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Inhoud

Beleidssamenvatting

De meeste studies vinden dat beroepsgerichte opleidingen, in vergelijking met meer algemene opleidingen, leiden tot betere kansen op werk en hogere lonen aan de start van de loopbaan. Sommige recente studies suggereren echter ook dat beroepsopgeleiden later in hun loopbaan veeleer slechter af zouden zijn met betrekking tot deze arbeidsmarktuitkomsten. Beleidsmakers lijken dus geconfronteerd te worden met een afweging tussen relatieve voordelen op korte termijn en relatieve nadelen op lange termijn voor beroepsopgeleiden. Sommige studies geven ook aan dat deze afweging het meest uitgesproken is in landen met een duale traditie zoals Duitsland of Zwitserland. Een mogelijke verklaring voor deze afweging die regelmatig wordt aangereikt in de literatuur, is een verschil tussen beroeps- en algemeen opgeleiden in de mate waarin ze (bij)leren op de werkvloer.

Voor zover ons bekend onderzocht tot nu toe slechts één studie empirisch hoe beroeps- en algemeen opgeleiden verschillen in de mate waarin ze bijleren tijdens hun loopbaan en hoe dit verschil verandert naarmate ze langer actief zijn op de arbeidsmarkt (Hanushek et al., 2017). Deze onderzoekers vonden indicaties dat, in de traditioneel duale landen (Denemarken, Duitsland, en Zwitserland), algemeen opgeleiden (in vergelijking met een beroepsgerichte opleiding) naarmate ze ouder worden relatief vaker deelnemen aan opleiding gerelateerd aan hun loopbaan. In dit rapport gaan we hier verder op door en onderzoeken we de relatie tussen het type onderwijs (beroepsgericht versus algemeen) en de (verdere) ontwikkeling van vaardigheden tijdens de loopbaan. Eerder dan te focussen op opleidingsparticipatie tijdens de loopbaan, meten we de ontwikkeling van vaardigheden op een meer directe manier. Meer concreet is onze indicator van vaardigheidsontwikkeling gebaseerd op de inschatting van de werknemer over de mate waarin hij of zij heeft bijgeleerd tijdens de uitoefening van zijn of haar job. Onze focus op deze ontwikkeling van vaardigheden biedt meerdere voordelen ten opzichte van indicatoren van levenslang leren die gebaseerd zijn op opleidingsparticipatie. Eerst en vooral capteren klassieke indicatoren van opleidingsparticipatie doorgaans slechts een klein aandeel van de totale tijd gespendeerd aan leren; ze houden bijvoorbeeld geen rekening met meer informele vormen van leren zoals leren door te kijken en leren door te doen. Ten tweede houden deze indicatoren ook geen rekening met de effectiviteit van opleidingsparticipatie met betrekking tot de opbouw van vaardigheden. Indien beroepsopgeleiden en algemeen opgeleiden een verschillende leercurve hebben, zal de tijd gespendeerd aan opleidingsactiviteiten bijgevolg weinig vertellen over de mate waarin deze groepen van werknemers effectief verschillen in de verdere ontwikkeling van vaardigheden.

Voor onze analyses maken we gebruik van de 'European Skills and Jobs Survey' (ESJS) data. Deze data werden in 2014 door het Europees Centrum voor de ontwikkeling van de beroepsopleiding (Cedefop) verzameld op basis van een survey onder werknemers in de 28 lidstaten van de Europese Unie. De survey heeft betrekking op de gehele beroepsbevolking, wat ons toelaat werknemers in verschillende stadia van hun loopbaan te vergelijken. Verder bevat deze dataset gedetailleerde informatie over de ontwikkeling van vaardigheden op het werk en de mate waarin het hoogst

behaalde diploma van werknemers behaald is in het kader van een beroepsgerichte opleiding. Meer specifiek laat deze dataset toe om beroepsgerichte onderwijsprogramma's op de volgende drie verschillende manieren te onderscheiden van algemene programma's: (1) programma's met een specifieke focus (versus programma's met een bredere, meer algemene focus), (2) programma's met een werkleerplekcomponent (versus programma's zonder werkplekleren) en (3) programma's met een specifieke focus en een werkleerplekcomponent (versus programma's zonder specifiek focus of werkleerplekcomponent).

Om de causale relatie tussen het type onderwijsprogramma (beroepsgericht versus algemeen) en de ontwikkeling van vaardigheden tijdens de loopbaan te identificeren, voeren we een zogenaamde instrumentele variabele (IV) analyse uit. Het gebruik van een IV analyse is aangewezen omdat jongeren die kiezen voor een algemene opleiding op tal van niet-waarneembare vlakken (talenten, motivaties,…) kunnen verschillen van jongeren die kiezen voor een meer beroepsgerichte opleiding. Indien deze niet-waargenomen eigenschappen tevens bepalend zijn voor de mate waarin bijgeleerd wordt op de werkvloer, dan zou een klassieke regressieanalyse leiden tot vertekende conclusies. Een IV analyse laat toe om dit probleem op te lossen.

Globaal gezien zijn onze resultaten consistent met het idee dat verschillen tussen beroeps- en algemeen opgeleiden in de mate waarin ze (bij)leren tijdens hun job een rol spelen in het afnemende relatieve voordeel van beroepsopgeleiden op het vlak van tewerkstellingskansen en lonen doorheen de loopbaan. Concreet vinden we dat beroepsopgeleiden in de eerste fase van hun loopbaan minder nieuwe vaardigheden verwerven dan algemeen opgeleiden. En hoewel dit relatieve nadeel met betrekking tot leren op het werk afneemt naarmate de loopbaan vordert, suggereren onze resultaten dat het bijna een volledige loopbaan duurt vooraleer ze algemeen opgeleiden op dit vlak kunnen bijbenen. Belangrijk hierbij is dat deze conclusie enkel betrekking heeft op de mate van bijleren binnen de job waarin ze op dat moment tewerkgesteld zijn. Dit betekent dus niet dat beroepsopgeleiden algemeen opgeleiden ook bijbenen op het vlak van de mate waarin ze over hun hele loopbaan beschouwd hebben bijgeleerd.[1]

Een andere cruciale bevinding is dat het relatieve nadeel voor beroepsopgeleiden op het vlak van bijleren tijdens de job in sterke mate gedreven is door opleidingen met een werkleerplekcomponent en door landen met een sterke duale traditie. Sommige resultaten suggereren zelfs dat beroepsopgeleiden uit landen zonder deze traditie en individuen met een beroepsopleiding zonder werkplekleren gemiddeld meer vaardigheden ontwikkelen tijdens hun job dan algemeen opgeleiden.

Waarom individuen met een beroepsgerichte opleiding gemiddeld minder bijleren tijdens een groot deel van hun loopbaan heeft twee mogelijke verklaringen. Enerzijds zijn werknemers met een beroepsgerichte opleiding vlugger inzetbaar dan hun algemeen opgeleide tegenhangers, waardoor hun nood om extra vaardigheden te ontwikkelen lager is. Anderzijds leggen algemene opleidingen, door hun grotere focus op cognitieve en conceptuele vaardigheden, mogelijk een

[1] Verder suggereren de resultaten ook dat de afname in de kloof tussen beroepsopgeleiden en algemeen opgeleiden op het vlak van bijleren ten dele verklaard wordt door een gelijkaardige (maar snellere) afname van de kloof op het vlak van opleidingsparticipatie tijdens de uitoefening van de job.

sterkere basis voor verdere ontwikkeling van vaardigheden tijdens de loopbaan. Op basis van onze analyse kan geen van deze twee verklaringen uitgesloten worden.

