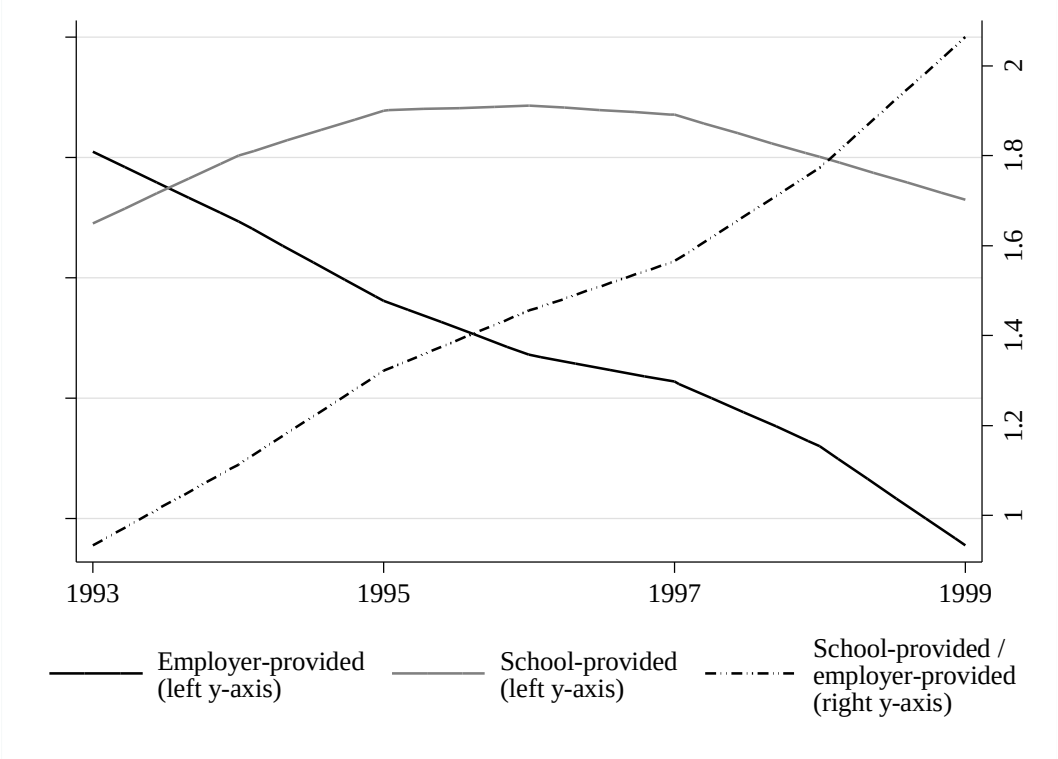
Note: All models control for respondents' age (ln). Social background = dummy variables mother's and father's education and employment status, and number of children living in household. County FE = county-specific dummy variables; Cohort FE = cohort-specific dummy variables; Year FE = year-specific dummy variables; County-specific trends = country-specific linear trends; County-by-year FE = exhaustive set of county-by-year dummy variables; County-by-cohort FE = exhaustive set of county-by-cohort dummy variables. Full results available on request.
Source: Hungarian Labor Force Survey and Hungarian School Survey (own calculations).
*** p<0.001, ** p<0.01, * p<0.05

Table 2. OLS estimates ("cluster robust" standard errors) of changing training provision and time since graduation on male VET graduates' unemployment probability 1-24 months after graduation, 1994-2000 graduation cohorts.

Sample	*Upper secondary graduates*		*Vocational school graduates*		*Vocational school graduates*	
Training Indicator	*school-provided / employer-provided training places*		*% school-provided training places*		*% employer-provided training places*	
ln(time since graduation)	-0.12***	-0.12***	-0.11***	-0.20***	-0.11***	-0.02
	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
ln(training indicator)	-0.06	-0.10	0.23*	0.60***	-0.18*	-0.46***
	(0.06)	(0.09)	(0.12)	(0.17)	(0.07)	(0.12)
· ln(time since graduation)		0.01		-0.15**		0.11**
		(0.03)		(0.05)		(0.04)
N	2590	2590	5584	5584	5584	5584
R^2	0.13	0.13	0.12	0.12	0.12	0.12

