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

European Sociological Review, 2024, **40**, 189–207
https://doi.org/10.1093/esr/jcad015
Advance access publication 2 May 2023
Original Article

OXFORD

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

Ilse Tobback[1], Dieter Verhaest[2,3,*], Stijn Baert[3,4], and Kristof De Witte[5,6]

[1]KU Leuven, Research Institute for Work and Society (HIVA), Parkstraat 47—bus 5300, 3000 Leuven, Belgium
[2]KU Leuven, Economics Research Group (ECON), Warmoesberg 26, 1000 Brussels, Belgium
[3]Ghent University, Department of Economics, Sint-Pietersplein 6, 9000 Ghent, Belgium
[4]University of Antwerp, Sint-Jacobstraat 2, 2000 Antwerp, Belgium
[5]KU Leuven, Leuven Economics of Education Research (LEER), Naamsestraat 69, 3000 Leuven, Belgium
[6]Maastricht University, UNU-MERIT, Boschstraat 24, 6211 AX Maastricht, The Netherlands
[*]Corresponding author. Email: dieter.verhaest@kuleuven.be

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 dataset and rely on instrumental variable estimation. While our descriptive results suggest that workers with a vocational degree experience on average more learning, this conclusion largely changes once endogeneity is taken into account. First, we find that, immediately after graduation, workers with a vocational education are less likely to further improve their skills in their jobs. Second, while this gap in on-the-job learning gradually fades over time, it takes almost a full career to catch up in terms of further on-the-job learning with those with a general degree. Finally, the effects are driven by individuals residing in dual system countries and those with a programme involving workplace learning. We argue that these results are likely explained by a combination of compensating (because vocationally educated obtained their specific skills already during education) and complementary (because general skills lay down a foundation for further learning) effects.

Introduction

Much of the discussion on how to best prepare youth for the labour market centres on whether education should be either vocationally or generally oriented (Ryan, 2001; Eichhorst *et al.*, 2015). 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 and Gangl, 2003; Mazrekaj, De Witte and Vansteenkiste, 2019). These relative advantages, however, do not seem to persist over time (McIntosh, 2006; Brunello and Rocco, 2017; Rözer and Bol, 2019; Neyt, Verhaest and Baert, 2020) and may, at later points in the career, even turn into disadvantages (Forster, Bol and Van de Werfhorst, 2016; Hampf and Woessmann, 2017; Hanushek *et al.*, 2017; Forster and Bol, 2018; Verhaest *et al.*, 2018b). Policymakers 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 difference in the specificity of acquired skills between vocationally and generally educated employees, with vocational programmes focussing on skills that are related to a specific context and general programmes focussing more on key cognitive skills like numeracy, literacy, and abstract thinking (Gamoran, 1998). Due to this difference, at the start of the career, vocationally educated individuals likely require less on-the-job learning and have a higher immediate employability (Forster and Bol, 2018) relative to their generally educated peers. However, at later points in the career, the combination of highly specific skills and changes in job tasks, for instance, due to technological changes, makes vocationally educated individuals relatively more prone to encounter skill obsolescence (Weber, 2014; Hanushek *et al.*, 2017). Moreover, this difference in adaptability might be reinforced by differences in the extent to which programmes lay down the foundation to acquire new skills throughout one's career, with

Received: May 2022; **revised:** January 2023; **accepted:** March 2023

this foundation potentially being stronger for those with general education (Heijke, Meng and Ris, 2003; Verhaest and Omey, 2013; Hanushek *et al.*, 2017).

We investigate empirically whether vocational and general programmes are associated with differences in on-the-job learning throughout the career. Despite the importance of looking beyond the immediate labour market effects, to the best of our knowledge, only two studies have already investigated the relationship between the vocational character of education and one's further learning throughout the career. Using cross-country data, Hanushek *et al.* (2017) found that, in the apprenticeship countries, those with a general education are, relatively to those with a vocational education, more likely to receive career-related adult education as they become older. Using British longitudinal data, Brunello and Rocco (2017) meanwhile found some evidence that generally educated individuals participate relatively more often in work-related training courses during the first stage of the career. Clearly, both findings are consistent with general education being more effective in promoting lifelong learning. However, while the former study suggests this to primarily explain the growing disadvantage of vocational degree holders in labour market chances during later stages of the career, the latter rather suggests this to explain their diminishing advantage during the early stages.

Our analysis contributes in four main ways to the literature. First, in contrast to Hanushek *et al.* (2017) and Brunello and Rocco (2017), who relied on an indicator of career-oriented adult education or work-related training as measures for lifelong learning, we rely on a more direct and overall measure of on-the-job learning. One drawback of the previously adopted indicators is that they exclude informal types of learning, like informal training courses, learning by watching and, in particular, learning by doing. Therefore, such measures only represent a fraction of the total time spent on learning (Barron, Berger and Black, 1997; Ferreira, Kühn-Nelen and de Grip, 2017). Another drawback is that they do not account for the effectiveness of learning activities. If generally and vocationally educated workers have different learning curves or if they differ in the relative time spent on learning activities with varying effectiveness,[1] the overall time spent on learning may have little to say about the true differences in their learning.[2]

As a second contribution, we explore the mechanisms that explain differences in learning between generally and vocationally educated individuals. In the paper, we argue that foundation skills may affect both one's skill development directly by improving one's learning in a given context, and indirectly by improving one's likelihood to obtain access to jobs that are conducive to learning. The importance of these two subchannels is tested indirectly by investigating whether generally and vocationally individuals differ in their learning attitudes and the learning contexts related to their jobs.

Third, we rely on a more fine-grained 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.*, 2018b). 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 and Woessmann, 2017; Hanushek *et al.*, 2017; Verhaest *et al.*, 2018b). Moreover, the aforesaid 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 more extended dataset of countries. This suggests that their results are driven by vocational programmes that are strongly workplace-based. By differentiating within countries between programmes with and without workplace-based learning, we test more directly whether this is indeed the case.

Finally, we adopt an instrumental variable (IV) approach to account for 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. 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.

Our analysis draws 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. A strength of this survey is its focus on the multiple dimensions of vocational education and its detailed information on on-the-job learning.

The paper is structured as follows. First, we present our theoretical framework regarding the linkage between the educational programme and lifelong learning. Next, we describe our dataset and research methods. Thereafter, we present our results. Last, we provide an overall discussion and conclusion.

Theoretical framework

To explain differences in post-school learning between vocationally and generally educated workers, we consider two mechanisms related to two different functions of initial education (Heijke, Meng and Ris, 2003; Verhaest and Omey, 2013). First, initial education has a vocational function by serving as a substitute for on-the-job training and directly producing the skills that are used on the labour market in general and in specific occupations or jobs in particular (Maton, 1969). As a focus on this function is less pronounced in general programs, workers with a general qualification are required to compensate this by further skill acquisition once entering the labour market. Those with a vocational degree, meanwhile, do face this need much less as long as they are matched with a job that is related with their education (Forster and Bol, 2018).

Second, initial education also has a generic function by laying down a foundation for further learning (Rosen, 1976). By focussing on key cognitive skills like numeracy, literacy, and abstract thinking (Gamoran, 1998), which are crucial to obtain access to and process new information, one may expect more general programs to be more successful in this respect (Heijke, Meng and Ris, 2003; Verhaest and Omey, 2013; Hanushek *et al*., 2017). However, as the processing of information occurs by linking this to knowledge that has already been acquired in the past (Bjork *et al*., 2013), also more specific skills may serve as a stepping stone to further learning. Higher levels of these foundational skills, whether they are general or specific, may not only directly lead to more skill development as they make learning more efficient in a given context, they may also do so indirectly as they may improve one's likelihood to be offered new training opportunities or to be selected and retained in jobs for which learning and new skill development is more important.

Assuming that both general and specific skills may be foundational, it is thus theoretically indefinite which type of programme is associated with a higher rate of learning at the start of the career. Moreover, also the empirical evidence based on the two aforementioned longitudinal studies of Hanushek *et al*. (2017) and Brunello and Rocco (2017) is not conclusive as only the latter found evidence of higher initial training participation among generally educated individuals. However, while focussing exclusively on the initial stage of the career and relying on more comprehensive measures of training and skill acquisition, also Heijke, Meng and Ris (2003) and Verhaest and Omey (2013) found higher learning among general degree holders. Indeed, for two main reasons, one may consider it more likely that general programs are more successful in this respect. For one thing, the foundational effect of specific skills that are acquired during education only holds in case one is employed in jobs that are related to one's education. For another thing, even if vocational degree holders would be more effective learners in matching jobs relative to those with a general degree, those with a general degree may still realize more skill development in these jobs due to the aforementioned compensation effect.