Engelstalig wetenschappelijk artikel

Vocational education, general education and on-the-job learning over the life cycle*

Ilse Tobback†, Dieter Verhaest‡, Stijn Baert§ & Kristof De Witte**

Abstract

We investigate whether vocationally and generally educated individuals differ in their on-the-job learning and how this difference evolves over the career. To this end, we exploit the European Skills and Jobs Survey (ESJS) dataset and rely on instrumental variable estimation using the fraction of students participating in a vocational (as opposed to a general) programme within one's country-specific cohort as instrument. We find that, during the initial phase of the career, workers with a vocational education are less likely to acquire new skills in their jobs. Moreover, while this relative disadvantage in on-the-job learning gradually fades over time, it takes almost a full career to catch up in terms of on-the-job learning with those with a general degree. We also find this disadvantage to be entirely driven by individuals residing in dual system countries and those with a programme involving workplace learning. These findings are consistent with the idea that differences in on-the-job learning contribute to the diminishing advantage over the career of vocationally educated individuals in terms of employment chances and earnings, as found in other studies.

Keywords: vocational training, apprenticeships, dual system, skill development, OJT, returns to education.

JEL classifications: I26, J24, C36.

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1. Introduction

How to best prepare youth for the labour market is a widely discussed topic. Much of this discussion centres on whether education should be either vocationally or generally oriented (Ryan, 2001; Verhaest & Baert, 2018). Research indicates that vocational education, in comparison to general education, is linked to higher earnings, a shorter job search and better matches between skills and job requirements at the start of the career (Müller & Gangl, 2003). These relative advantages, however, do not seem to persist over time (Brunello & Rocco, 2017; Mazrekaj, De Witte & Vansteenkiste, 2019; McIntosh, 2006; Neyt, Verhaest, & Baert, 2018) and may, at later points in the career, even turn into a disadvantage (Forster, Bol, & Van de Werfhorst, 2016; Hampf & Woessmann, 2017; Hanushek, Schwerdt, Woessmann, & Zhang, 2017; Lavrijsen & Nicaise, 2017; Verhaest, Lavrijsen, Van Trier, Nicaise, & Omey, 2018). Educational programmers and policy makers may thus be confronted with a trade-off between fostering short-run and long-run employability (Hanushek et al., 2017).

This trade-off is potentially attributed to the combined effect of changes in job tasks, for instance due to globalization and accelerated technological changes (Bowman, 1993), and differences in the adaptability of vocationally and generally educated employees. Changing skill needs most likely impact vocationally educated workers relatively more than their generally educated peers, as their acquired skills are largely related to a specific context, making these individuals more prone to encounter skill obsolescence (Hanushek et al., 2017). Moreover, this difference in adaptability might be reinforced by differences in the extent to which these programmes lay down the foundation for further learning through one's career. Focussing much more on key cognitive skills like numeracy, literacy and abstract thinking (Gamoran, Raffe, & Rosenbaum, 1998), and less on learning that is linked to a specific context, this foundation may be stronger for general than for vocational education.

This paper investigates empirically whether vocational and general programmes are associated with differences in on-the-job learning and training throughout the career. Despite the importance of looking beyond the immediate effects on the labour market, to the best of our knowledge, only Hanushek et al. (2017) have already investigated the relationship between the vocational character of education and one's further learning throughout the career. Using cross country data, they found that, for the apprenticeship countries (Denmark, Germany, and Switzerland), those with a general education (as opposed to a

vocational one) are more likely to receive career-related adult education as they become older. While this is consistent with general education being more effective in promoting life-long learning, Hanushek et al. (2017) did not find any difference in lifelong learning between generally and vocationally educated individuals during the early stages of the career. This suggests that, while differences in lifelong learning may explain the growing disadvantage of vocationally educated workers in labour market chances during later stages of the career, this is not the case for their diminishing advantage in labour market chances during the early stage.

Our analysis contributes in three main ways to the literature. As a first contribution, in contrast to Hanushek et al. (2017) who are relying on an indicator of career-oriented adult education as measure for lifelong learning, we rely on a more direct and overall measure of on-the-job learning and training. One drawback of a career-oriented adult education indicator is that it excludes more informal types of training, like informal training courses, learning by watching and, in particular, learning by doing. Therefore, such a measure only represents a fraction of the total amount of time spent on activities of lifelong learning (Barron, Berger, & Black, 1997; Verhaest & Omey, 2010). A second drawback is that it does not account for the effectiveness of training and learning activities. If generally and vocationally educated workers have a different learning curve, the overall time spent on learning activities may have little to say about the true differences in skill development between these types of workers.[1]

As a second contribution, we rely on a more detailed definition of vocational education, taking into account both the extent to which a programme has a specific focus and the extent to which it includes workplace-based learning (cf. Verhaest et al., 2018). Some studies found the trade-off between short-run and long-run labour market chances to be the most pronounced in the apprenticeship countries (Hampf & Woessmann, 2017; Hanushek et al., 2017; Verhaest et al., 2018). Moreover, the aforementioned positive association between general education and adult education, that was found by Hanushek et al. (2017) for the apprenticeship countries, was not found when relying on a dataset that also included vocational countries in which apprenticeships are less usual. This suggests that their results are primarily driven by vocational programmes that are strongly workplace based. By explicitly differentiating within countries

[1] The importance of relying on more direct measures of skill development in the context of our paper is also illustrated by the results of Verhaest and Omey (2013), who found generally educated young workers to be more likely to acquire new skills in their first job than vocationally educated young workers. Unlike our study and the one by Hanushek et al. (2017), however, Verhaest and Omey (2013) did not investigate lifelong learning throughout other stages of the career.

between programmes with and without workplace-based learning, we test more directly whether this is indeed the case.

As a third contribution, we compare potentially endogenous OLS regression results with an instrumental variable (IV) approach that accounts for potential endogeneity problems. Individuals participating in general programmes may differ from their vocational counterparts in terms of unobservable factors, such as cognitive innate abilities and psychological traits. Not accounting for these differences may lead to biased conclusions in case they are related to both the treatment variable (vocational versus general education) and the outcome variable (skill development). Our instrument is based on the fraction of students participating in a vocational (as opposed to a general) programme within one's country-specific cohort. This choice is only valid in case this variable is, conditionally on the observable confounding variables, unrelated to the aforementioned unobserved factors. In the paper, we discuss in detail why we believe this is the case.

For our analysis, we draw on the European Skills and Jobs Survey (ESJS) data collected by the European Centre for the Development of Vocational Training (Cedefop) in the EU-28 Member States in 2014. The ESJS is a large dataset which covers the full workforce, allowing us to compare employees in different stages of their career. A major strength of this survey, related to the aforementioned contributions of our study, is its focus on the multiple dimensions of vocational educational programmes and, in particular, its detailed information on on-the-job skill development.

The paper is structured in the following way. In the next section, we describe our dataset in more detail and depict our research method. Next, we present our results. Last, we provide an overall discussion and conclusion.

2. Methodology

2.1. Data

The ESJS data, collected by Cedefop in 2014, was designed to measure skill development and skill mismatches among workers in the EU-28 Member States. The survey was carried out among 48,676 employees aged 24 to 65 from different demographic and socioeconomic groups that were selected based

on quota sampling.[2,3] To guarantee representativeness, we rely on weighted data using the sampling weights as provided by Cedefop.[4] From the dataset, we select all respondents born in the country of residence with an upper secondary education (ISCED 3), a post-secondary education (ISCED 4), or a first-level of tertiary education (ISCED 5) qualification. In our sample, around 49% of the workers acquired an upper secondary education (ISCED 3), 13% completed a post-secondary education (ISCED 4), and approximately 38% obtained a first-level of tertiary education qualification (ISCED 5) (see Table 1).