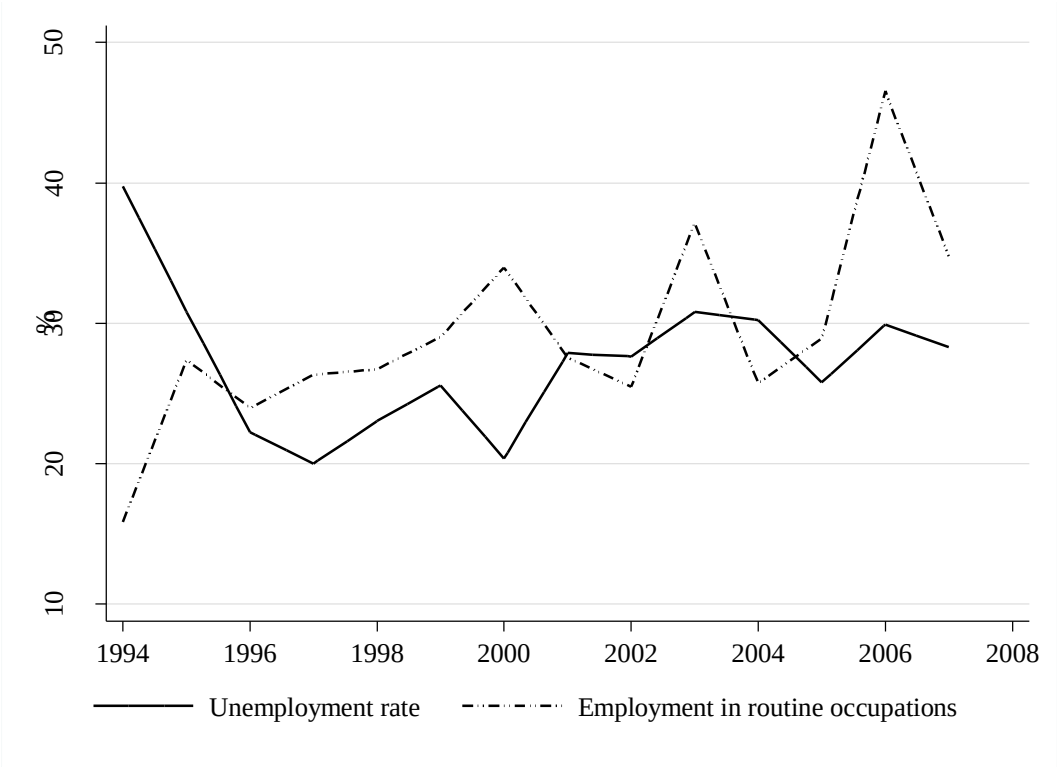
Note: All models control for respondents' age (ln), respondents social background, county, cohort and year fixed effects. Full results available on request.
Source: Hungarian Labor Force Survey and Hungarian School Survey (own calculations).
*** p<0.001, ** p<0.01, * p<0.05

Figure 1. The changing provision of training places.



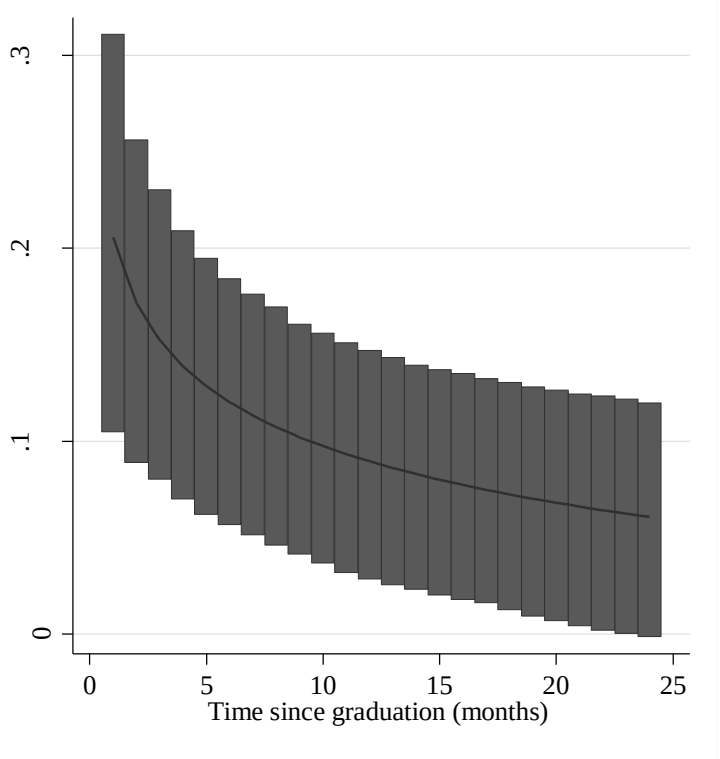
Source: Hungarian School Survey (own calculations).

Figure 2. Cohort-specific percentages unemployed and employed in routine occupations (among employed).