Likewise, it is theoretically not clear how this difference in the rate of post-school learning evolves at later moments in the career. Specific skills, either acquired in school or at work, are likely to gradually obsolete over time (Weber, 2014; Hanushek *et al*., 2017). This obsolescence may be due both to internal and external deprecation, with the former referring to skill loss due to ageing and skill underutilization, and the latter referring to skills that become outdated due to technological progress and other structural changes in skill demand (Weber, 2014). Accordingly, the need for further learning among those with a vocational degree to compensate for implied skill shortages may catch up with that of those with a general degree. The evolution in the relative difference in learning due to differences in foundational skills, meanwhile, is more difficult to predict. On the one hand, also vocational degree holders may gradually build up more general labour market skills. On the other hand, given the accumulative nature of learning, one may just as well expect general degree holders to further develop their general skills and, therefore, their learning potential over time.

The scant empirical evidence on the longitudinal effects of general and vocational education on learning provides little guidance either. That general degree holders may experience a (further) rise in their learning potential over time, seems consistent with Hanushek *et al*. (2017) who found some evidence of a rising advantage over time among general degree holders in training participation. However, Brunello and Rocco (2017) rather found a declining advantage of general degree holders in this respect. While the latter finding should not be inconsistent with a further rise over time in the learning potential of those with a general degree, it may indicate that the countervailing effect of specific skill obsolescence dominates. Finally, this reasoning also neglects the effect of the reduction of the investment horizon over the lifecycle, which causes the optimal level of human capital investments to converge to zero towards the end of the career (Ben-Porath, 1967). If any, also this mechanism should rather lead to a decline over time in the gap between general and vocational degree holders in the rate at which they develop additional skills.

Up until now, we only considered the case where programs are either general or vocational. In practice, however, there is a broad range of programs depending on their relative focus on one specific job or occupation, and other skills that are directly applicable on the labour market (e.g. through workplace learning). Evidently, both compensation effects and effects related to the presence of general foundation skills can be expected to be the strongest in purely general programs, while we expect both types of effects to be the weakest in purely vocational programs that are based on workplace learning within one narrowly defined occupation. With respect to effects resulting from more specific foundational skills, however, this is less straightforward. For instance, if school-based vocational programs attach more attention to field-specific theoretical knowledge, one may expect them to be even more effective in this respect relative to workplace-based programs. And to the extent that these programs also devote sufficient time to more general skills and/or prepare for occupations that are sufficiently broadly defined, they may also be at least as successful in this respect compared to purely general programs.

Methodology

Data

The ESJS data, collected in 2014 via online and telephone surveying, was designed to measure skill development and mismatches among workers in all EU-28 Member States (Cedefop, 2015). The survey was carried out among 48,676 employees aged 24–65 based on quota sampling. To guarantee representativeness, we rely on weighted data.[3] We select all respondents born in the country of residence with an upper secondary (ISCED 3), post-secondary (ISCED 4), or first-level of tertiary education (ISCED 5) qualification. Furthermore, we only retain those who started their current job at the time of or after graduation, as we focus on learning during employment and want to avoid confounding effects resulting from contemporaneous educational participation. Finally, to make our sample representative for those with a typical career and to minimize the influence of reporting errors, we select those who reported to have obtained their highest degree between ages 16 and 35. At the latter age, over 95 per cent of the sample had obtained their highest degree. In our final sample, which includes 25,377 individuals, 51 per cent acquired an ISCED 3 qualification, 13 per cent an ISCED 4 qualification, and 36 per cent an ISCED 5 qualification (see Table 1).

Table 1 Descriptive statistics

	Mean	Std. Dev.	Min	Max	N
Male	0.508	0.500	0	1	25,377
Age	42.138	9.867	24	65	25,377
Highest qualification obtained					
ISCED 3	0.513	0.500	0	1	25,377
ISCED 4	0.127	0.333	0	1	25,377
ISCED 5	0.360	0.480	0	1	25,377
Vocational programme					
Specific Focus	0.725	0.446	0	1	25,377
Workplace Learning	0.419	0.493	0	1	25,377
Specific Focus and Workplace Learning	0.366	0.482	0	1	25,377
YSG	20.878	10.776	0	49	25,377
Years with current employer	9.712	8.837	0	46	25,377
Skill development	7.705	1.729	0	10	24,904
Training in the last twelve months for the current job					
(Any) training	0.684	0.465	0	1	25,377
Training courses attended mostly or only during work hours	0.434	0.496	0	1	25,377
Training courses attended mostly or only outside of work hours	0.184	0.387	0	1	25,377
Training whilst performing the regular job [on-the-job training]	0.355	0.479	0	1	25,377
Learning context					
Variety of tasks	7.357	1.950	0	10	25,258
Difficulty of the tasks	7.127	1.885	0	10	25,258
Need to learn new things	7.365	1.919	0	10	25,258
Learning attitude: I enjoy learning for its own sake	7.345	2.297	**0**	**10**	25,261

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

In the next subsections, we discuss the measurement of the key variables related to our first three contributions: on-the-job learning and training, learning contexts and attitudes, and the programme orientations. Summary statistics on these variables are reported in Table 1. In the last subsection, we discuss our model specification and identification, which relate to the fourth contribution of our study.

On-the-job learning and training

Rather than focussing on training participation, which measures skill development only in an indirect way and may capture only particular types of learning activities, our benchmark analysis is based on a more direct and comprehensive measure of on-the-job learning. This measure 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 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 7.71 (see Table 1), indicating that most individuals have experienced at least some skill improvement in their job. Nonetheless, a small proportion of 2.8 per cent reports a depreciation of their skills.

To assess whether the results are sensitive to this focus on learning itself, we also conduct a few supplementary analyses relying on training participation measures as more indirect indicators of learning. The dataset includes the following question on training: '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, 68 per cent of the workers participated in some kind of training (see Table 1). Interestingly, while being strongly statistically significant, the correlation between our direct indicator of learning and a dummy measuring any training participation is fairly low (0.164).[4] This is consistent with learning and training participation being closely related but different concepts.

Learning context and attitudes

As argued in the theory section, higher levels of foundational skills may lead to more skill development both directly by facilitating learning in a given context and indirectly by improving one's likelihood to be selected into contexts that require more and are conducive towards learning. To assess whether these mechanisms are important, we also study the effect of the programme on the learning context and workers' attitudes towards learning. The learning context is derived from the following three statements, to be rated on an 11-point Likert scale from 0 to 10: 'Have the following increased, decreased or remained the same since you started your job with your current employer? (1) The variety of tasks, (2) The difficulty of the tasks and (3) The need to learn new things'. The average ratings on these statements are 7.36, 7.13, and 7.37, respectively. Note that, although also the compensation mechanism is likely to induce a need for learning, the statement rather assesses how this changes during one's job. While we expect this need to increase due to the foundation channel, the opposite is expected when the compensation channel dominates. Workers' attitude towards learning is proxied by the question: 'On a scale from 0 to 10, where 0 is strongly disagree and 10 strongly agree, please indicate to what extent do you agree or disagree with the following statements: I enjoy learning for its own sake'.[5] We presume this attitude towards learning to provide an indication of the direct effect of foundational skills as effective learners can be expected to be more likely to enjoy learning and as one can also expect to learn more in a given context if one enjoys learning. The average rating of this statement is 7.35 (see Table 1).

Programme orientation

We measure the vocational character of the programme of one's highest qualification based on two different dimensions: whether the programme is linked to a specific job or trade and whether the programme includes workplace-based learning.[6] The first dimension is derived from the question: '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 the question: '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 ways: (i) those with a specific focus (versus those without a specific focus), (ii) those involving workplace learning (versus those without workplace learning), and (iii) those combining a specific focus with workplace learning (i.e. purely vocational programs). In our sample, 73 per cent of the workers have a degree with a specific focus. Furthermore, 42 per cent indicated that their study involved some workplace learning, resulting in a total of 37 per cent of the workers with a qualification that combines a specific focus with workplace learning (see Table 1).

