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Patterns of Overeducation in Europe: The Role of Field of Study

Abstract

This study investigates the incidence of overeducation among graduate workers in 21 European Union countries and its underlying factors based on the European Labor Force Survey 2016. Although controlling for a wide range of covariates, the particular interest lies in the role of fields of study for vertical educational mismatch. The study reveals country differences in the impact of these factors. Compared to Social sciences, male graduates from, for example, Education, Health and welfare, Engineering, and ICT (Information and Communication Technologies) are less and those from Services and Natural sciences are more at risk in a clear majority of countries. These findings are robust against changes of the standard education. Moreover, some fields show gender-specific risks. We suggest that occupational closure, productivity signals and gender stereotypes answer for these cross-field and cross-country differentials. Moreover, country fixed effects point to relevant structural differences between national labor markets and between educational systems.

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1 Introduction

In general, the term overeducation refers to a job match in which the educational level of the worker clearly exceeds the educational requirements of the job. In the terminology of labor economics, this is often considered a vertical skill mismatch, as opposed to horizontal mismatches (workers choosing jobs with requirements outside the scope of their field of study/apprenticeship). A widespread occurrence of this phenomenon can seriously impair the competitiveness of an economy. From a macroeconomic perspective, an overeducation status of qualified workers reflects a waste of scarce human capital. From a microeconomic perspective, it can affect a worker's job satisfaction. In turn, a skill mismatch can reduce overall work motivation, expressing itself in more frequent absenteeism and higher turnover of the workforce (Tsang and Levin, 1985; Sicherman, 1991; Sloane et al., 1999). Moreover, overeducation is associated with earnings losses (Daly et al., 2000; Bauer, 2002; Boll and Leppin, 2016).

However, before being able to tackle the problem successfully, it is essential to understand the driving forces of overeducation at the individual level. There is a vast body of literature including meta-studies documenting the importance of job-related and micro-level factors as well as country specificities in the context of overeducation. However, most investigations address either one or only a few countries in the same methodological and data setting, which hampers a substantial cross-country comparison. Moreover, few studies investigate the role of field of study, although from a theoretical point of view, the magnitude of skill mismatch should relate to structural features of field-specific labor market segments. Finally, many studies lack a substantial sensitivity analysis, although it could be shown that the choice of the educational standard heavily impacts the results (Battu et al., 2000; Verhaest and Omey, 2006; Quintini, 2011; Boll et al., 2016).

Against this background, the aim of this paper is to identify possible determinants of overeducation for young (20–35 years) highly educated (tertiary level) workers in EU-28 countries with a special focus on the role of field of study. We make use of the 2016 wave of the European Labour Force Survey (EU-LFS), a quarterly household sample survey that covers approximately 1.8 million individuals aged 15 years or older. We contribute to the literature in three ways. First, we investigate the role of field of study as a so far widely neglected factor in the context of overeducation. We are able to identify the significance of this factor by controlling for a range of alternative explanatory factors. Second, we present country-specific results for 21 EU countries together with a cross-country estimation within the same methodological framework. This helps to identify differences in the seriousness of the phenomenon between countries and to develop tailor-made policy recipes. Third, we provide a solid robustness check of our results, deploying two more measures of overeducation which largely confirm the results of our benchmark measure.

Our findings reveal different overeducation risks for graduates from different fields. Compared to social sciences, male graduates from, for example, Education, Health and Welfare, Engineering, and ICT (Information and Communication Technologies) are less and those from, for example, Services and Natural Sciences are more at risk. These findings hold for the majority of countries and are robust against a change of the standard education. However, some fields show gender-specific risks. We suggest that different degrees of job-specificity, productivity signals, and gender stereotypes answer for the cross-field and cross-gender differentials. Moreover, country fixed effects point to relevant structural differences between national labor markets and educational systems.

2 Literature findings

The empirical literature on the topic of overeducation has come up with a wide range of findings on the influence of some individual- and job-related factors, in particular work experience (Alba-Ramirez, 1993; Groot, 1996; Sloane et al., 1999; Nielsen, 2011, Boll et al., 2016) and job tenure (Büchel and van Ham, 2003; Büchel and Battu, 2003; Groot and van den Brink, 2003; Ortiz, 2010), beyond macro-level factors like job scarcity on the labor market, which might advantage graduates due to lower expected training requirements on the side of employers (Thurow, 1975).