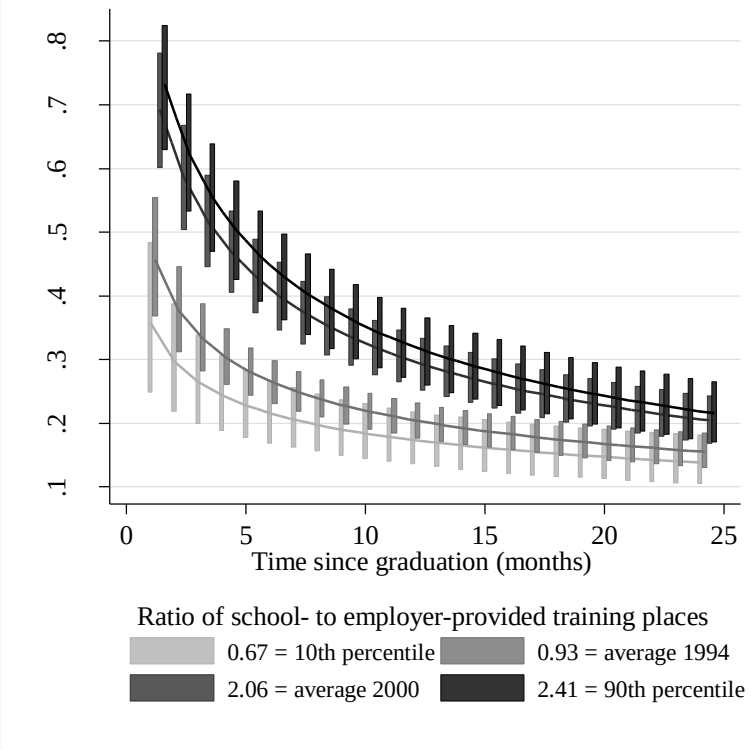
Note: Male VET graduates aged 17-22, observed 1-24 months after graduation. The multivariate analysis only uses data for the 1994-2000 cohorts.
Source: Hungarian Labor Force Survey (own calculations).

Figure 3. Simulated effect of changing training provision (ratio of employer- to school-provided training places) from 0.93 (average value 1994 cohort) to 2.06 (average value 2000 cohort) on unemployment probability, by months since graduation.



Note: Based on logistic regression with covariate specification as in Table 2, Model M1i. Vertical bars represent 90% confidence intervals.
Source: Hungarian Labor Force Survey and Hungarian School Survey (own calculations).

Figure 4. Simulated effect of months since graduation on unemployment probability for different training indicator values.

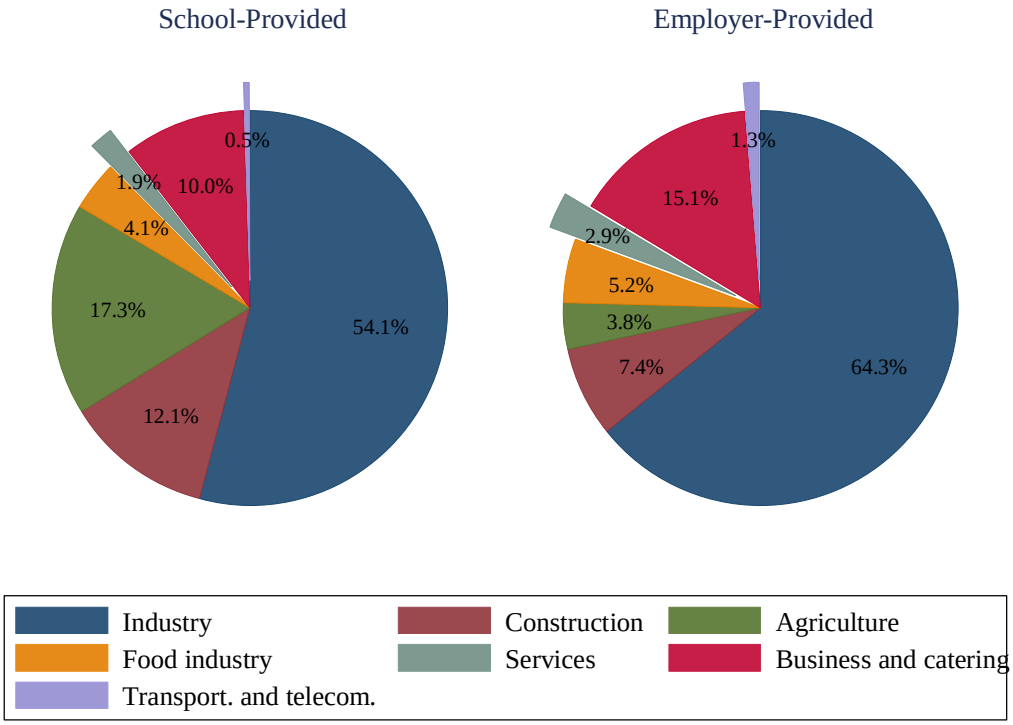


Note: Based on logistic regression with covariate specification as in Table 2, Model M1i. Vertical bars represent 90% confidence intervals.
Source: Hungarian Labor Force Survey and Hungarian School Survey (own calculations).