Using these two dimensions of programmes has two distinct advantages over relying on institutionalized qualification frameworks to distinguish between general and vocational education (Verhaest *et al.*, 2018b). First, our definitions do not depend on country-specific administrative decisions, hereby making the cross-country comparison more reliable. Second, we can pinpoint whether one of these dimensions (specific versus general focus, or the inclusion of workplace learning) is more crucial with respect to on-the-job learning and whether the effects of purely vocational programs that combine a specific focus with workplace learning differ from other types of vocational programs. As we argued in the theory section, the latter may, indeed, be the case.

Model specification and identification

As aforementioned, we analyse the impact of the programme orientation on on-the-job learning, training participation, the learning context of one's job, and the learning attitude. Our benchmark model takes the following general form:

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

with Y_i denoting one of the aforementioned outcomes of individual i, VP_i being a dummy variable indicating whether the programme is vocational, YSG_i denoting the number of years since graduation (YSG),[7] X_i being a vector of control variables (dummies for gender, ISCED level of education (2 dummies),[8] and country (27 dummies)), and ε_i being the residual term. Following Hanushek *et al.* (2017), we allow the effect of vocational education to change over time by including interactions with YSG and its square.[9] This model is estimated separately for each of our vocational education measures.

In line with other studies (Hampf and Woessmann, 2017; Hanushek *et al.*, 2017; Verhaest *et al.*, 2018b), we also investigate whether the effect of the programme differs between dual system and other countries. To this end, we estimate additional specifications in which we include interactions between the three vocational programme variables and a dummy measuring whether the individual's country has an educational system that is largely based on a dual system. Following Verhaest *et al.* (2018b), we consider Austria, Denmark, Germany, Luxembourg, Czech Republic, Hungary, Romania, and Slovenia as dual-system countries.[10]

The estimated coefficients in Equation (1) might be endogenous as individuals select themselves into educational programmes. In other words, unobservable factors like cognitive innate abilities, psychological traits, or unmeasured background characteristics are likely to be related to both the programme orientation and lifelong learning (i.e. $Cov(\varepsilon_i, VP_i) \neq 0$). To deal with this selectivity, the literature often interprets the estimation of β_2 and β_3 within a difference-in-differences logic and assumes that the relative selectivity of vocational and general programmes remains stable over time; since test score differences between generally and vocationally educated individuals are found to be relatively stable across age cohorts (Hanushek *et al.*, 2017; Verhaest *et al.*, 2018b), 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 for β_1 which reflects the initial effect of vocational programmes. Since this parameter is crucial to assess whether differences in learning may contribute to the relative improvement in labour market conditions of generally educated workers, we employ an IV approach. For our instrument, we exploit the variation in the proportion of students participating in vocational (as opposed to a general) programmes across countries and graduation cohorts. This IV is similar to the one adopted by Cavaglia, McNally and Ventura (2020) and by Birkelund and van de Werfhorst (2022) who studied the effects of vocationally oriented programs and tracks on more standard labour market outcomes such as earnings and employment. The main difference with our approach is that both studies relied on the share of students from the same (gender-)specific age cohort within their school. These authors argued that their instrument is valid as exposure to peers who participate in a vocational programme impacts an individual's choice to partake in such a programme. Indeed, there is ample empirical evidence on strong peer effects related to students' educational choices (Rosenqvist, 2018; Andersen and Hjortskov, 2022). The literature points to several channels that may explain these effects, such as through the provision of information about different educational options or the normative influence students may have on their friends (Rosenqvist, 2018; Birkelund and van de Werfhorst, 2022). However, the exogeneity of this instrument may be violated if there is a relation between the unobserved characteristics that determine selection into schools and those that determine the selection in vocational programmes.[11] By measuring peer-exposure at the country level, 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.

For each individual *i* and each definition of vocational education, we calculate the instrument as the fraction of students ($\overline{VP}_{(i)c}$) from the same country-specific graduation cohort combination (c)[12] who participate in a vocational programme leaving out the individual her-/himself[13]:

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

with N_c being the number of individuals in the individual's country-specific graduation cohort c and $\overline{\mathrm{VP}}_c$ being the fraction of students from one's country-specific graduation cohort who participate in a vocational programme including the individual her-/himself.[14] The numerator of Equation (2) thus counts the number of (other) individuals in one's country-specific cohort with a vocational degree, while the denominator equals the total number of (other) individuals in one's cohort. Along with using this fraction as instrument for VP_i, we use $\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} * \mathrm{YSG}$ and $\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} * \mathrm{YSG}^2$ as instruments for $\mathrm{VP}_i * \mathrm{YSG}$ and $\mathrm{VP}_i * \mathrm{YSG}^2$, respectively, leading to the following set of first-stage equations:

$$\begin{aligned}\mathrm{VP}_i = \; & \alpha_{01} + \alpha_{11}\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} + \alpha_{21}\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} * \mathrm{YSG}_i + \\ & \alpha_{31}\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} * \mathrm{YSG}_i^2 + \alpha_{41}\mathrm{YSG}_i \\ & + \alpha_{51}\mathrm{YSG}_i^2 + X_i\alpha_{61} + \nu_{1i}\end{aligned} \tag{3}$$

$$\begin{aligned}\mathrm{VP}_i * \mathrm{YSG}_i = \; & \alpha_{02} + \alpha_{12}\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} + \alpha_{22}\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} * \\ & \mathrm{YSG}_i + \alpha_{32}\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} * \mathrm{YSG}_i^2 + \alpha_{42}\mathrm{YSG}_i \\ & + \alpha_{52}\mathrm{YSG}_i^2 + X_i\alpha_{62} + \nu_{2i}\end{aligned} \tag{4}$$

$$\begin{aligned}\mathrm{VP}_i * \mathrm{YSG}_i^2 = \; & \alpha_{03} + \alpha_{13}\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} + \alpha_{23}\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} * \\ & \mathrm{YSG}_i + \alpha_{33}\overline{\mathrm{VP}}_{(\mathrm{i})\mathrm{c}} * \mathrm{YSG}_i^2 + \alpha_{43}\mathrm{YSG}_i \\ & + \alpha_{53}\mathrm{YSG}_i^2 + X_i\alpha_{63} + \nu_{3i}\end{aligned} \tag{5}$$

Moreover, to account for the aggregate nature of our instrument, we cluster standard errors at the country-specific graduation cohort level.

There are several assumptions underlying the validity of the instrument. First, there should be a sufficiently strong relationship between the country-level vocational participation rate and one's own programme choice. Besides peer effects, we expect also other factors such as changes in educational policies to contribute to this relationship. Indeed, the coefficients of the instruments in the first stage always have the expected sign. Moreover, as reported in Supplementary Appendix A2, most first stage F-statistics for our benchmark analyses substantially surpass the benchmark of 10 as suggested by Stock, Wright and Yogo (2002). Finally, 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 IV problems for these analyses. Only for the analyses that test whether the results differ between dual system and other countries, we face weak IV problems. To solve this problem, we replace the individual country dummies with one dummy that differentiates between dual system and other countries. Therefore, these results are based on stronger exogeneity assumptions (cf. infra).

Second, the country-level vocational participation rate should only be related to on-the-job learning through its impact on the individual's program choice. This assumption may be violated if policy changes that affect the participation rate themselves are induced by country-specific changes in the skill development of workers. However, 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. Moreover, even if policies respond to changes in learning, this relationship is likely to be rather loose as it usually takes many years to develop and implement educational policy reforms.[15] Another violation of the exclusion restriction may result from exogenous cohort-specific shocks that affect both the vocational participation rate and learning in a direct way. As we condition on country-fixed effects along with years of graduation and its quadratic term in all models, cohort-specific shocks that are driven by common factors across the EU such as technological advances, globalization, or business cycle co-movements are largely accounted for.[16] The role of within-country cohort-specific shocks, meanwhile, may be considered to be more concerning as our IV strategy does not allow us to account for detailed country-cohort effects. However, for two main reasons, these shocks need not cause major problems. First, there are substantial 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).[17] Second, even in the case of a moderate violation of the exclusion restriction, the induced bias may be rather small as long as the instrument is sufficiently strong (Angrist, Imbens and Rubin, 1996; Hoogerheide, Block and Thurik, 2012).[18]

A third assumption is monotonicity, implying that the relationship between the country-level participation rate and the individual program choice should be non-negative for each individual. If fulfilled, the estimated effect is to be interpreted as a local average treatment effect (LATE) among compliers. Clearly, we cannot exclude there to be some defiers, for instance, because some individuals may be inclined to do the opposite of their peers. The results from an additional compliers analysis, reported in Supplementary Appendix A3, are somewhat comforting in this respect; both among males and females and among the medium and the highly educated, we find compliance to be significant.[19] Moreover, also the bias resulting from a violation of monotonicity is negatively related to the strength of the instrument (Angrist, Imbens and Rubin, 1996). Finally, even in the presence of defiers, the estimated effect can be interpreted as a LATE for a subset of compliers as long as there exists a group of compliers of the same size as and with the same average treatment effect of the defiers (de Chaisemartin, 2017). Also the latter is more likely when the instrument is sufficiently strong.