2.2. Programme orientation

As opposed to other datasets, the ESJS dataset allows us to measure the vocational character of the programme based on two different dimensions: whether the programme is linked to a specific job or trade and whether the programme includes workplace-based learning.[5] The first dimension is derived from the following question in the survey: "Overall, would you describe your highest qualification as a vocational qualification? Vocational means it is designed for acquiring knowledge, skills and competences closely linked to a particular job or trade." The second dimension is based on a question that is worded as follows: "Did your study take place only within an educational institution (e.g. a school, college or university) or did it involve some learning in a workplace (e.g. through apprenticeships, internships, or other forms of work-based learning)?" Combining these two questions allows us to define vocational programmes in three different ways: (1) those with a specific focus (versus those without a specific focus), (2) those involving workplace learning (versus those without workplace learning) and (3) those combining a specific focus with workplace learning. In our sample, around 74% of the workers have a degree with a specific focus. Furthermore, 44% indicated that their study involved some learning at a workplace, resulting in a

[2] More information on the ESJS dataset can be obtained from Cedefop (2015).
[3] Unfortunately, we do not have information on unemployed individuals and persons outside the labour force. However, in case our IV strategy is valid, this should not be an issue.
[4] By using these weights, data are also weighted based on country size. An alternative may be to rely on senate weights, which give equal weight to every country (see Jerrim et al., 2017, for a discussion). We did not adopt this alternative weighting method since is resulted in weak instrumental variable problems in our case.
[5] These dimensions are only available for the ISCED 3 to ISCED 5 levels; hence our decision to confine our analysis to the these educational levels.

total of 39% of the workers with a specific focus education which also involved workplace learning (see Table 1).

Using the two dimensions of the educational programme, namely specific focus and workplace learning, has two distinct advantages over relying on institutionalized qualification frameworks to distinguish between general and vocational education (Verhaest et al., 2018). First, our definitions do not depend on country-specific administrative decisions impacting the classification. Second, we can pinpoint which dimension (specific versus general focus, or the inclusion of workplace learning) is the most crucial factor with respect to on-the-job learning and training.

2.3. On-the-job learning and training

Our main dependent variable measures one's skill development on the job and is derived from the following survey question: "Compared to when you started your job with your current employer, would you say your skills have now improved, worsened or stayed the same?". The answer options for this question range from 0 to 10, where 0 means your skills have worsened a lot, 5 means they have stayed the same and 10 means they have improved a lot. The average value on this question is 7.78 with a standard deviation of 1.72 (see Table 1), indicating that most individuals have experienced at least some improvement of their skills in their current job.

To assess whether the results are sensitive to the usage of this more direct measure of skill development, we also conduct additional analyses relying on rather traditional training participation measures as indicators of skill development. The ESJS dataset includes the following question on career-related training participation: "In the last 12 months, have you undergone any of the following types of training for your current job? (1) training courses attended mostly or only during work hours (2) training courses attended mostly or only outside of work hours (3) training whilst performing your regular job (e.g. instruction by a supervisor/coworker using your normal tools of work; job rotation; peer support, participation in learning or quality circles) (4) I have not undergone any training". Respondents were asked to select all options that apply. In our sample, around 70% of the workers participated in some kind of training during the twelve months leading to the survey (see Table 1).

2.4. Model specification and identification

As aforementioned, we focus on the impact of programme orientation on on-the-job learning and training. Our benchmark model specification takes the following general form:

$$(1)\quad Y_i = \beta_0 + \beta_1 VP_i + \beta_2 VP_i * YSG_i + \beta_3 VP_i * YSG_i^2 + \beta_4 YSG_i + \beta_5 YSG_i^2 + \boldsymbol{X_i}\boldsymbol{\beta_6} + \varepsilon_i,$$

where Y_i denotes either skill development or training participation of individual i, VP_i corresponds to a dummy variable indicating whether the programme is vocational, YSG_i denotes the number of years since graduation, $\boldsymbol{X_i}$ being a vector of control variables (dummies for gender, level of education (ISCED) and country), and ε_i corresponds to an i.i.d. residual term.[6] Following Hanushek et al. (2017), we allow the effect of vocational education to change over time by including interactions between the vocational programme dummy and the years since graduation. Moreover, by also including an interaction term with the square of years since graduation, we allow this change over time to be nonlinear.

In line with many other studies on the long-run effects of vocational education (Hampf and Woessmann, 2017; Hanushek et al., 2017; Verhaest et al., 2018), we also investigate, in a more extended model, whether the effect of the programme orientation differs between dual system and other countries. To this end, we estimate a number of additional specifications in which we include interactions between the three vocational programme variables and a dummy measuring whether secondary the individual's country has an educational system that is largely based on a dual system. Following Verhaest et al. (2018), we consider Austria, Denmark, Germany, Luxembourg, Czech Republic, Hungary, Romania and Slovenia as dual system countries.

The estimated coefficients in Equation (1) might be endogenous as individuals select themselves into educational programmes. In other words, our treatment is unlikely to be exogenous as unobservable factors like cognitive innate abilities and psychological traits are likely to be related to both our treatment variable (programme orientation) and our outcome variable (lifelong learning). The standard approach in the literature on the long-run effects of vocational and general education to deal with this selectivity is to interpret the estimation of parameters β_2 and β_3 within a difference-in-differences logic and to assume that the relative selectivity of vocational and general programmes remains stable over time; since test score

[6] Given the aggregate nature of our instrument, we correct the standard errors for clustering at the country and time since graduation level.

differences between generally and vocationally educated individuals are usually found to be relatively stable across age cohorts (Hanushek et al., 2017; Verhaest et al., 2018), this assumption seems realistic.

While the stability in relative selectivity is a sufficient condition to consistently estimate the parameters on the change in effect over time, this is not the case with respect to the parameter on the initial effect of vocational programmes (β_l). Since this parameter is crucial to assess whether differences in lifelong learning may contribute to the relative improvement in labour market conditions of generally educated workers, we employ an instrumental variables (IV) approach. For our instrument, we exploit the variation in the proportion of students participating in a vocational (as opposed to a general) programme across countries and cohorts. It should be noted that the employed instrument is similar to the one adopted by Cavaglia, McNally, and Ventura (2018) when studying the payoff to apprenticeships in terms of employment and earnings, except that they relied on the share of students from the same gender-specific age cohort within their school. Cavaglia et al. (2018) argue that the instrument is valid as exposure to peers who participate in a vocational programme (positively) impacts an individual's choice to partake in such a programme. The exogeneity of this instrument depends on the absence of any relation between the unobserved characteristics that determine selection into schools and those that determine the selection in vocational programs; obviously, this is a strong assumption. By measuring peer-exposure at the level of the country, we largely overcome this problem as it is sufficient to assume that country-level cohorts are similar in terms of innate abilities or, in case country and cohort effects are controlled for, that changes in the innate ability distribution over time are similar across countries.

The instrument is calculated as follows. For each individual i, we calculate the fraction of students ($\overline{VP}_{(i)c}$) from the same country-specific graduation cohort combination (c)[7] who participate in a vocational programme leaving out the individual her-/himself:[8]

(2) $\overline{VP}_{(i)c} = \frac{N_c * \overline{VP}_c - VP_i}{N_c - 1}$,

[7] We define nine cohorts based on the year in which the worker achieved his or her highest level of education: (1) 1953-1974, (2) 1975-1979, (3) 1980-1984, (4) 1985-1989, (5) 1990-1994, (6) 1995-1999, (7) 2000-2004, (8) 2005-2009 and (9) 2010-2014.