Appendix

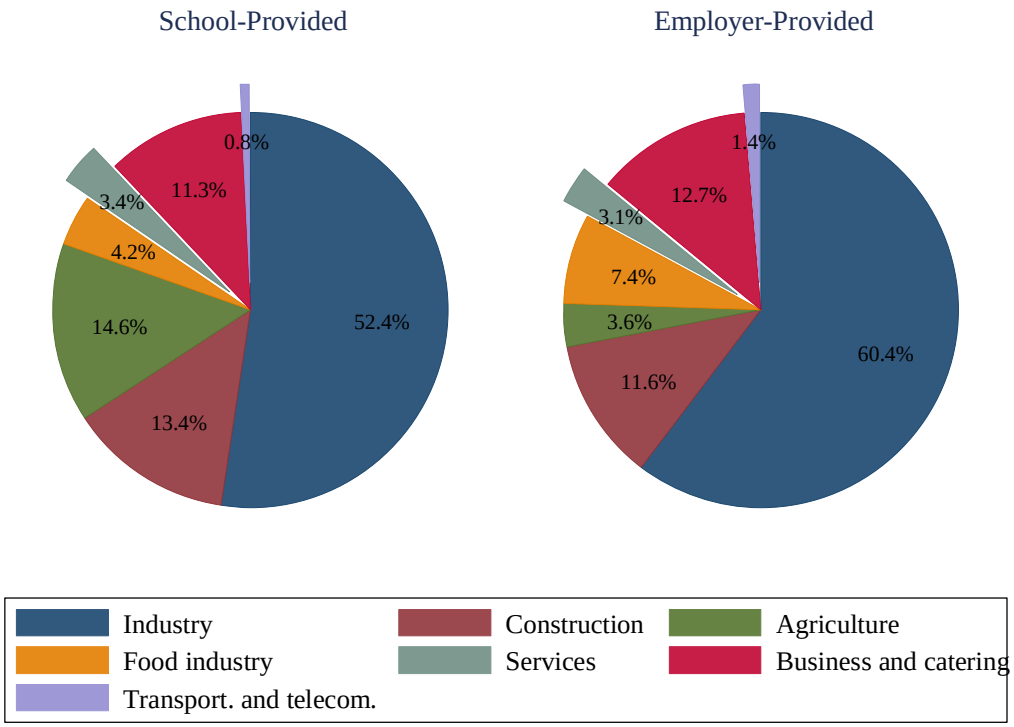
Further Details on Hungarian VET

Figure A1. Distribution of Training Places across Industries, by Training Site, 1995 Cohort



Source: Hungarian School Survey (own calculations).

Figure A2. Distribution of Training Places across Industries, by Training Site, 1998 Cohort



Source: Hungarian School Survey (own calculations).

Further Details on Prior Research

Prior research has identified the effect of VET training provision by comparing VET graduates who received employer-provided training to "similar" VET graduates who enrolled in fully school-based VET programs. Studies from Western European countries find that employer-provided training lowers unemployment or non-employment risks in the years following graduation (Bonnal et al., 2002; Parey, 2009; Plug and Groot, 1998; Winkelmann, 1996). Plug and Groot (1998) find that these advantages fade and that there are no differences in terms of earnings growth (see also, Parey, 2009). In contrast, studies on Croatia (Matkovic, 2011) and Poland (Baranowska, 2011) find little or no evidence that employer-provided training leads to faster labour market entries or better job quality.

Evidence from cross-nationally comparative studies is based on comparing differences in outcomes between VET graduates and other secondary school graduates across countries, and yields generally less conclusive results. Müller and Shavit (1998; Shavit and Müller, 2000) find that in countries with dual systems, such as Germany, the Netherlands or Switzerland, vocational graduates are more likely avoid unemployment, to enter skilled rather than unskilled jobs, but also have lower occupational prestige. Wolbers (2007) finds that in countries with larger dual systems, mainly the least educated benefit in terms of faster transitions to first jobs, while vocational secondary graduates do not benefit, and academic secondary graduates even suffer slower labour market entries. For ten CEE countries, Kogan, Noelke and Gebel (2011) find no evidence that VET graduates have better early labor market outcomes in countries, where a substantial share of employer-provided training occurs in VET.

Further Details on Variables Used

The training data measure training provision in the last two years of vocational school, during which training takes place. Using contemporaneous values on training indicators would be misleading, since it reflects the situation of those currently in school. We therefore match cohorts entering the labour market in year t to training indicator values in year t-1.

In the LFS data, we only have information on respondent's location at the time of observation, which we assume to be identical to the county, in which vocational education and training was obtained. This assumption is defensible since spatial mobility, especially among the less wealthy and lower educated, tends to be very low in Hungary (Cseres-Gergely, 2004). In the analysis sample, mean age is 18.7 years, with 83% being between the ages of 17 and 19. 95% of respondents are identified as children living together with their parents. We can therefore assume that respondents are still living with their parents in the county where they attended vocational school. While selective mobility might attenuate our effect estimates, we tested whether our training variable is correlated with residing vs. not residing with one's parents. Estimating equation 1 and all other specifications reported in Table 1, we found no evidence of this being the case (results available on request).