Results

On-the-job learning

In Table 2, we report our benchmark results, with on-the-job learning as outcome and relying on IV estimation. Besides our most general specification (Model C),[20] we also report results on two more restricted specifications that either exclude both $VP_i{*}YSG$ and $VP_i{*}YSG^2$ (Model A) or only $VP_i{*}YSG^2$ (Model B) from the model.

Based on our most restricted specification (Model A), we do not find strong evidence on differences in on-the-job learning between vocational and general degree holders. However, this largely changes when the interaction terms are included (Models B and C). Looking at the early career phase, those who obtained their degree through workplace learning realize less on-the-job learning than their general counterparts. These initial effects seem quite substantial as they are estimated to be equivalent to 73 per cent (1.264/1.729 = 0.731) to 90 per cent (1.560/1.729 = 0.902) of a standard deviation. Moreover, while these vocationally educated individuals realize a relative improvement in their further on-the-job learning over time, they only catch up with those with a general degree by the end of their career. For example, as depicted in Figure 1, the estimates suggest that, for those with a vocational education based on workplace learning (regardless of the specific orientation), it takes about 38 years after graduation to catch up in terms of on-the-job learning with those with a general education (Model 2B).[21] When graduating at age 18, this is around age 56. As the additional estimates reported in Table 3 illustrate, accounting for endogeneity is crucial; based on standard linear regression we rather find vocationally educated workers to realize more on-the-job learning on average.

In Table 4, we also examine how these effects differ between dual system and other countries. For both types of countries, we find some evidence suggesting that workers who obtained their degree through workplace learning initially realize less learning than their general counterparts (Models 2C and 3C).

Table 2 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	−0.175	−1.191	−1.354*	−0.222	−1.110***	−1.374***	−0.203	−1.264***	−1.560***
	(0.693)	(0.770)	(0.818)	(0.224)	(0.295)	(0.355)	(0.270)	(0.351)	(0.417)
Vocational education × YSG/10		0.342***	0.144		0.293***	0.614**		0.329***	0.675**
		(0.110)	(0.611)		(0.066)	(0.276)		(0.071)	(0.292)
Vocational education × (YSG/10)²			0.028			−0.067			−0.072
			(0.116)			(0.057)			(0.060)
YSG/10	0.054	−0.220**	−0.390	0.042	−0.127*	−0.268**	0.043	−0.121*	−0.255**
	(0.053)	(0.108)	(0.359)	(0.058)	(0.069)	(0.125)	(0.058)	(0.069)	(0.119)
(YSG/10)²	0.000	0.006	0.042	0.002	0.009	0.039	0.002	0.009	0.036
	(0.012)	(0.012)	(0.070)	(0.012)	(0.012)	(0.025)	(0.012)	(0.012)	(0.024)

Notes. N = 24,903. 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 the programme orientation section for a more detailed definition with respect to these three vocational programmes types.) 'YSG' stands for years since graduation. The sample includes employees aged 25–65 with ISCED 3–5. The presented statistics are based on an IV approach (see the model specification and identification section 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 YSG level. *** (**) ((*)) indicates significance at the 1 per cent (5 per cent) ((10 per cent)) significance level. All data are weighted using sampling weights, with 'weight_with_education' as weighting variable.

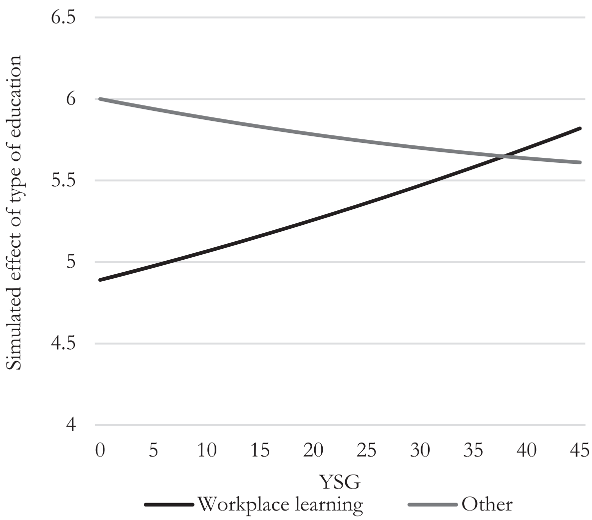

Figure 1 Simulated effect of type of education on on-the-job learning (on a scale from 0 to 10). Notes. Graphical depiction of Column 2b of Table 2, where 'b' implies a linear specification that interacts vocational education with YSG. The simulated effects are merely indicative.

Nonetheless, both this negative initial effect and the positive interaction effect with YSG is stronger for the dual system countries. These estimates suggest it takes about 27 years among vocationally educated workers in dual system countries to catch up with those with a more general education in terms of on-the-job learning (Model 2B). While being above half of a full career of 45 years, this is below the turning point found in our benchmark analysis. However, at least part of this difference seems to be attributed to the fact that we do not control for detailed country dummies in Table 4.[22] Overall, these results are consistent with the idea that the effects are more substantial for programmes that include more intensive and sizeable components of workplace learning (as is the case in dual system countries). Moreover, for specific programs (regardless of the inclusion of workplace learning) in the non-dual system countries, we even find the average effect over the full career to be positive (Model 1A).

Training participation

We also report results for overall training participation as outcome (Table 5).[23] Except for a marginally significant initial negative effect of programmes with both a specific focus and workplace learning (Model 3B), model specifications 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 learning, we find

Table 3 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	0.153***	0.145**	0.205**	0.110***	−0.032	−0.062	0.149***	−0.019	−0.037
	(0.032)	(0.061)	(0.100)	(0.031)	(0.060)	(0.093)	(0.032)	(0.059)	(0.091)
Vocational education – YSG/10		0.004	−0.068		0.070***	0.107		0.082***	0.104
		(0.026)	(0.106)		(0.026)	(0.096)		(0.026)	(0.096)
Vocational education – (YSG/10)²			0.016			−0.009			−0.005
			(0.024)			(0.022)			(0.022)
YSG/10	0.052	0.049	0.101	0.058	0.021	0.005	0.060	0.023	0.015
	(0.053)	(0.057)	(0.093)	(0.053)	(0.053)	(0.064)	(0.053)	(0.052)	(0.062)
(YSG/10)²	0.001	0.001	−0.011	0.000	0.001	0.005	0.000	0.001	0.003
	(0.012)	(0.012)	(0.021)	(0.012)	(0.011)	(0.014)	(0.012)	(0.011)	(0.014)