Much less well-documented is the role of the educational field of a person, which constitutes an important element for predicting labor market outcomes (van de Werfhorst and Kraaykamp, 2001; Hansen, 2001) and hence might also be a determinant of overeducation. Several reasons motivate this view. First, fields of study differ in their occupational focus. Fields like medicine or engineering with their quite narrowly defined job profiles might require more occupation-specific skills, raising the chances of graduates to find appropriate jobs in the corresponding occupational groups (Reimer et al., 2008). The high job-specificity protects graduates of fields like medicine, law, or architecture from educational mismatch (Ortiz and Kucel, 2008). Second, credentialism theories suggest that in a world where the true personal abilities are unknown, the chosen field of study can also act as an ability signal to employers. Obtaining a degree in fields like maths, natural sciences, or technical disciplines, which enjoy the reputation of imposing high intellectual demands on their students, could convince employers of the extraordinary talent and/or motivation of applicants (Barone and Ortiz, 2011). This could give them preferred access to positions with high skill requirements, possibly also outside the occupational groups associated with their subjects. Third, field choice might be triggered by individual gender role orientations and social origin (Polachek, 1978; Bradley, 2000), such that field-specific labor market outcomes are not purely causal effects but to some part driven by selection into fields. More specifically, gender norms might impact decisions on family formation and marriage and via this channel impact educational choices (Chiappori et al., 2009; Attanasio and Kaufmann, 2017). Beyond horizontal segregation, also vertical segregation relates to gender norms. Whereas women still bear the lion's share of household chores, they are underrepresented in managerial positions throughout Europe. For example in April 2015, the EU-average of women's share among senior executives of the largest nationally registered companies listed on the national stock exchange amounted to 13.7% and their share among nonexecutive directors stood at 22.5% (European Union, 2016, p. 26). Both the choice of "female" occupations at the beginning of the career and the typically "female" decisions in its subsequent stages can be associated with the underutilization of formal education in the current job. Furthermore, having graduated as a female in a male dominated field could convey a negative productivity signal to employers, relative to male graduates in the same field, resulting in ceteris paribus higher overeducation.

The impact of the chosen field on the risk of overeducation is also likely to differ with educational level. The training received by graduates from tertiary education is typically of a more academic nature and less focused on occupation-specific skills than vocational programs. In the first analysis of this kind, Green and McIntosh (2007) restrict their estimation for the United Kingdom to the subsample of university graduates. Also some later studies

focused on tertiary graduates only (Reimer et al., 2008; Smyth and Steinmetz, 2008; Tarvid, 2012; Berlingieri and Zierahn, 2014; Capsada-Munsech, 2015).

The comparability of results is limited by the different methodological settings that have been used in the literature so far, for example, with respect to field classifications, measures of educational standards, or the list of covariates. For example, in the analysis of Green and McIntosh (2007), who make a quite detailed distinction between 12 educational fields, degrees in Physical sciences and in Computing are estimated to lower the overeducation probability significantly relative to the reference category Business and Management Studies.[1] According to the findings of Ortiz and Kucel (2008) for Germany and Spain, the field of Services is, compared to the reference category Social sciences, businesses and law, associated with the highest overeducation risk of tertiary graduates in both countries, followed by Human arts.

Also Tarvid (2012) who makes use of the European Social Survey data and tests the field effect in a supranational sample comprising 30 countries finds that graduates from Services exhibit a much higher overeducation probability than graduates from business, law, and economics. Probabilities lower than for the reference were detected for the fields education and health. The results of Berlingieri and Zierahn (2014) for German male graduates support the notion of a low risk for graduates of natural sciences, compared to business and law. Finally, the most recent test we are aware of was conducted by Capsada-Munsech (2015) for Italian university graduates. The study reports the lowest overeducation probability for Medicine, compared with the reference category humanities.

To sum up, the literature so far suggests that, albeit a considerable degree of heterogeneity in methodology and data, students of Social sciences, Services and Humanities tend to be at higher risk than those in Natural sciences and ICT. This supports the notion that there is a linkage between occupational closure and the risk of overeducation. Highly job-specific programs like medicine seem to represent generally acknowledged entry requirements for the corresponding occupations, which restrict job competition to the graduates from these fields.

With respect to gender-specific field-of-study effects one could think of six (nonexclusive) channels. First, the risk discrepancies might reflect that, on average, female graduates exhibit different preferences in terms of job attributes than their male counterparts in the same educational fields (Coudin et al., 2018). Second, they might be a sign of field-specific gender discrimination concerning access to adequate jobs, for example, as a consequence of gender stereotypes regarding job images (Glick et al., 1995). Third, they could indicate that in these fields male graduates (for Services and Natural sciences) and female graduates (for Arts and humanities) showed on average the better academic performance, giving them better chances to enter adequate positions. Fourth, they could also indicate the existence of educational sorting at a lower aggregation level than measured. Fifth, gender differences in field-specific risks could origin in masked gender differences regarding assumed occupations.[2] Sixth, gender differences in field-specific overeducation rates could origin in gender-different field-specific enrollment rates and correspondingly different demand/supply ratios on the labor market.[3]

1 The insignificance of the field Math explain the authors by the fact that school grades in Maths were included as an additional control variable, thereby diluting the measurement of the field effect.