Since we lack information on the precise month in which individuals obtained a degree, we assume that students completed school in June, the ending date of the official school year. Our assumption that school is completed in June and not, say, July is random with respect to each respondent, but may introduce measurement error. The plausibility

of imputing June is assessed by inspecting the distribution of respondents, who report having obtained a vocational degree in the year of survey, across the months in which they were surveyed. Only 0.7% of respondents who report having obtained a vocational degree in the year of survey are surveyed in the months from January to May, while the remaining 99.3% are almost equally distributed over the months June to December. On this basis, we construct the variable "time since graduation" (potential labour force experience), measured in months, which starts counting in July (=1) in the year the vocational school degree was obtained.

All analyses control for the following variables measuring social background: father present/absent, father's education (lower secondary or less, gymnasium/tehnikum, postsecondary/tertiary; reference: vocational school) and employment status (unemployed, inactive; reference: employed), mother's presence/absence, education, and employment status (coded as for fathers'), and dummies for the number children living in the household (one, three, four or more; reference: two). For the 5% of respondents not identified as children on the household roster, we add a dummy variable.

Descriptives

Table A1. Means and standard deviations[a].

	Mean	S.D.
Individual data		
Unemployed	0.27	
Time since graduation in months	13.83	6.55
Age in years	18.69	1.05
Respondent self-identifies as parent, cohabiting or other	0.05	
Father absent	0.15	
Father employed	0.56	
Father unemployed	0.06	
Father inactive	0.18	
Father's education – lower secondary	0.26	
Father's education – vocational school	0.42	
Father's education – upper secondary	0.10	
Father's education – postsecondary / tertiary	0.01	
Mother absent	0.03	
Mother employed	0.59	
Mother unemployed	0.06	
Mother inactive	0.27	
Mother's education – lower secondary	0.49	
Mother's education – vocational school	0.22	
Mother's education – upper secondary	0.19	
Mother's education – postsecondary / tertiary	0.02	
0 siblings	0.33	
1 sibling	0.45	
2 siblings	0.13	
3 siblings	0.08	
Number of individuals	5584	
Macro data		
Ratio of school- to employer-provided training places	1.46	0.85
Ratio of school-provided to total training places	0.55	0.13
Ratio of employer-provided to total training places	0.45	0.13
Number of macro-level contexts	140	

Note: [a]only standard deviations for continuous variables reported. Except for the training indicators, age and time since graduation, all variables are binary. The sample is restricted to observations used in the unemployment analyses.
Source: Hungarian Labor Force Survey and Hungarian School Survey (own calculations).

Further Discussion of Identification Strategy

How does our application differ from traditional DD? In a canonical example, Card and Krueger (1994) analyse the employment effect of a minimum wage increase in New Jersey in April 1992. They compare the change in employment rates in New Jersey from February 1992 to November 1992 to the change in employment in Pennsylvania, where the minimum wage remained constant, over the same period. The DD estimate of the effect of the minimum wage increase is the difference in outcomes for New Jersey minus the difference in outcomes for Pennsylvania. Generalizing this example, we can think of a reform that is enacted in some U.S. states but not in others, and we have data from repeated cross-sectional surveys on individual outcomes from before and after reform for treated and control states. We can obtain the estimate of the effect of reform from the following linear model (Angrist and Pischke, 2009, p. 233f.):

$$(2)\ Y_{ijt} = \beta_0 + \delta\, T_{jt} + \gamma_t + \mu_j + \varepsilon_{ijt}.$$

Here, T_{jt} is a binary reform indicator equal to 1 in states and periods affected by reform, γ_t are year fixed effects, μ_j are state fixed effects. Compared to the conventional DD model in equation 2, equation 1 differs in several respects. These differences are based on straightforward generalizations of the conventional model that create no special complications for identification. First, while T_{jt} in equation 2 varies across states and years, $TRAIN_{cj}$ in equation 1 varies across states (i.e. Hungarian counties) and cohorts. Second, rather than a binary variable T_{jt}, $TRAIN_{cj}$ is a continuous variable measuring treatment intensity. Third, all our cohorts are exposed to some level of treatment, i.e. there is no distinction between before and after reform and treated and control states.

While the first point is an innocuous change, the second and third points are generalizations of DD discussed by Angrist and Pischke (Angrist and Pischke, 2009, p. 233f.). Specifically, Equation 1 is a variant of equation 5.2.5 in Angrist and Pischke (2009: 237). The difference is that in equation 1 our treatment variable varies not across states (counties) and years, but across counties and cohorts (and that we additionally include cohort fixed effects). Apart from the functional form of the treatment variable, equation 1 and 5.2.5 in Angrist and Pischke (2009: 237) represent no break from the canonical DD model in terms of identification. They both contain unit and time fixed effects that control non-parametrically for unobserved time-constant and time-varying confounders, which makes the DD approach so attractive for causal inference.