Notes. N = 24,904. 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 the programme orientation section for a more detailed definition with respect to these three vocational programmes types). 'YSG' stands for years since graduation. The sample includes employees aged 25–65 with ISCED 3–5. Each regression includes controls for gender, level of education and country. Standard errors are corrected for clustering at the country and YSG level. *** (**) ((*)) indicates significance at the 1 per cent (5 per cent) ((10 per cent)) 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		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
Vocational education	1.041***	−0.090	−1.123	0.036	−0.340	−0.779*
	(0.175)	(0.394)	(0.697)	(0.160)	(0.299)	(0.400)
Vocational education × YSG/10		0.514***	1.727***		0.166	0.661
		(0.144)	(0.625)		(0.121)	(0.470)
Vocational education × $(YSG/10)^2$			−0.264**			−0.104
			(0.128)			(0.114)
Vocational education × Dual	−0.917**	−2.755***	−1.951	−0.280	−1.451***	−1.688**
	(0.375)	(0.928)	(1.572)	(0.238)	(0.470)	(0.704)
Vocational education × YSG/10 × Dual		0.788**	−0.316		0.495***	0.620
		(0.399)	(1.409)		(0.189)	(0.754)
Vocational education × $(YSG/10)^2$ × Dual			0.259			−0.010
			(0.303)			(0.175)
YSG/10	0.009	−0.355***	−1.231***	0.002	−0.043	−0.304*
	(0.062)	(0.129)	(0.440)	(0.063)	(0.086)	(0.176)
$(YSG/10)^2$	0.009	0.011	0.201**	0.010	0.002	0.058
	(0.013)	(0.014)	(0.088)	(0.014)	(0.014)	(0.039)
Dual	0.519*	2.196***	1.538	0.090	0.757***	0.767**
	(0.307)	(0.751)	(1.277)	(0.124)	(0.240)	(0.363)
YSG/10 × Dual		−0.735**	0.165		−0.297***	−0.232
		(0.327)	(1.152)		(0.102)	(0.402)
$(YSG/10)^2$ × Dual			−0.212			−0.026
			(0.249)			(0.095)
Wald tests						
Vocational education + (Vocational education × Dual) = 0						
Chi^2 (1)	0.139	11.520	4.714	2.022	27.270	18.17
Prob > chi^2	0.709	0.001	0.030	0.155	0.000	0.000
(Vocational education × YSG/10) + (Vocational education × YSG/10 × Dual) = 0						
Chi^2 (1)		12.455	0.251		23.435	4.783
Prob > chi^2		0.000	0.263		0.000	0.029
(Vocational education × $(YSG/10)^2$) + (Vocational education × $(YSG/10)^2$ × Dual) = 0						
Chi^2 (1)			0.000			0.738
Prob > chi^2			0.987			0.390

Table 4. Continued

	Indicator vocational program: specific focus			Indicator vocational program: workplace learning		
	(1a)	(1b)	(1c)	(2a)	(2b)	(2c)
	Indicator vocational program: specific focus and workplace learning					
	(3a)	(3b)	(3c)			
Vocational education	0.042	−0.550	−1.013**			
	(0.188)	(0.346)	(0.451)			
Vocational education × YSG/10		0.283**	0.810			
		(0.137)	(0.529)			
Vocational education × (YSG/10)^2			−0.112			
			(0.129)			
Vocational education × Dual	−0.246	−1.131**	−1.393*			
	(0.253)	(0.505)	(0.765)			
Vocational education × YSG/10 × Dual		0.341*	0.461			
		(0.201)	(0.793)			
Vocational education × (YSG/10)^2 × Dual			−0.004			
			(0.181)			
YSG/10	0.002	−0.077	−0.322*			
	(0.063)	(0.087)	(0.172)			
(YSG/10)^2	0.010	0.005	0.057			
	(0.014)	(0.014)	(0.038)			
Dual	0.054	0.557**	0.567			
	(0.112)	(0.225)	(0.351)			
YSG/10 × Dual		−0.218**	−0.143			
		(0.094)	(0.363)			
(YSG/10)^2 × Dual			−0.029			
			(0.083)			
Wald tests						
Vocational education + (Vocational education × Dual) = 0						
Chi^2(1)	1.546	23.181	15.072			
Prob > chi^2	0.214	0.000	0.000			
(Vocational education × YSG/10) + (Vocational education × YSG/10 × Dual) = 0						
Chi^2(1)		20.445	4.724			
Prob > chi^2		0.000	0.030			
(Vocational education × (YSG/10)^2) + (Vocational education × (YSG/10)^2 × Dual) = 0						
Chi^2(1)			0.849			
Prob > chi^2			0.357			

Notes. N = 24,903. 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 3.4 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 25–65 with ISCED 3–5. The presented statistics are based on an IV approach (see section 3.5 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, respectively. 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	−0.109	−0.261	−0.507**	−0.056	−0.124	−0.336***	−0.083	−0.189*	−0.442***
	(0.185)	(0.207)	(0.231)	(0.063)	(0.085)	(0.100)	(0.075)	(0.100)	(0.114)
Vocational education × YSG/10		0.051	0.401***		0.022	0.279***		0.033	0.329***
		(0.032)	(0.139)		(0.019)	(0.075)		(0.021)	(0.079)
Vocational education × (YSG/10)²			−0.075***			−0.054***			−0.062***
			(0.028)			(0.015)			(0.016)
YSG/10	0.040***	−0.001	−0.259**	0.036**	0.023	−0.090**	0.035**	0.018	−0.096***
	(0.015)	(0.030)	(0.106)	(0.016)	(0.019)	(0.035)	(0.016)	(0.019)	(0.033)
(YSG/10)²	−0.012***	−0.011***	0.043**	−0.012***	−0.011***	0.012*	−0.012***	−0.011***	0.013*
	(0.003)	(0.003)	(0.021)	(0.003)	(0.003)	(0.007)	(0.003)	(0.003)	(0.007)

Notes. *N* = 25,376. 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 the programme orientation section for a more detailed definition with respect to these three vocational programmes types). 'YSG' stands for years since graduation. The sample includes employees aged 25–65 with ISCED 3–5. The presented statistics are based on an IV approach (see the model specification and identification section 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 YSG level. *** (**) ((*)) indicates significance at the 1 per cent (5 per cent) ((10 per cent)) significance level. All data are weighted using sampling weights, with 'weight_with_education' as weighting variable.

those with a vocational programme to participate less often in training at the start of the career. Moreover, similar to on-the-job learning, we observe this relatively lower training participation to diminish as the career advances. Finally, while these workers catch up with other workers somewhat earlier in their career in terms of training participation (19 years after graduation) than in terms of on-the-job learning, this relative improvement also fades over time (Model 2C).[24]

In Supplementary Appendix A5, we further report results for different types of training. These results indicate that the lower levels of overall training participation during the first half of the career of those having participated in a vocational programme are most apparent with respect to training whilst performing the regular job and training courses attended mostly during work hours.

Learning context and attitudes

To explore the mechanisms that explain the relationship between the programme and one's learning, we look at the workers' learning context and attitudes towards learning. Table 6 reports the results for these outcomes based on Model C.[25]

Looking at the learning context, we do not find clear evidence on systematic initial differences between workers with a specific focus degree and their generally educated counterparts. However, this conclusion largely changes based on the workplace learning indicator for vocational education. We find those with a workplace learning degree to be less likely to work in challenging work contexts at the start of the career than their generally educated peers. Moreover, while we observe these effect to diminish as their career advances, simple back-of-the-envelope calculations suggests the effects to disappear towards the end of the career only (see Supplementary Appendix A4). For instance, based on Model 2C, we find workers with programmes characterized by workplace learning to catch up in terms of the improvement of the variety of their tasks after about 31 years after graduation. The results on the attitude towards learning are quite similar. While we do not observe a clear effect of a specific focus degree, we find those with a programme including workplace learning to enjoy learning less throughout their full career. These results are consistent with our findings on learning, with adverse initial effects of vocational programmes that are stronger when they include workplace learning. Moreover, they suggest these adverse effects on learning to be realized both through a lower access to jobs that offer learning opportunities and through adverse effects on learning attitudes *per se*.