[8] The instrument (VP_i) is calculated separately for each vocational programme type.

with N_c being the number of individuals in the individual's country-specific graduation cohort c and $\overline{VP_c}$ being the fraction of students from one's country-specific graduation cohort who participate in a vocational programme including the individual her-/himself. Along with using this fraction as instrument for VP_i, we use $\overline{VP}_{(i)c} * TSG$ and $\overline{VP}_{(i)c} * TSG^2$ as instruments for $VP_i * TSG$ and $VP_i * TSG^2$ respectively.

There are several assumptions underlying the validity of the instrument. First, the relationship between the vocational participation rate at the country level and one's own programme choice may not just be explained by peer-effects, but also by other factors like changes in educational policies. These policy changes should thus be exogenous to country-specific changes in the skill development of workers. For several reasons, we believe this is not a major issue in this case. First of all, we believe policies to be more responsive to shocks in earnings and employment than to shocks in the skill development of the workers. After all, while evolutions in earnings and employment are closely monitored and at the centre of the public debate, this is much less the case for a less-visible concept like on-the-job learning. Second, independent changes in the on-the-job learning over time are unlikely to be abrupt, resulting in a rather loose relationship with policy changes. Third, changes in the skill development of workers may be largely driven by factors that are common across European countries such as technological advances and globalisation. Since cross-country trends are controlled for in our analysis, they cannot bias our results. And finally, even if new policies result from country-specific shocks in the skill development of workers, there are substantial time lags between the time at which people decide to participate in a vocational programme and the time of measured on-the-job learning in our data (from a couple of years to several decades).

Although an IV approach may generate consistent estimates, it is usually less efficient. However, in the case of our benchmark analysis, all first stage F-statistics substantially surpass the benchmark of 10 as suggested by Stock, Wright, and Yogo (2002) (see the Appendix for more details). Moreover, also additional tests that account for the fact that we have multiple endogenous variables, like the Cragg-Donald Wald tests and Sanderson-Windmeijer multivariate F-test, do not indicate any weak instrumental variable problems for these analyses. Only for the analyses that test whether the results differ between dual system and other countries, we face weak instrumental variable problems. To solve this problem, we

replace the individual country dummies with one dummy that differentiates between dual system countries and other countries. Therefore, these results are based on stronger exogeneity assumptions.

3. Results

3.1. On-the-job learning: benchmark results

For the benchmark analysis on on-the-job learning, we estimate for each definition of vocational programmes three types of specifications. A first specification (Model A) only includes, next to a set of control variables, a dummy variable measuring whether the programme is vocational. Model B adds an interaction with the years since graduation. Model C denotes a third and more general specification that also includes an interaction with the quadratic of the years since graduation. We report both standard OLS regression results (Table 2) and results based on IV estimation (Table 3).

Simple OLS regression results (Table 2) suggest that workers with a vocational education, on average, acquire more skills than those with a more general education (Model A). How these effects are distributed over the career seems to differ depending on the adopted indicator of vocational programmes (Model B and C). While this advantage is concentrated at the start of the career for those with a specific program, the benefits contrarily seem situated later in the career in case we base our definition of vocational programmes with workplace learning.

< Table 2 about here >

When relying on IV estimation (Table 3), however, this relatively favourable result for vocational programmes largely disappears. Accounting for endogeneity in this way, we do not find strong evidence on average differences in on-the-job learning between workers with a vocational degree and their generally educated counterparts (Model A). Only when considering vocational programmes with a specific orientation, we do find some weakly statistically significant evidence that these programmes are, on average, relatively advantageous in terms of on-the-job learning. Moreover, looking at the initial phase of the career, those who obtained their degree through workplace learning even realise less skill improvement in their job than their general counterparts (Model B and C). Finally, while these vocationally educated individuals realise a relative improvement over time, they only manage to catch up to those with a more general degree by the end of their career with respect to skills. For example, the estimates suggest that, for

those with a vocational education based on workplace learning (without specific orientation), it takes about 38 years on the labour market (1.129/0.300*10=38) to catch up in terms of on-the-job skill acquisition with those with a more general education (Model 3B). For someone that graduates at age 18, this will be around the age 56.

< Table 3 about here >

3.2 On-the-job learning: dual system versus other countries

We examine how the effect of the programme orientation dimension differs between countries with a dual system and other countries (Table 4). We do find clear evidence on differences in average effects across countries when defining vocational education based on whether the programme has a specific orientation (Model 1A). For non-dual system countries, we observe that those who obtained a degree with a specific focus realise, on average, more on-the-job learning than those with a more general education. Although this result is similar to the findings obtained for the full set of countries (cf. Table 3, Model 1A), the evidence is much more convincing for the set of non-dual countries as the effect is statistically significant at the 1% level in this case. Alternatively, for dual system countries, no statistically significant evidence is found that specific programmes differ on average from other programme in terms of on-the-job learning (this effect is equal to 1.186-1.304=-0.118). The latter result aligns with those for the full set of countries but when relying on indicators that take into account the presence of workplace learning (cf. Table 3, Model 2A and 3A). As a focus on workplace learning is the most essential feature of the dual system, this equivalence in results may come as no surprise.

A similar equivalence in results with our benchmark analysis is found when interactions with the years since graduation are included (Model 1B and 1C). The advantage of specific programmes over other programmes gradually increases over the career in non-dual system countries. Alternatively, in dual system countries, those with a specific programme initially realise less on-the-job learnings but realise a relative improvement over time. Somewhat different from our benchmark analysis on the workplace learning indicators for the full set of countries (cf. Table 3, Model 2B and 3B), however, we do find those with a specific programme in these countries to catch up already after about 24 years (-(-0.185-1.028)/(0.625-0.114)*10=24). This is slightly above but close to about half a standard career of 45 years and well below the turning point found in our benchmark analysis when relying on the presence of workplace learning to

define vocational programmes (i.e. about 38 years). Note, however, that part of this difference in estimated turning point may be attributed to the fact that we do not control for detailed country dummies in Table 4.[9]

Finally, based on our indicators that take into account the presence of workplace learning to distinguish between vocational and general programmes (Models 2 and 3), we do not find any evidence on difference in effects between dual system and other countries. This suggests that the presence or absence of workplace learning (rather than the type of country) is the key factor determining the effect of vocational programmes on on-the-job learning.

< Table 4 about here >

3.3 Training Participation

Following earlier literature on lifelong learning, we report in Table 5 the results for overall training participation relying on linear IV estimation.[10] Model specification A and B do not yield significant differences depending on the programme orientation. However, this conclusion largely changes once we allow the effect to change over the career in a non-linear way (Models C). In line with the results on on-the-job learning, we find those with a programme that is characterised by workplace learning to participate less often in training at the start of the career (Models 2C and 3C). Moreover, similar to on-the-job learning, we observe this relative disadvantage to diminish as their career advances. Finally, while these workers catch up with other workers somewhat earlier in their career in terms of training participation (20 to 30 years after graduation)[11] than in terms of on-the-job learning, this relative improvement also fades over time.

In the Appendix, (Table A1-A3), we also report the results of more in depth analyses for the different types of training (Appendix Table A1-A3). These results indicate that the lower levels of overall training participation of those having participated in a programme with workplace learning during the first

[9] Unreported results indeed indicate a lower turning point for the benchmark analysis on programs with workplace learning when detailed country dummies are not controlled for.

[10] In line with Angrist and Pischke (2008), we prefer these linear probability estimates to probit estimates. However, IV probit regressions yield approximately the same results. These results are available upon request.