To further elucidate our application, consider again the example of Card and Krueger (1994). Individuals in this case may be in four distinct conditions: treatment (New Jersey) before reform; control (Pennsylvania) before reform, treatment after reform, control after reform. In the context of equation 2, T_{jt} would not change over time for individuals in the control state (i.e. remain 0) and switch from 0 to 1 for individuals in the treated state. Whatever changes over time occur that are common to both treated and control, are controlled away by the γ_t year fixed effects (i.e. a November 1992 dummy), and whatever unobserved time-constant factors cause individuals in treated and control condition to differ are controlled away by μ_j county fixed effects (i.e. a New Jersey dummy). Our example differs in that individuals may not be in four conditions, but 140 conditions (corresponding to the 140 cohorts, i.e. 7 cohorts from 20 counties) or 140 levels of treatment. Whatever changes over time occur that are common to individuals with different levels of treatment are controlled away by the γ_t year fixed effects, and whatever

unobserved time-constant factors cause individuals with different levels of treatment to differ are controlled away by μ_j county fixed effects. In both equation 1 and 2, the μ_j county/state fixed effects and γ_t fixed effects are used in the same way to secure identification.

The main difference is that T_{jt} is a binary variable in equation 2 and $TRAIN_{cj}$ is a continuous variable in equation 1, i.e. the substantively relevant difference concerns the functional form of the treatment variable. While confounding is addressed non-parametrically via fixed effects, misspecification of the functional form may introduce bias. We did not coarsen $TRAIN_{cj}$ because that would lead to an unnecessary loss of information. However, we tested different functional forms (linear, natural log, first and second order polynomial, square root). The choice proved to be inconsequential for the results (we opted for the natural log). The analysis with first and second order polynomial indicated a positive effect of the first order polynomial and a negative effect of the second order polynomial of $TRAIN_{cj}$ in the unemployment analysis. This "declining effects" pattern was well approximated by the natural log.

Furthermore, from the perspective of causal inference, equation 1 more effectively eliminates time-varying confounders than equation 2: Because each cohort is observed in two different calendar years, we can control for cohort fixed effects that eliminate unobserved confounding factors that are common to all graduates who enter the labour market in a given year. We also exploit this feature of the data to conduct a differences-in-differences-in-differences specification check (DDD).

Results for Women

Table A2. OLS estimates ("cluster robust" standard errors) of the effect of the ratio of school-provided to employer-provided training places and time since graduation on female VET graduates' labor market outcomes 1-24 months after graduation, 1994-2000 graduation cohorts.

	M1	M2	M3	M1i	M2i	M3i	M4i
Unemployment probability							
ln(time since graduation)	-0.11***	-0.11***	-0.11***	-0.10***	-0.10***	-0.11***	-0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ln(school-/employer-provided places)	-0.04	-0.02	0.14	0.04	0.06	0.19*	
	(0.05)	(0.09)	(0.09)	(0.08)	(0.10)	(0.09)	
· ln(time since graduation)				-0.03	-0.04	-0.03	-0.04
				(0.02)	(0.02)	(0.03)	(0.03)
N	3677	3677	3677	3677	3677	3677	3677
R^2	0.09	0.12	0.18	0.09	0.12	0.18	0.19
Probability of employment in routine vs. other occupation							
ln(time since graduation)	0.03	0.03	0.02	0.04	0.04	0.03	0.02
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
ln(school-/employer-provided places)	0.05	0.14	0.10	0.11	0.19	0.15	
	(0.08)	(0.13)	(0.12)	(0.14)	(0.16)	(0.15)	
· ln(time since graduation)				-0.02	-0.03	-0.03	0.03
				(0.04)	(0.04)	(0.04)	(0.05)
N	2893	2893	2893	2893	2893	2893	2893
R^2	0.10	0.12	0.20	0.10	0.12	0.20	0.23
Social background	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	No	Yes	Yes	No	No
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	No
Year FE	Yes	Yes	No	Yes	Yes	No	Yes
County-specific trends	No	Yes	No	No	Yes	No	No
County-by-year FE	No	No	Yes	No	No	Yes	No
County-by-cohort FE	No	No	No	No	No	No	Yes

Note: All models control for respondents' age (ln). Social background = dummy variables mother's and father's education and employment status, and number of children living in household. County FE = county-specific dummy variables; Cohort FE = cohort-specific dummy variables; Year FE = year-specific dummy variables; County-specific trends = country-specific linear trends; County-by-year FE = exhaustive set of county-by-year dummy variables; County-by-cohort FE = exhaustive set of county-by-cohort dummy variables. Full results available on request.
Source: Hungarian Labor Force Survey and Hungarian School Survey (own calculations).
*** p<0.001, ** p<0.01, * p<0.05

Additional Results for Men

Table A3. OLS estimates ("cluster robust" standard errors) of the effect of the ratio of school-provided to employer-provided training places and time since graduation on male VET graduates' labor market outcomes 1-24 months after graduation, 1994-2000 graduation cohorts.