Sensitivity and robustness analyses

We end with several sensitivity and robustness analyses regarding on-the-job learning. First, as general upper-secondary education is often directed towards

Table 6 Vocational education and learning context throughout the career: IV regression coefficients (and standard errors)

	Indicator vocational program: specific focus				Indicator vocational program: workplace learning			
	(1c)				(2c)			
	Learning context			Learning attitude	Learning context			Learning attitude
	Variety of tasks	Difficulty of the tasks	Need to learn new things		Variety of tasks	Difficulty of the tasks	Need to learn new things	
Vocational education	−1.902*	−1.404	−1.333	−0.073	−1.896***	−1.970***	−1.733***	−0.807*
	(0.996)	(0.972)	(0.908)	(1.037)	(0.404)	(0.440)	(0.415)	(0.470)
Vocational education × YSG/10	0.976*	1.171**	0.855	−0.602	0.980***	0.974***	0.939***	−0.554
	(0.529)	(0.502)	(0.575)	(0.608)	(0.294)	(0.331)	(0.330)	(0.339)
Vocational education × $(YSG/10)^2$	−0.114	−0.172*	−0.098	0.207*	−0.119**	−0.134**	−0.116*	0.153**
	(0.107)	(0.099)	(0.116)	(0.124)	(0.060)	(0.065)	(0.067)	(0.068)
YSG/10	−0.443	−0.628*	−0.403	0.392	−0.191	−0.230	−0.215	0.148
	(0.405)	(0.371)	(0.434)	(0.459)	(0.143)	(0.149)	(0.153)	(0.163)
$(YSG/10)^2$	0.048	0.100	0.056	−0.132	0.021	0.038	0.039	−0.044
	(0.081)	(0.073)	(0.087)	(0.093)	(0.029)	(0.029)	(0.031)	(0.033)

	Indicator vocational program: specific focus and workplace learning			
	(3c)			
	Learning context			Learning attitude
	Variety of tasks	Difficulty of the tasks	Need to learn new things	
Vocational education	−2.172***	−2.230***	−1.940***	−0.867*
	(0.470)	(0.512)	(0.475)	(0.527)
Vocational education × YSG/10	1.064***	1.019***	0.990***	−0.741**
	(0.315)	(0.357)	(0.351)	(0.354)
Vocational education × $(YSG/10)^2$	−0.127**	−0.135*	−0.119*	0.192***
	(0.064)	(0.069)	(0.071)	(0.070)
YSG/10	−0.168	−0.195	−0.180	0.186
	(0.137)	(0.143)	(0.145)	(0.154)
$(YSG/10)^2$	0.017	0.031	0.033	−0.050
	(0.027)	(0.028)	(0.029)	(0.031)

Notes. N = 25,257. 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 3.4 for a more detailed definition with respect to these three vocational programmes types). 'YSG' stands for years since graduation. The sample includes employees aged 25–65 with ISCED 3–5. The presented statistics are based on an IV approach (see section 3.5 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, respectively. All data are weighted using sampling weights, with 'weight_with_education' as weighting variable.

further learning in higher education and as those with an ISCED 6 qualification were not included in our sample, this is likely to lead to an underrepresentation of general degree holders in our sample. Moreover, we also had to exclude those with an ISCED 1 or 2 level degree and, therefore, a more general basic education. As the calculation of our instrument was based on this restricted sample, this might have biased our estimates. For our robustness analyses that address this problem, we focus on our workplace learning indicator, as this indicator is also observed for ISCED 6 qualifications. First, we recalculate our instrument and re-run our benchmark analysis (Model B) by extending the sample with those with ISCED 6 as highest qualification. Second, we re-run our analysis for the sample of workers with ISCED 3–5 as a maximum qualification, but adopting the instrument that is calculated based on the extended sample that also includes individuals with an ISCED 6 qualification. Third, we re-run our analysis based on the original sample, but further extend our sample with individuals with ISCED 1 or 2 for the calculation of the instrument and by presuming these individuals have had a general education. Each of these robustness checks, reported in Supplementary Appendix A7, yield results that are largely similar to those in our benchmark analyses.

Second, vocational and general programmes may be somehow different depending on the level of education. That this may be relevant is illustrated by Brunello and Rocco (2017) as they only found evidence on a relationship between one's programme orientation and training participation among workers without tertiary education. To test whether we find similar heterogeneous effects, we add interaction terms between our variables of interest and a dummy for tertiary education (ISCED 5). However, as displayed in Supplementary Appendix A8, none of these interactions are statistically significant.

Third, we assess whether our results are sensitive to the addition of work-related characteristics as control variables. We add controls for the industry in which the individual is working, size of the organization, self-assessed mismatch between the worker's skills and what is required to do the job at the start of the current employment, and, finally, our indicators for the learning context (cf. the learning context and attitudes section). In our benchmark analysis, we did not control for these characteristics for two reasons. First of all, obtaining access to jobs with particular learning opportunities may be an important channel through which one's programme affects one's future learning opportunities. Therefore, job characteristics that are correlated with these learning opportunities may be considered as bad controls (Angrist and Pischke, 2008) as they may capture part of the true causal effect of one's program and as they may introduce selection bias problems. Second, adding these characteristics may generate problems of reversed causality as one's learning may itself affect one's access to particular jobs. As shown in Supplementary Appendix A9, the results are largely insensitive to the inclusion of the industry, organization size, and skill mismatch variables. Overall, this suggests that the effect of the programme orientation on skill development are not explained by differences in access to particular industries or differences in initial skill shortages or surpluses. Adding the indicators on the learning context, meanwhile, strongly reduces the size and significance of both the initial effect of workplace-based programmes and their interaction with YSG. This suggests that differences in access to jobs with different learning environments is a prime channel through which the programme affects one's later learning. However, given the aforementioned potential problem of reversed causality, these results are merely suggestive.

Fourth, as our main indicator of learning refers to skill development since the start of the current job, the estimated effects do neither represent pure differences in the rate of learning over a fixed period nor pure accumulative effects over one's career. Not only does this somehow complicate their interpretation, the implication may also be that part of the estimated effects result from differences in job length. For similar reasons as for other job characteristics, we did not add the number of years with the current employer as control variable in our benchmark analysis. Indeed, on-the-job skill development and the length of one's job most likely affect each other, leading to reversed causality problems. Moreover, as lengthier jobs allow one to develop a larger stock of job-specific skills, access to these jobs may be one more valid channel through which one's educational programme causally affects one's learning. Nonetheless, as shown in Supplementary Appendix A10, adding job length (along with its square) as control variable does not affect our results in a major way, although the estimated time at which the relatively lower learning for those with a programme with workplace learning disappears is now a bit earlier. This suggests that the finding of lower levels of learning among those with a programme with workplace learning relative to those with a general degree holds, at least during the first half of the career, also among those with jobs that are of similar length.

Fifth, we further add interaction terms between job length and the program dummy. As reported in Supplementary Appendix A11, these results suggest that the gap in the rate of skill development between generally educated and those with a programme based on workplace learning diminishes much more slowly if individuals remain employed in the same job. When changing jobs, meanwhile, this gap seems to be closed already at about 15 years after graduation. A potential explanation may be that job changes induce more substantial skill obsolescence and, therefore, a more substantial compensation effect among those with a vocational degree. Yet, given the aforementioned endogeneity regarding job length, also these results are to be interpreted with great caution.

Finally, as women often have less stable labour-force participation patterns than men, this may raise concerns about cohort-specific selection into work by women (Hanushek *et al*., 2017; Brunello and Rocco, 2017). This would be problematic when comparing younger and older workers. To address this concern, we restrict our sample to male workers. Our IV regressions for the male sample, reported in Supplementary Appendix A12, yield approximately the same results as our benchmark analyses, with workers with a vocational education initially being less likely to improve their skills in their job, and this effect (while fading over time) lasting a full career.

Discussion and conclusion

Previous research indicated that the initial advantage of vocationally relative to generally educated individuals in terms of employment chances and earnings diminishes over time and, ultimately, may even turn into a disadvantage (e.g. Hanushek *et al*., 2017). An often suggested explanation for this trade-off are differences in on-the-job learning. In this paper, we investigated whether this is indeed the case by means of data covering workers in all EU-28 countries.

Overall, our results are consistent with the idea that differences in learning contribute to a diminishing labour market advantage over time of vocationally educated individuals. We observed that, immediately after graduation, workers with a vocational education improve their skills less in their jobs than general degree holders. Moreover, while this initial difference was found to diminish over time, only towards the end of their career workers with general and vocational education report similar levels of learning. Although these results align both with those by Brunello and Rocco (2017) and those of a few older studies that focussed on the initial stage of the career only (Heijke, Meng and Ris, 2003; Verhaest and Omey, 2013), they are clearly different from those of Hanushek *et al*. (2017). However, our study and that of Brunello and Rocco (2017) differed in several respects from the latter one. First, unlike Hanushek *et al*. (2017) who focussed on career-related education, we relied on a more comprehensive and direct indicator of learning. And although also Brunello and Rocco (2017) measured learning in an indirect way, their indicator of work-related training courses may at least capture a broader range of training activities relative to the one adopted by Hanushek *et al*. (2017). Indeed, while the results of our supplementary analysis focussing on any training participation closely mimicked those of our benchmark analysis on leaning, this was not the case when we confined the analysis to training courses outside working hours. Second, like Brunello and Rocco (2017), we accounted in a more detailed way for endogeneity by means of an IV approach. That also this may matter was illustrated by our additional standard regression estimates, which were clearly different as well.