[11] Model 2C: $\frac{-0.242+\sqrt{(0.242)^2-4\times(-0.293)\times(-0.048)}}{2\times(-0.048)}\times 10 = 20$ and $\frac{-0.242-\sqrt{(0.242)^2-4\times(-0.293)\times(-0.048)}}{2\times(-0.048)}\times 10 = 30$.

half of the career are most apparent with respect to training whilst performing the regular job and training courses attended mostly or only during work hours. Alternatively, when defining vocational programmes as programmes with a specific orientation, we do find them to be associated with more participation in training outside working hours.

< Table 5 about here >

4 Discussion and conclusion

Previous research indicated that vocational education leads, in comparison to general education, to improved employment chances and earnings at the start of the career. At later points in the career, however, vocationally educated individuals are often found to be rather worse off in terms of these labour market outcomes. Some studies also indicate this trade-off to be the most pronounced in dual system countries. One of the explanations that is often suggested for this trade-off is differences between vocationally and generally educated workers in on-the-job learning throughout the career. In this paper, we investigated whether this is indeed the case.

Overall, our results are consistent with the idea that differences in on-the-job learning contribute to a diminishing advantage over time of vocationally educated individuals. We observed that, at the start of the career, workers with a vocational education acquire less new skills in their jobs than those with a general background. Moreover, while this relative disadvantage in on-the-job learning was found to diminish over time, it seems to take almost a full career to catch up in terms of on-the-job learning with those with a general degree. Interestingly, we also found this disadvantage to be driven by individuals residing in dual system countries and those with a vocational programme involving learning at a workplace. Individuals from other countries and with degrees without workplace learning, meanwhile, even seemed to realise higher levels of on-the-job learning. This aligns with the aforementioned stronger trade-off that is usually found for these workers and indicates that in particular programmes that are strongly workplace based are detrimental to one's chances to acquire new skills on the job.

Why vocationally educated individuals realise relatively less on-the-job learning throughout most part of their careers may be explained in two ways. First, since vocationally educated workers, and in particular those with substantial workplace experience, may be immediately employable, their need for additional skill development may simply be lower. Second, since general education focusses more strongly

on cognitive and conceptual skills, it may lay down a stronger foundation for further skill development. Our analysis delivered indirect indications of the importance of both mechanisms. On the one hand, we found the gap in on-the-job learning to decline over time, which is consistent with a compensation logic. On the other hand, the relative advantage of generally educated individuals over those with a vocational degree based on workplace learning was found to endure much longer in terms of learning on-the-job than in terms of training participation. However, which mechanism dominates remains unanswered. We are therefore in favour of further research focussing on this issue, for instance by exploiting exogenous variation in training participation.

Several other directions for future research can be advanced as well. First, our results suggested effects to depend largely on the type of vocational programme with school-based vocational programmes being much less detrimental to on-the-job learning than workplace-based ones. However, it remains an open question why this is the case, whether this is the case in all occupational contexts and whether it depends on the exact way these programmes are designed. To guide educational programmers and policy makers, further research that relies on even more fine-grained measures of different types of vocational education would be helpful. Second, although we measured acquired skills in a more direct way than most other studies in this respect, our indicator of on-the-job learning was a general one and did not allow one to identify which skills are developed in particular. Differentiation between different types of acquired skills would also help determining whether the stronger on-the-job learning results from a compensation logic or from complementary effects between formal education and on-the-job learning. Finally, while we were the first to study the effects of programme orientation on future skill development using a quasi-experimental design, our instrumental variable approach relies on assumptions that are open to discussion. Other analyses, relying on different designs could help warranting that the relationships identified in our study are indeed causal.

5 References

Angrist, J. D., & Pischke, J.-S. (2008). *Mostly harmless econometrics: an empiricist's companion*. Princeton, N.J.: Princeton University Press.

Barron, J. M., Berger, M. C., & Black, D. A. (1997). How Well Do We Measure Training? *Journal of Labor Economics, 15*(3), 507-528.

Bowman, M. J. (1993). The economics of education in a world of change. In E. Hoffman (Ed.), *Essays on the economics of education* (pp. 163–174). Michigan: Upjohn Institute for Employment Research.

Brunello, G., & Rocco, L. (2017). The labor market effects of academic and vocational education over the life cycle: evidence based on a British cohort. *Journal of Human Capital, 11*(1), 106-166.

Cavaglia, C., McNally, S., & Ventura, G. (2018). Do Apprenticeships Pay? Evidence for England. *CVER Discussion Paper,* n.014, London: Centre for Vocational Educational Research.

Cedefop. (2015). *Skills, Qualifications and Jobs in the EU: The Making of a Perfect Match? Evidence from Cedefop's European Skills and Jobs Survey*. Publications Office of the European Union, Luxembourg.

Forster, A. G., Bol, T., & Van de Werfhorst, H. G. (2016). Vocational education and employment over the life cycle. *Sociological Science, 3*, 473-494.

Gamoran, A., Raffe, D., & Rosenbaum, J. (1998). The impact of academic course work on labor market outcomes for youth who do not attend college: A research review. In A. Gamoran (Ed.), *The quality of vocational education: Background papers from the 1994 National Assessment of Vocational Education* (pp. 133-175). Washington, DC: U. S. Department of Education.

Hampf, F., & Woessmann, L. (2017). Vocational vs. General Education and Employment over the Life Cycle: New Evidence from PIAAC. *CESifo Economic Studies, 63*, 255-269.

Hanushek, E. A., Schwerdt, G., Woessmann, L., & Zhang, L. (2017). General Education, Vocational Education, and Labor-Market Outcomes over the Lifecycle. *Journal of Human Resources, 52*, 48-87.

Jerrim, J., Lopez-Agudo, L. A., Marcenaro-Gutierrez, O. D., & Shure, N. (2017). What happens when econometrics and psychometrics collide? An example using the PISA data. *Economics of Education Review*, *61*, 51–58.

Lavrijsen, J., & Nicaise, I. (2017). Returns on vocational education over the life cycle: Between immediate labour market preparation and lifelong employability. *International Review of Education, 63*(2), 257-280.

Mazrekaj, D., De Witte, K., & Vansteenkiste, S. (2019). Labour Market Consequences of a High School Diploma. *Applied Economics, 51*(21), 2313-2325.

McIntosh, S. (2006). Further Analysis of the Returns to Academic and Vocational Qualifications. *Oxford Bulletin of Economics and Statistics, 68*(2), 225-251.

Müller, W., & Gangl, M. (2003). The transition from school to work: a European perspective. In W. Müller & M. Gangl (Eds.), *Transitions from Education to Work in Europe* (pp. 1-19). Oxford: Oxford University Press.

Neyt, B., Verhaest, D., & Baert, S. (2018). The Impact of Dual Apprenticeship Programs on Early Labour Market Outcomes: A Dynamic Approach. *IZA Discussion Papers, n. 12011,* Bonn: Institute for the Study of Labor.

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

Stock, J. H., Wright, J. H., & Yogo, M. (2002). A survey of weak instruments and weak identification in generalized method of moments. *Journal of Business & Economic Statistics, 20*(4), 518-529.

Verhaest, D., & Baert, S. (2018). The effects of workplace learning in higher education on employment and match quality: is there an early-career trade-off? *Empirical Economics*, 55(3), 1229-1270.

Verhaest, D., Lavrijsen, J., Van Trier, W., Nicaise, I., & Omey, E. (2018). General education, vocational education and skill mismatches: short-run versus long-run effects. *Oxford Economic Papers, 70*(4), 974-993.