	M1	M2	M3	M1i	M2i	M3i	M4i
Unemployment probability including respondents enrolled in school							
ln(time since graduation)	-0.11***	-0.11***	-0.11***	-0.10***	-0.09***	-0.09***	-0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ln(school-/employer-provided places)	0.11*	0.13	0.19*	0.28***	0.28**	0.34***	
	(0.04)	(0.08)	(0.09)	(0.07)	(0.09)	(0.09)	
· ln(time since graduation)				-0.07***	-0.07***	-0.08***	-0.06**
				(0.02)	(0.02)	(0.02)	(0.02)
N	5824	5824	5824	5824	5824	5824	5824
R^2	0.12	0.13	0.17	0.12	0.14	0.17	0.18
Employment probability including respondents enrolled in school							
ln(time since graduation)	0.10***	0.10***	0.10***	0.09***	0.09***	0.09***	0.10***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ln(school-/employer-provided places)	-0.06	0.05	0.02	-0.17**	-0.06	-0.09	
	(0.04)	(0.08)	(0.08)	(0.05)	(0.08)	(0.08)	
· ln(time since graduation)				0.04**	0.06***	0.06***	0.05**
				(0.02)	(0.02)	(0.01)	(0.02)
N	9244	9244	9244	9244	9244	9244	9244
R^2	0.08	0.09	0.11	0.08	0.09	0.11	0.12
Probability being not in education or employment (=1) vs. employed (=0)							
ln(time since graduation)	-0.12***	-0.12***	-0.12***	-0.11***	-0.11***	-0.11***	-0.11***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
ln(school-/employer-provided places)	0.06	0.06	0.04	0.11	0.10	0.08	
	(0.04)	(0.07)	(0.08)	(0.06)	(0.08)	(0.09)	
· ln(time since graduation)				-0.02	-0.02	-0.03	-0.02
				(0.02)	(0.02)	(0.02)	(0.02)
N	9244	9244	9244	9244	9244	9244	9244
R^2	0.09	0.10	0.13	0.09	0.10	0.13	0.13
Social background	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	No	Yes	Yes	No	No
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	No
Year FE	Yes	Yes	No	Yes	Yes	No	Yes
County-specific trends	No	Yes	No	No	Yes	No	No
County-by-year FE	No	No	Yes	No	No	Yes	No
County-by-cohort FE	No	No	No	No	No	No	Yes

Note: See Table A1.
Source: Hungarian Labor Force Survey and Hungarian School Survey (own calculations).
*** p<0.001, ** p<0.01, * p<0.05

Additional Results for Men – Placebo Analyses

Table A4. OLS estimates ("cluster robust" standard errors) of the effect of the ratio of school-provided to employer-provided training places and time since graduation on male upper secondary graduates' labor market outcomes 1-24 months after graduation, 1994-2000 graduation cohorts.

	M1	M2	M3	M1i	M2i	M3i	M4i
Unemployment probability							
ln(time since graduation)	-0.12***	-0.12***	-0.12***	-0.12***	-0.12***	-0.13***	-0.12***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
ln(school-/employer-provided places)	-0.06	-0.03	-0.10	-0.10	-0.04	-0.13	
	(0.06)	(0.10)	(0.12)	(0.09)	(0.12)	(0.14)	
· ln(time since graduation)				0.01	0.01	0.02	0.02
				(0.03)	(0.03)	(0.03)	(0.03)
N	2590	2590	2590	2590	2590	2590	2590
R^2	0.13	0.15	0.21	0.13	0.15	0.21	0.21
Probability of employment in routine vs. other occupation							
ln(time since graduation)	0.03	0.02	0.02	0.05	0.03	0.03	0.03
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
ln(school-/employer-provided places)	0.01	-0.06	-0.18	0.15	0.03	-0.12	
	(0.09)	(0.16)	(0.17)	(0.14)	(0.18)	(0.19)	
· ln(time since graduation)				-0.05	-0.04	-0.03	-0.04
				(0.04)	(0.05)	(0.05)	(0.04)
N	2893	2893	2893	2893	2893	2893	2893
R^2	0.10	0.12	0.20	0.10	0.12	0.20	0.23
Social background	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	No	Yes	Yes	No	No
Cohort FE	Yes	Yes	Yes	Yes	Yes	Yes	No
Year FE	Yes	Yes	No	Yes	Yes	No	Yes
County-specific trends	No	Yes	No	No	Yes	No	No
County-by-year FE	No	No	Yes	No	No	Yes	No
County-by-cohort FE	No	No	No	No	No	No	Yes

Note: See Table A1.
Source: Hungarian Labor Force Survey and Hungarian School Survey (own calculations).
*** p<0.001, ** p<0.01, * p<0.05

References

Angrist, J. D. and Pischke, J.-S. (2009). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton and Oxford: Princeton University Press.