Why vocationally educated workers realize relatively less learning throughout most part of their careers may be explained both by lower levels of foundation skills and by a lower need to compensate for gaps in specific and directly applicable skills. At first blush, the latter explanation seems more likely given our finding that the gap in learning declines over time. However, as argued in the theory section, this may also reflect the effect of gradual specific skill obsolescence among vocational degree holders that partly countervails the foundation effect among general degree holders. Moreover, also several (other) of our findings suggest that the compensation channel is not the full story. First, we find the advantage of those with a general degree in terms of learning to endure well beyond the first decades after graduation. Second, in line with the foundation channel, we find general programmes to be associated with a relatively higher eagerness to learn new things for its own sake throughout the career. Third, for most parts of their career, we find those with a general degree to be also more likely to be selected in jobs that require more and are conducive towards learning, such as jobs that become more complex over time and are associated with an increase in the variability of tasks. Fourth, our conclusions were largely unaffected when initial skill shortages and surpluses were added as control variables. Nonetheless, as the latter finding cannot be interpreted in a causal way, the question which of these two mechanisms dominates remains unanswered. We are therefore in favour of further research focussing on the relative importance of the foundation and compensation mechanisms, for instance by monitoring the overall skills levels of workers over time.

Interestingly, our results were largely 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 specific focus degrees (regardless of the inclusion of workplace learning), meanwhile, even seemed to realize 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 develop new skills on the job. We have two explanations for this finding. First, as is often presumed (e.g. Hanushek *et al.*, 2017), the specific (general) component of school-based vocational programmes may be less (more) substantial relative to apprenticeship-based programs. Second, also specific skills may be foundational and to the extent that school-based programmes attach more attention to field-specific theories and concepts, they may be more successful in this respect relatively to both general and workplace-based vocational programs. Nonetheless, it remains an open question which of these two explanations is dominant, whether our findings hold in all occupational contexts and whether they depend on the exact way these programmes are designed. To guide educational programmers, further research that relies on even more fine-grained measures of different types of vocational education would be helpful.

Important to mention is that most of these conclusions are conditional on using our IV approach. Without accounting for endogeneity, we rather find vocationally educated workers to realize as much or even more learning than generally educated workers. This is remarkable as participants in vocational education are often presumed to have, on average, lower cognitive abilities and to be of lower social backgrounds (Ryan, 2001). Several explanations can be advanced for finding a (more) negative coefficient based on IV estimation. First, obtaining access to apprenticeships is found to be more difficult for students with less favourable educational records (Helland and Støren, 2006; Tobback, Verhaest and Baert, 2020), and some evidence also indicates that individuals who choose and have access to programs with apprenticeships or internships are more intrinsically motivated (Verhaest and Baert, 2018; Tobback *et al.*, 2020). Second, while the more able within general programs usually transit to more advanced degrees, less-performing students in vocational education may be more likely to dropout from education. Hence, among workers with the same level of education, those with a general degree may be a negatively selected group even if enrolment in these programs were random. Third, IV estimates can counteract not only biases due to unobserved heterogeneity, but also biases due to measurement errors in the regressor (Angrist and Pischke, 2008). Given the subjective nature of our vocational education variables (e.g. people might understand the survey questions differently), this may at least partially explain the difference in results between the two estimation methods. Indeed, classical errors may strongly bias the estimated effects towards zero when using standard linear regression. Moreover, if these errors are correlated with the measured outcome, they may also reverse the direction of the estimated relationship. Fourth, as explained in the methods section, the LATE may deviate from the average effect for the overall sample. For instance, it is often presumed that peer effects are more prominent among students that are uncertain about their educational choices (Rosenqvist, 2018; Birkelund and van de Werfhorst, 2022). A potential explanation may therefore be that vocational education is less effective in terms of learning for these compliers, perhaps because they are also more uncertain about their occupational aspirations. However, this suggested explanation is merely speculative and, therefore, requires further investigation.

Several other directions for future research can be advanced as well. First, although we measured developed skills in a more direct way than most other studies in this respect, our indicator of learning was a general one and did not allow one to identify which skills are developed in particular. Differentiation between different types of developed skills would also help determining whether the stronger on-the-job learning results from a compensation or foundation channel. Second, also further analyses relying on more objective (but direct) indicators of learning would be interesting. Finally, while we were the first to study the effects of programme orientation on future skill development using a quasi-experimental design, our IV approach relies on assumptions that are open to discussion. Other identification strategies, for instance by relying on a clear natural experiment, could help warranting that the relationships identified in our study are indeed causal.

Notes

1 Ferreira, Kühn-Nelen and de Grip (2017), for instance, found informal training to be more effective than formal training.

2 For similar reasons, also many recent studies on differences in human capital between nations focus on direct measures of skills rather than indirect ones based on years of schooling (Hanushek and Woessmann, 2015).

3 The weights, which are provided by Cedefop, also account for country size. An alternative is use senate weights, which give equal weight to every country. We did not adopt this alternative weighting since it resulted in weak IV problems.

4 The correlations with training during working hours, training outside work hours, and training whilst performing the job are 0.152, 0.057, and 0.134, respectively (all significant at $P < 0.01$).

5 This question also includes three other items, namely 'I try to relate learning to practical issues', 'I prefer to have others plan my learning', and 'I prefer problems to which there is only one solution'. We did not study these items as they were not included in the telephone survey and as the expected direction of the effect is less clear.

6 The specific focus dimension is only available for the ISCED 3–5 levels; hence our decision to confine our analysis to these educational levels.
7 This is derived from a comparison of the age when surveyed and the self-reported age when having obtained one's highest qualification of education or training.
8 By controlling for level of education, we aim at identifying effects of vocational/general education that are attributed to differences in orientation and not just to average differences in the program duration and the level at which they may be taught.
9 Alternatively, one may add interactions with age, as done by Hanushek *et al*. (2017). We prefer to rely on YSG since this is more closely connected with the theoretical framework. Nonetheless, unreported results based on interactions with age were very similar.
10 The dual system dummy is coded zero for all other countries.
11 Birkelund and van de Werfhorst (2022) address this problem, at least partly, by adding also sibling fixed effects. Our data do not allow us to adopt this strategy.
12 We define nine cohorts based on the year in which the worker achieved his or her highest educational level: (i) 1953–1974, (ii) 1975–1979, (iii) 1980–1984, (iv) 1985–1989, (v) 1990–1994, (vi) 1995–1999, (vii) 2000–2004, (viii) 2005–2009, and (ix) 2010–2014.
13 We calculate this variable relying on all workers born in the country of residence who obtained ISCED level 3–5 between ages 16 and 35, and having started their current job at the time of or after graduation.
14 To exemplify the exploited variation, Supplementary Appendix A1 reports the share of peers by country by cohort.
15 As an illustration, we refer to a major reform in Belgium that introduced dual learning in full-time vocational education. While this reform was partly initiated by the rise in youth unemployment during the great recession, it took until the school year 2019–2020 to be implemented (Verhaest *et al*., 2018a).
16 We also conducted a few estimations by replacing the main and quadratic term for YSG by graduation cohort dummies, but the results were largely similar.
17 Of course, both educational choices and learning may be determined by the same more structural country-specific factors. However, these structural factors are accounted for by the addition of the country-level dummies.
18 Besides the high F-statistics reported in Supplementary Appendix A2, this is also illustrated by the strong correlations between the instrument and the endogenous variable which range from 0.288 to 0.417 depending on the adopted measure of vocational education.
19 Unfortunately, our data do not include more detailed background characteristics for a compliers analysis.
20 Additional unreported analyses indicate that controlling for the natural logarithm of YSG_i instead yields approximately the same results as in our benchmark analyses.
21 In Supplementary Appendix A4, we report the simulated YSG needed to catch up based on all IV estimates reported in the main tables.
22 This is derived from unreported results for our benchmark analysis on programmes with workplace learning that find a lower turning point when detailed country dummies are not controlled for.
23 While based on a linear probability model, unreported IV probit regressions yield approximately the same results.
24 Although we did not find complete catching up for pure vocational programs based on Model 3C (Supplementary Appendix A4), the estimated effect is close to zero when reaching its minimum (in absolute terms) after about 27 years.
25 Results for Models A and B are available in Supplementary Appendix A6.