Verhaest, D., & Omey, E. (2010). The Measurement and Determinants of Skill Acquisition in Young Workers' First Job. *Economic and Industrial Democracy, 31*(1), 116-149.

Verhaest, D., & Omey, E. (2013). The relationship between formal education and skill acquisition in young workers' first jobs. *Manchester School, 81*(4), 638-659.

Tables

Table 1. Descriptive statistics

	Mean	Std. Dev.	Min	Max	N
Male	0.507	0.500	0	1	31,441
Age	42.459	9.958	24	65	31,441
Highest qualification obtained					
ISCED 3	0.487	0.500	0	1	31,441
ISCED 4	0.133	0.340	0	1	31,441
ISCED 5	0.379	0.485	0	1	31,441
Vocational programme					
Specific Focus	0.742	0.437	0	1	31,441
Workplace Learning	0.437	0.496	0	1	31,441
Specific Focus and Workplace Learning	0.385	0.487	0	1	31,441
Years since graduation	19.377	11.278	0	61	31,441
Years with current employer	10.535	9.440	0	50	31,441
Skill development (index)	7.780	1.722	0	10	30,840
Training in the last twelve months for the current job					
(Any) training	0.701	0.458	0	1	31,441
Training courses attended mostly or only during work hours	0.447	0.497	0	1	31,441
Training courses attended mostly or only outside of work hours	0.201	0.401	0	1	31,441
Training whilst performing the regular job [on-the-job training]	0.361	0.480	0	1	31,441

Note. ESJS, authors' calculations. All data are weighted using sampling weights [iw=weight_with_education].

Table 2. Vocational education and on-the-job learning throughout the career: OLS regression coefficients (and standard errors)

	Indicator Vocational Program: Specific Focus			Indicator Vocational Program: Workplace Learning			Indicator Vocational Program: Specific Focus and Workplace Learning		
	(1A)	(1B)	(1C)	(2A)	(2B)	(2C)	(3A)	(3B)	(3C)
Vocational education	0.221***	0.279***	0.394***	0.157***	0.072	0.140*	0.195***	0.097**	0.170**
	(0.029)	(0.051)	(0.077)	(0.028)	(0.053)	(0.079)	(0.028)	(0.049)	(0.075)
Vocational education × YSG/10		-0.029	-0.179**		0.045*	-0.049		0.052**	-0.049
		(0.023)	(0.087)		(0.024)	(0.089)		(0.023)	(0.087)
Vocational education × (YSG/10)²			0.035*			0.022			0.024
			(0.020)			(0.021)			(0.021)
YSG/10	-0.177***	-0.151***	-0.039	-0.176***	-0.202***	-0.160***	-0.172***	-0.198***	-0.158***
	(0.047)	(0.051)	(0.077)	(0.047)	(0.048)	(0.054)	(0.047)	(0.047)	(0.052)
(YSG/10)²	0.042***	0.041***	0.015	0.043***	0.044***	0.034***	0.042***	0.043***	0.034***
	(0.011)	(0.011)	(0.018)	(0.011)	(0.011)	(0.013)	(0.011)	(0.011)	(0.012)

Notes. N=30,840. Vocational education is a dummy variable equal to 1 if the programme is vocationally oriented, and zero otherwise. We use different indicators for vocational education throughout the regression models. In model 1 (a)-(c) vocational education stands for educational programmes with a Specific Focus. In model 2 (a)-(c) we use our Workplace Learning indicator for vocational education. In model 3 (a)-(c) vocational education is an indicator for programmes with a Specific Focus that involve Workplace Learning. (See section 2.2 for a more detailed definition with respect to these three vocational programmes types.) 'YSG' stands for years since graduation. The sample includes employees aged 25 to 65 with at least upper secondary education completed. Each regression includes controls for gender, level of education and country. Standard errors are corrected for clustering at the country and years since graduation level. *** (**) ((*)) indicates significance at the 1% (5%) ((10%)) significance level. All data are weighted using sampling weights, with 'weight_with_education' as weighting variable.

Table 3. Vocational education and on-the-job learning throughout the career: IV regression coefficients (and standard errors)

	Indicator Vocational Program: Specific Focus			Indicator Vocational Program: Workplace Learning			Indicator Vocational Program: Specific Focus and Workplace Learning		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
Vocational education	0.813*	-0.020	-0.125	-0.167	-1.129***	-1.358***	-0.070	-1.057***	-1.218***
	(0.416)	(0.552)	(0.577)	(0.217)	(0.323)	(0.395)	(0.250)	(0.365)	(0.436)
Vocational education × YSG/10		0.262**	0.395		0.300***	0.561**		0.298***	0.480*
		(0.103)	(0.375)		(0.070)	(0.266)		(0.073)	(0.274)
Vocational education × (YSG/10)²			-0.029			-0.055			-0.039
			(0.080)			(0.056)			(0.058)
YSG/10	-0.151***	-0.392***	-0.494*	-0.197***	-0.392***	-0.512***	-0.191***	-0.369***	-0.443***
	(0.048)	(0.111)	(0.285)	(0.051)	(0.070)	(0.133)	(0.051)	(0.069)	(0.124)
(YSG/10)²	0.038***	0.047***	0.069	0.045***	0.055***	0.080***	0.044***	0.055***	0.070***
	(0.011)	(0.012)	(0.059)	(0.011)	(0.012)	(0.026)	(0.011)	(0.012)	(0.025)

Notes. N=30,840. Vocational education is a dummy variable equal to 1 if the programme is vocationally oriented, and zero otherwise. We use different indicators for vocational education throughout the regression models. In model 1 (a)-(c) vocational education stands for educational programmes with a Specific Focus. In model 2 (a)-(c) we use our Workplace Learning indicator for vocational education. In model 3 (a)-(c) vocational education is an indicator for programmes with a Specific Focus that involve Workplace Learning. (See section 2.2 for a more detailed definition with respect to these three vocational programmes types.) 'YSG' stands for years since graduation. The sample includes employees aged 25 to 65 with at least upper secondary education completed. The presented statistics are based on an IV approach (see section 2.4 for an extended discussion on the adopted method and our instrument). Each regression includes controls for gender, level of education and country. Standard errors are corrected for clustering at the country and years since graduation level. *** (**) ((*)) indicates significance at the 1% (5%) ((10%)) significance level. All data are weighted using sampling weights, with 'weight_with_education' as weighting variable.

Table 4. Vocational education and on-the-job learning throughout the career – dual versus non-dual system countries: IV regression coefficients (and standard errors)