Baranowska, A. (2011). Does Horizontal Differentiation Make Any Difference? Heterogeneity of Educational Degrees and Labor Market Entry in Poland. In Kogan, I., Noelke, C., and Gebel, M. (Eds.), *Making the Transition: Education and Labor Market Entry in Central and Eastern Europe*. Palo Alto: Stanford University Press, pp. 216–240.

Bonnal, L., Mendes, S. and Sofer, C. (2002). School-to-Work Transition: Apprenticeship Versus Vocational School in France, *International Journal of Manpower*, **23**, 426–442.

Card, D. and Krueger, A. B. (1994). Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania, *American Economic Review*, **84**, 772–93.

Cseres-Gergely, Z. (2004). Infocus – Labour Market Inequality and Geographical Mobility in Hungary. In Fazekas, K., Koltay, J., and Cseres-Gergely, Z. (Eds.), *The Hungarian Labour Market - Review and Analysis*. Budapest: Institute of Economics - Hungarian Academy of Sciences, pp. 41–114.

Kogan, I., Noelke, C. and Gebel, M. (2011). Comparative Analysis of Social Transformation, Education Systems, and School-to-Work Transitions in Central and Eastern Europe. In Kogan, I., Noelke, C., and Gebel, M. (Eds.), *Making the Transition: Education and Labor Market Entry in Central and Eastern Europe*. Palo Alto: Stanford University Press, pp. 320–354.

Matkovic, T. (2011). Screens and Credentials: Education and Labor Market Entry in Croatia in the Early 2000s. In Kogan, I., Noelke, C., and Gebel, M. (Eds.), *Making the Transition: Education and Labor Market Entry in Central and Eastern Europe*. Palo Alto: Stanford University Press, pp. 110–140.

Müller, W. and Shavit, Y. (1998). The Institutional Embeddedness of the Stratification Process: A Comparative Study of Qualifications and Occupations in Thirteen Countries. In Shavit, Y. and Müller, W. (Eds.), *From School to Work: A Comparative Study of Educational Qualifications and Occupational Destinations*. Oxford: Clarendon Press, pp. 1–48.

Parey, M. (2009). Vocational Schooling Versus Apprenticeship Training - Evidence from Vacancy Data, *Unpublished manuscript*.

Plug, E. and Groot, W. (1998). Apprenticeship Versus Vocational Education: Exemplified by the Dutch Situation, *Unpublished manuscript*.

Shavit, Y. and Müller, W. (2000). Vocational Secondary Education: Where Diversion and Where Safety Net?, *European Societies*, **21**, 29–50.

Winkelmann, R. (1996). Employment Prospects and Skill Acquisition of Apprenticeship-Trained Workers in Germany, *Industrial and Labor Relations Review*, **49**, 658–672.

Wolbers, M. H. J. (2007). Patterns of Labour Market Entry: A Comparative Perspective on School-to-Work Transitions in 11 European Countries, *Acta Sociologica*, **50**, 189–210.

Endnotes

1 For a description the Hungarian education system, see Bukodi and Robert (2008).

2 The third indicator is simply one minus the second indicator.

3 This effect is likely to cause downward bias in our analyses of unemployment probability.

4 The individual level training effect would likely be larger because of self-selection into firm-based training.

5 Epidemiologists refer to conceptually similar effect estimates in clinical trials as intent-to-treat effects, which measure the total effect of being exposed to (a certain level of) treatment at baseline irrespective of subsequent changes in treatment status (Hernán and Hernández-Díaz, 2012).

6 Moreover, we need to make an assumption about the functional form of effect of the treatment variable. While we chose the natural log, we obtained substantively similar results with other functional forms (see Online Appendix, for further discussion).

7 If we modelled training choice at the individual level, using individual fixed effects to rule out selection on time-constant unobservables (IQ, personality etc.) would be practically impossible. Because we are dealing with initial labour market entrants, by definition, we lack pre-training outcome data to estimate individual fixed effects.

8 We also experimented with flexibly specified control variables measured at the county- and year/cohort level (youth unemployment rates, adult male vocational graduate unemployment rate, and cohort size). The results of the latter specification checks were similar to the ones reported here (available on request), but they are less attractive since they are based on the inclusion of endogenous covariates.

9 The interaction effect suggests that the more VET students receive on-the-job training, the less negative is the unemployment-reducing effect of labour market experience on class position. Unemployment-experience profiles become less steep, as the outcomes of graduates who have little or no experience improve relative to those who have more experience.

10 Excluding respondents enrolled in school does not affect the employment results (results available on request).

11 Job security provisions are relatively weak and employment contracts are weakly regulated in Hungary during the period of observation (Bukodi and Robert 2012), resulting in a low incentive for employer to use temporary contracts.

12 U.S. President Barack Obama praised the German dual system in his 2013 State of the Union Address (New York Times, 2013), and Italian and Spanish politicians have taken efforts to boost dual system VET to combat disastrous levels of youth unemployment (Frankfurter Allgemeine Zeitung, 2013).