Supplementary Data

Supplementary data are available at *ESR* online.

Acknowledgements

We thank Nick Deschacht, Rolf van der Velden, Ides Nicaise, and three anonymous reviewers for their valuable comments on earlier versions of this article. We also thank the European Centre for the Development of Vocational Training (Cedefop). Cedefop European skills and jobs survey (ESJS), Wave 1, Spring 2014 [computer file], 1st edition, Thessaloniki: Greece, Downloaded from: http://www.cedefop.europa.eu/en/events-and-projects/projects/european-skills-and-jobs-esj-survey. ESJS microdata are Cedefop copyright and are reproduced with the permission of Cedefop.

Funding

This work was supported by the Flemish Authority within the frame of the policy research centre on educational research (Steunpunt SONO).

Submission declaration

We confirm that this work has not been published elsewhere and is not under consideration for publication elsewhere. A former version of the paper has been disseminated as SONO research paper. This is a series that disseminates discussion papers and reports on research conducted within the frame of the policy research centre on educational research (Steunpunt SONO). SONO was an interuniversity research centre that was funded by the Flemish Government. This former version has been disseminated electronically on the website of the Flemish Government (https://data-onderwijs.vlaanderen.be/formulieren/default.aspx?id=12348), and a Dutch summary of our paper has been disseminated electronically on the website of SONO (http://steunpuntsono.be/publicaties/).

References

Andersen, S. C. and Hjortskov, M. (2022). The unnoticed influence of peers on educational preferences. *Behavioural Public Policy*, **6**, 530–553.

Angrist, J., Imbens, G. and Rubin, D. (1996). Identification of causal effects using instrumental variables. *Journal of the American Statistical Association*, **91**, 444–455.

Angrist J. and Pischke J.-S. (2008). *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton: Princeton University Press.

Barron, J. M., Berger, M. C. and Black, D. A. (1997). How well do we measure training? *Journal of Labor Economics*, **15**, 507–528.

Ben-Porath, Y. (1967). The production of human capital and the life cycle of earnings. *Journal of Political Economy*, **75**, 352–365.

Birkelund, J. F. and van de Werfhorst, H. G. (2022). Long-term labor market returns to upper secondary school track choice: leveraging idiosyncratic variation in peers' choices. *Social Science Research*, **102**, 102629.

Bjork, R. A., Dunlosky, J. and Kornell, N. (2013). Self-regulated learning: beliefs, techniques, and illusions. *Annual Review of Psychology*, **64**, 417–444.

Brunello, G. and 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**, 106–166.

Cavaglia, C., McNally, S. and Ventura, G. (2020). Do apprenticeships pay? Evidence for England. *Oxford Bulletin of Economics and Statistics*, **82**, 1094–1134.

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

de Chaisemartin, C. (2017). Tolerating defiance? Local average treatment effects without monotonicity. *Quantitative Economics*, **8**, 367–396.

Eichhorst, W. *et al*. (2015). A road map to vocational education and training in industrialized countries. *ILR Review*, **68**, 314–337.

Ferreira M., Kühn-Nelen A. and de Grip A. (2017). Work-related learning and skill development in Europe: does initial skill mismatch matter? In Solomon W. *et al*. (Eds.). *Skill Mismatch in Labour Markets*, Vol. **45**. Bingley, UK: Emerald Publishing Ltd, pp. 345–407.

Forster, A. G. and Bol, T. (2018). Vocational education and employment over the life course using a new measure of occupational specificity. *Social Science Research*, **70**, 176–197.

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

Gamoran A. (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*. Washington DC: U.S. Department of Education, pp. 133–175.

Hampf, F. and 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. *et al*. (2017). General education, vocational education, and labor-market outcomes over the lifecycle. *Journal of Human Resources*, **52**, 48–87.

Hanushek E.A. and Woesssman L. (2015). *The Knowledge Capital of Nations*. Cambridge: MIT Press.

Heijke, H., Meng, C. and Ris, C. (2003). Fitting to the job: the role of generic and vocational competencies in adjustment and performance. *Labour Economics*, **10**, 215–229.

Helland, H. and Støren, L. A. (2006). Vocational education and the allocation of apprenticeships: equal chances for applicants regardless of immigrant background? *European Sociological Review*, **22**, 351.

Hoogerheide, L., Block, J. H. and Thurik, R. (2012). Family background variables as instruments for education in income regressions: a Bayesian analysis. *Economics of Education Review*, **31**, 515–523.

Maton, J. (1969). Experience on the job and formal training as alternative means of skill acquisition: an empirical study. *International Labour Review*, **100**, 239–255.

Mazrekaj, D., De Witte, K. and Vansteenkiste, S. (2019). Labour market consequences of a high school diploma. *Applied Economics*, **51**, 2313–2325.

McIntosh, S. (2006). Further analysis of the returns to academic and vocational qualifications. *Oxford Bulletin of Economics and Statistics*, **68**, 225–251.

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

Neyt, B., Verhaest, D. and Baert, S. (2020). The impact of dual apprenticeship programs on early labour market outcomes: a dynamic approach. *Economics of Education Review*, **78**, 102022.

Rosen, S. (1976). A theory of life earnings. *Journal of Political Economy*, **84**, S45–S67.

Rosenqvist, E. (2018). Two functions of peer influence on upper-secondary education application behavior. *Sociology of Education*, **91**, 72–89.

Rözer, J. J. and Bol, T. (2019). Labour market effects of general and vocational education over the life-cycle and across time: accounting for age, period, and cohort effects. *European Sociological Review*, **35**, 701–717.

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. and Yogo, M. (2002). A survey of weak instruments and weak identification in generalized method of moments. *Journal of Business & Economic Statistics*, **20**, 518–529.

Tobback, I., Verhaest, D. and Baert, S. (2020). Student access to apprenticeships: evidence from a vignette experiment. *Industrial Relations: A Journal of Economy and Society*, **59**, 435–465.

Verhaest, D. and 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**, 1229–1270.

Verhaest D. *et al*. (2018a). *Duaal leren in Vlaanderen: kansen en gevaren*. Gent: SONO - Skribis.

Verhaest, D. *et al*. (2018b). General education, vocational education and skill mismatches: short-run versus long-run effects. *Oxford Economic Papers*, **70**, 974–993.

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

Weber, S. (2014). Human capital depreciation and education level. *International Journal of Manpower*, **35**, 613–642.

Ilse Tobback is Doctor in Business Economics and employed as a senior researcher at HIVA – Research Institute for Work and Society. She obtained her degree in October 2020 at the KU Leuven, Faculty of Economics and Business (FEB). Her dissertation is titled “Essays on the effectiveness of work-based learning and vocational education”. Her research interests are Economics of Education, Labour Economics and applied econometrics. She has published in Industrial Relations and Economics of Education Review.

Dieter Verhaest is associate professor at the Faculty of Economics and Business at KU Leuven, Belgium, Brussels Campus. He is also affiliated to Ghent University and Global Labor Office (GLO). His research is mainly situated in Labour Economics and Economics of Education. He has published in journals such as the European Sociological Review, Industrial Relations, Labour Economics, Journal of Business Research, Journal of Economic Surveys, Social Science & Medicine, and Kyklos.

Stijn Baert is associate professor at the Faculty of Economics and Business at Ghent University, Belgium. He is also affiliated to University of Antwerp and to Université catholique de Louvain, Global Labor Office (GLO), IMISCOE and Institute for the Study of Labor (IZA). His research is mainly situated in the broad field of labour economics. He has published in journals such as European Sociological Review, Health Economics, Industrial Relations, ILR Review, Journal of Applied Econometrics, Journal of Economic Surveys, Labour Economics, New Media & Society, and Social Science & Medicine.

Kristof De Witte is professor at the Faculty of Economics and Business at KU Leuven, Belgium. At KU Leuven he is program director of the Master in Economic Education, and is director of the research group ‘Leuven Economics of Education Research’. He also affiliated to Maastricht University, the CESifo Network and the Finish VATT Institute for Economic Research. His research interests comprise education economics, performance evaluation and political economy. He has published in journals such as American Sociological Review, Labour Economics, British Educational Research Journal, Journal of the Operational Research Society, Economics of Education Review and International Sociology.