		Indicator Vocational Program: Specific Focus			Indicator Vocational Program: Workplace Learning			Indicator Vocational Program: Specific Focus and Workplace Learning		
		(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
Vocational education		1.186***	-0.185	-0.816	-0.115	-1.077***	-1.440***	-0.082	-1.140***	-1.420***
		(0.181)	(0.388)	(0.564)	(0.169)	(0.278)	(0.377)	(0.195)	(0.311)	(0.410)
Vocational education × YSG/10			0.625***	1.357***		0.434***	0.748*		0.501***	0.671
			(0.135)	(0.497)		(0.110)	(0.449)		(0.122)	(0.491)
Vocational education × (YSG/10)²				-0.158			-0.052			-0.015
				(0.105)			(0.108)			(0.119)
Vocational education × Dual		-1.304***	-1.028***	-0.959**	-0.245	-0.164	-0.333	-0.242	-0.096	-0.320
		(0.364)	(0.376)	(0.381)	(0.252)	(0.270)	(0.288)	(0.262)	(0.287)	(0.305)
Vocational education × YSG/10 * Dual			-0.114***	-0.187		-0.056	0.216		-0.103	0.265
			(0.044)	(0.171)		(0.069)	(0.281)		(0.079)	(0.325)
Vocational education × (YSG/10)² * Dual				0.017			-0.070			-0.095
				(0.040)			(0.071)			(0.083)
YSG/10		-0.181***	-0.696***	-1.230***	-0.233***	-0.467***	-0.678***	-0.232***	-0.462***	-0.616***
		(0.054)	(0.130)	(0.362)	(0.056)	(0.077)	(0.168)	(0.056)	(0.077)	(0.160)
(YSG/10)²		0.045***	0.063***	0.177**	0.052***	0.063***	0.105***	0.052***	0.064***	0.092***
		(0.012)	(0.014)	(0.073)	(0.013)	(0.013)	(0.037)	(0.013)	(0.013)	(0.035)
Dual		0.881***	0.833***	0.819***	0.153	0.150	0.138	0.127	0.127	0.117
		(0.297)	(0.291)	(0.294)	(0.132)	(0.122)	(0.122)	(0.117)	(0.110)	(0.110)
Wald tests										
Vocational education + (Vocational education × Dual) = 0	Chi²(1)	0.14	9.80	11.33	3.88	25.10	25.80	3.61	25.80	23.86
	Prob > chi²	0.708	0.002	0.001	0.049	0.000	0.000	0.058	0.000	0.000
(Vocational education × YSG/10) + (Vocational education × YSG/10 * Dual) = 0	Chi²(1)		20.40	7.61		28.59	11.16		28.39	9.68
	Prob > chi²		0.000	0.006		0.000	0.001		0.000	0.002
(Vocational education × (YSG/10)²) + (Vocational education × (YSG/10)² * Dual) = 0	Chi²(1)			2.65			3.79			2.88
	Prob > chi²			0.104			0.051			0.090

Notes. N=30,840. Vocational education is a dummy variable equal to 1 if the programme is vocationally oriented, and zero otherwise. We use different indicators for vocational education throughout the regression models. In model 1 (a)-(c) vocational education stands for educational programmes with a Specific Focus. In model 2 (a)-(c) we use our Workplace Learning indicator for vocational education. In model 3 (a)-(c) vocational education is an indicator for programmes with a Specific Focus that involve Workplace Learning. (See section 2.2 for a more detailed definition with respect to these three vocational programmes types.) 'YSG' stands for years since graduation. 'Dual' is a dummy variable equal to 1 if a country is a dual system country (Austria, Denmark, Germany, Luxembourg, Czech Republic, Hungary, Romania and Slovenia), and zero otherwise. The sample includes employees aged 25 to 65 with at least upper secondary education completed. The presented statistics are based on an IV approach (see section 2.4 for an extended discussion on the adopted method and our instrument). Each regression includes controls for gender, level of education. Standard errors are corrected for clustering at the country and years since graduation level. *** (**) ((*)) indicates significance at the 1% (5%) ((10%)) significance level. All data are weighted using sampling weights, with 'weight_with_education' as weighting variable.

Table 5. Vocational education and training participation throughout the career: IV regression coefficients (and standard errors)

	Indicator Vocational Program: Specific Focus			Indicator Vocational Program: Workplace Learning			Indicator Vocational Program: Specific Focus and Workplace Learning		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
Vocational education	0.077	-0.048	-0.301	-0.042	-0.092	-0.293***	-0.055	-0.127	-0.355***
	(0.124)	(0.163)	(0.187)	(0.063)	(0.092)	(0.109)	(0.074)	(0.107)	(0.121)
Vocational education × YSG/10		0.039	0.357***		0.016	0.242***		0.022	0.277***
		(0.030)	(0.122)		(0.019)	(0.075)		(0.021)	(0.077)
Vocational education × (YSG/10)²			-0.068***			-0.048***			-0.054***
			(0.025)			(0.015)			(0.015)
YSG/10	-0.007	-0.042	-0.284***	-0.013	-0.023	-0.127***	-0.014	-0.027	-0.131***
	(0.013)	(0.029)	(0.095)	(0.014)	(0.018)	(0.037)	(0.014)	(0.018)	(0.035)
(YSG/10)²	-0.004	-0.003	0.049***	-0.003	-0.003	0.019***	-0.003	-0.002	0.020***
	(0.003)	(0.003)	(0.019)	(0.003)	(0.003)	(0.007)	(0.003)	(0.003)	(0.007)

Notes. N=31,441. Vocational education is a dummy variable equal to 1 if the programme is vocationally oriented, and zero otherwise. We use different indicators for vocational education throughout the regression models. In model 1 (a)-(c) vocational education stands for educational programmes with a Specific Focus. In model 2 (a)-(c) we use our Workplace Learning indicator for vocational education. In model 3 (a)-(c) vocational education is an indicator for programmes with a Specific Focus that involve Workplace Learning. (See section 2.2 for a more detailed definition with respect to these three vocational programmes types.) 'YSG' stands for years since graduation. The sample includes employees aged 25 to 65 with at least upper secondary education completed. The presented statistics are based on an IV approach (see section 2.4 for an extended discussion on the adopted method and our instrument). Each regression includes controls for gender, level of education and country. Standard errors are corrected for clustering at the country and years since graduation level. *** (**) ((*)) indicates significance at the 1% (5%) ((10%)) significance level. All data are weighted using sampling weights, with 'weight_with_education' as weighting variable.

Appendix

Table A1. Vocational education and participation in training courses attended mostly or only during work hours throughout the career: IV regression coefficients (and standard errors)

	Indicator Vocational Program: Specific Focus			Indicator Vocational Program: Workplace Learning			Indicator Vocational Program: Specific Focus and Workplace Learning		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
Vocational education	-0.070	-0.174	-0.334*	-0.095	-0.110	-0.228*	-0.132*	-0.162	-0.308**
	(0.129)	(0.174)	(0.189)	(0.064)	(0.100)	(0.119)	(0.075)	(0.115)	(0.131)
Vocational education × YSG/10		0.032	0.234*		0.005	0.138*		0.009	0.172**
		(0.032)	(0.122)		(0.022)	(0.079)		(0.023)	(0.082)
Vocational education × (YSG/10)²			-0.043*			-0.028*			-0.035**
			(0.025)			(0.016)			(0.017)
YSG/10	0.018	-0.011	-0.164*	0.015	0.012	-0.049	0.012	0.007	-0.060*
	(0.013)	(0.034)	(0.094)	(0.014)	(0.020)	(0.038)	(0.014)	(0.020)	(0.035)
(YSG/10)²	-0.006**	-0.005	0.028	-0.006*	-0.006*	0.007	-0.005*	-0.005	0.009
	(0.003)	(0.003)	(0.018)	(0.003)	(0.003)	(0.007)	(0.003)	(0.003)	(0.007)

Notes. N=31,441. Vocational education is a dummy variable equal to 1 if the programme is vocationally oriented, and zero otherwise. We use different indicators for vocational education throughout the regression models. In model 1 (a)-(c) vocational education stands for educational programmes with a Specific Focus. In model 2 (a)-(c) we use our Workplace Learning indicator for vocational education. In model 3 (a)-(c) vocational education is an indicator for programmes with a Specific Focus that involve Workplace Learning. (See section 2.2 for a more detailed definition with respect to these three vocational programmes types.) 'YSG' stands for years since graduation. The sample includes employees aged 25 to 65 with at least upper secondary education completed. The presented statistics are based on an IV approach (see section 2.4 for an extended discussion on the adopted method and our instrument). Each regression includes controls for gender, level of education and country. Standard errors are corrected for clustering at the country and years since graduation level. *** (**) ((*)) indicates significance at the 1% (5%) ((10%)) significance level. All data are weighted using sampling weights, with 'weight_with_education' as weighting variable.

Table A2. Vocational education and participation in training courses attended mostly or only outside work hours throughout the career: IV regression coefficients (and standard errors): an IV approach

	Indicator Vocational Program: Specific Focus			Indicator Vocational Program: Workplace Learning			Indicator Vocational Program: Specific Focus and Workplace Learning		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
Vocational education	0.203**	0.212*	0.137	0.021	0.033	-0.008	0.032	0.040	-0.009
	(0.084)	(0.111)	(0.122)	(0.044)	(0.064)	(0.082)	(0.052)	(0.074)	(0.092)
Vocational education × YSG/10		-0.003	0.092		-0.004	0.042		-0.003	0.053
		(0.018)	(0.086)		(0.013)	(0.059)		(0.014)	(0.062)
Vocational education × (YSG/10)²			-0.020			-0.010			-0.012
			(0.017)			(0.012)			(0.012)
YSG/10	-0.036***	-0.033*	-0.105*	-0.043***	-0.040***	-0.062**	-0.042***	-0.040***	-0.063**
	(0.011)	(0.019)	(0.063)	(0.011)	(0.013)	(0.027)	(0.011)	(0.013)	(0.025)
(YSG/10)²	0.005**	0.004**	0.020	0.006***	0.006***	0.010*	0.006**	0.006**	0.010**
	(0.002)	(0.002)	(0.012)	(0.002)	(0.002)	(0.005)	(0.002)	(0.002)	(0.005)

Notes. N=31,441. Vocational education is a dummy variable equal to 1 if the programme is vocationally oriented, and zero otherwise. We use different indicators for vocational education throughout the regression models. In model 1 (a)-(c) vocational education stands for educational programmes with a Specific Focus. In model 2 (a)-(c) we use our Workplace Learning indicator for vocational education. In model 3 (a)-(c) vocational education is an indicator for programmes with a Specific Focus that involve Workplace Learning. (See section 2.2 for a more detailed definition with respect to these three vocational programmes types.) 'YSG' stands for years since graduation. The sample includes employees aged 25 to 65 with at least upper secondary education completed. The presented statistics are based on an IV approach (see section 2.4 for an extended discussion on the adopted method and our instrument). Each regression includes controls for gender, level of education and country. Standard errors are corrected for clustering at the country and years since graduation level. *** (**) ((*)) indicates significance at the 1% (5%) ((10%)) significance level. All data are weighted using sampling weights, with 'weight_with_education' as weighting variable.

Table A3. Vocational education and participation in training whilst performing one's regular job: IV regression coefficients (and standard errors)

	Indicator Vocational Program: Specific Focus			Indicator Vocational Program: Workplace Learning			Indicator Vocational Program: Specific Focus and Workplace Learning		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
Vocational education	0.014	-0.310**	-0.568***	0.108*	-0.039	-0.201*	0.122*	-0.054	-0.228**
	(0.112)	(0.150)	(0.162)	(0.061)	(0.086)	(0.106)	(0.071)	(0.096)	(0.115)
Vocational education × YSG/10		0.100***	0.426***		0.045**	0.228***		0.053**	0.247***
		(0.031)	(0.118)		(0.021)	(0.080)		(0.022)	(0.082)
Vocational education × (YSG/10)²			-0.070***			-0.039**			-0.041**
			(0.025)			(0.017)			(0.018)
YSG/10	-0.004	-0.096***	-0.343***	0.002	-0.027	-0.111***	0.004	-0.027	-0.107***
	(0.015)	(0.032)	(0.088)	(0.015)	(0.021)	(0.038)	(0.015)	(0.021)	(0.035)
(YSG/10)²	-0.003	0.000	0.053***	-0.004	-0.002	0.015**	-0.004	-0.002	0.014**
	(0.003)	(0.004)	(0.018)	(0.003)	(0.004)	(0.008)	(0.003)	(0.004)	(0.007)

Notes. N=31,441. Vocational education is a dummy variable equal to 1 if the programme is vocationally oriented, and zero otherwise. We use different indicators for vocational education throughout the regression models. In model 1 (a)-(c) vocational education stands for educational programmes with a Specific Focus. In model 2 (a)-(c) we use our Workplace Learning indicator for vocational education. In model 3 (a)-(c) vocational education is an indicator for programmes with a Specific Focus that involve Workplace Learning. (See section 2.2 for a more detailed definition with respect to these three vocational programmes types.) 'YSG' stands for years since graduation. The sample includes employees aged 25 to 65 with at least upper secondary education completed. The presented statistics are based on an IV approach (see section 2.4 for an extended discussion on the adopted method and our instrument). Each regression includes controls for gender, level of education and country. Standard errors are corrected for clustering at the country and years since graduation level. *** (**) ((*)) indicates significance at the 1% (5%) ((10%)) significance level. All data are weighted using sampling weights, with 'weight_with_education' as weighting variable.

Table A4. First stage F-statistics

	Indicator Vocational Program: Specific Focus			Indicator Vocational Program: Workplace Learning			Indicator Vocational Program: Specific Focus and Workplace Learning		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)	(3a)	(3b)	(3c)
Table 3 (N=30,840)									
Vocational education	105.90***	54.23***	36.99***	394.04***	198.35***	132.62***	333.82***	165.24***	109.75***
Vocational education × YSG/10		183.13***	136.56***		403.13***	367.37***		395.15***	349.28***
Vocational education × (YSG/10)²			183.73***			423.48***			398.90***
Table 4 (N=30,840)									
Vocational education	479.24***	244.68***	166.21***	1117.38***	584.68***	396.08***	1071.93***	553.23***	372.16***
Vocational education × YSG/10		282.28***	202.82***		663.18***	523.10***		631.07***	495.55***
Vocational education × (YSG/10)²			180.00***			459.62***			430.24***
Vocational education × Dual	155.97***	85.15***	61.17***	491.28***	257.23***	174.54***	559.80***	281.48***	188.36***
Vocational education × YSG/10 * Dual		3746.21***	2911.83***		1070.80***	842.09***		946.12***	730.43***
Vocational education × (YSG/10)² * Dual			4142.83***			942.39***			831.54***
Table 5, A1, A2 and A3 (N=31,441)									
Vocational education	105.62***	54.63***	37.31***	386.12***	194.75***	130.06***	322.34***	160.37***	106.52***
Vocational education × YSG/10		189.65***	136.52***		414.00***	379.26***		408.87***	365.19***
Vocational education × (YSG/10)²			184.41***			437.32***			418.30***

Notes. Vocational education is a dummy variable equal to 1 if the programme is vocationally oriented, and zero otherwise. We use different indicators for vocational education throughout the regression models. In model 1 (a)-(c) vocational education stands for educational programmes with a Specific Focus. In model 2 (a)-(c) we use our Workplace Learning indicator for vocational education. In model 3 (a)-(c) vocational education is an indicator for programmes with a Specific Focus that involve Workplace Learning. (See section 2.2 for a more detailed definition with respect to these three vocational programmes types.) 'YSG' stands for years since graduation. The sample includes employees aged 25 to 65 with at least upper secondary education completed. The presented statistics are first stage F-statistics from our IV approach (see section 2.4 for an extended discussion on the adopted method and our instrument). Each IV regression included controls for gender, level of education and country and the standard errors are corrected for clustering at the country and years since graduation level. *** (**) ((*)) indicates significance at the 1% (5%) ((10%)) significance level. All data were weighted using sampling weights, with 'weight_with_education' as weighting variable.