2 Note that although we specify overeducation as an occupation-specific risk (see Section 3), this does obviously not prevent genders from sorting into different occupations within the same educational field.

3 Cf. Zuazu (2018) and Smyth and Steinmetz (2008) or a discussion of the role of institutional factors underlying the observed gender segregation in the fields of study as family policies, prevalent gender norms, gender pay gaps etc. in a cross-country comparison.

Contrary to fields where women are underrepresented (ICT, Natural Sciences, and Engineering) and fields where women dominate among university leavers (education, health and welfare, art and humanities, and social sciences), women and men are almost equally distributed among university leavers in the field of Services (OECD, 2016). Combined with a lower employment rate of women (also) in this field compared to their male counterparts, this could lead to a relative scarcity of highly educated women in Services-related occupations on the labor market. Contrary to STEM professions where women often suffer negative productivity signals arising from gender stereotypes, there is hardly any comparable stigma in service-related professions. In sum, this might trigger a lower overedcuation risk of female graduates in the field of services.

The study at hand aims to verify the linkage between job-specificity and overeducation in a consistent methodological and data framework. In particular, we hypothesize that those study programs that train graduates for a more clearly defined range of occupations are associated with a lower overeducation risk than less job-specific study programs. Further, based on the above discussed channels of gendered preferences, gendered ability signals and demand/supply ratios on the labor market we expect a comparatively lower overeducation risk of female graduates in the field of services compared to their male counterparts. In order to validate the sensitivity of our results to the measurement methods, we compare our baseline measure of overeducation with two alternatives.

3 Data and measurement

We use data from the European Labour Force Survey (EU-LFS)[4] to identify possible determinants of overeducation. The EU-LFS covers approximately 1.8 million individuals from the EU-28 countries (plus Iceland, Norway, and Switzerland) aged 15 years or older[5] and provides rich information on the respondent's demographic background, labor status, employment characteristics, and educational attainment. It allows us to assess and compare the impact of a large variety of potential determinants, both separately for single countries and in a cross-country estimation. Our analysis is based on 2016 data and is restricted to 21 EU-countries, guided by issues of data availability regarding household variables and occupational groups. Respondents are assigned to countries based on their place of work. In order to illustrate country differences in overeducation risk and its determinants, we perform estimations both for an aggregate cross-country sample with country fixed effects and for the single countries separately to allow for country-specific associations of the included explanatory variables to the dependent variable.

In line with previous studies (Reimer et al., 2008; Smyth and Steinmetz, 2008), we restrict our sample to highly educated individuals, as the issue of overeducation is by definition most relevant for members of this group and, with a sharp increase of graduates' population shares during the last decades in OECD countries (from 23.3% in 1995 to 43.1% in 2016

4 For more detailed information on the European Labour Force Survey, see, for example, European Union (2014).

5 Norway and Sweden only cover persons between 15 and 74 years and Iceland and Switzerland only provide data on people aged 15 and more.

on average), affecting more and more people (OECD, 2018).[6] Highly educated individuals are defined as persons who have completed tertiary education. This corresponds to educational levels 6, 7, and 8 of the ISCED 2011 classification included in the dataset. Furthermore, the sample is restricted to respondents aged 20–34 years. This restriction is motivated by our primary interest in the impact of field of study, which is in EU-LFS merely available for this age group.

We refer to the above-mentioned overeducation as a vertical inadequacy. In the literature, different ways for measuring overeducation are followed, from expert evaluation of occupation-specific required education (which is seldomly available, Eckaus, 1964) and respondents' subjective assessments to statistical approaches (realized matches). Results often change when subjective evaluations of overeducation are used instead of the statistical measure (Bauer, 2002; Chiswick and Miller, 2010; Nielsen, 2011; Boll et al., 2016). For our purposes, we adopt the variant of the realized matches approach. This is the only measure that can be employed based on the data at hand, but referring to the literature, each measure has its pros and cons. Empirical evidence suggests that self-assessed overeducation is subject to other job features such as occupational status and particularly income (Dolton and Vignoles, 2000). Survey participants may be inclined to exaggerate educational requirements of their job for various reasons (Borghans and de Grip, 2000). Furthermore, self-assessed overeducation might be gender biased (Leuven and Oosterbeek, 2011).

More specifically, we follow the realized matches approach proposed by Kiker et al. (1997) and code a person as being overeducated if his or her highest educational attainment level is higher than the benchmark education level of her occupation group at the two-digit ISCO level.[7] As a benchmark, we apply in our main analyses the 80th percentile of the levels of education within each occupational group as proposed by Ortiz and Kucel (2008). It considers a worker to be overeducated in her given job match if her educational level exceeds the 80th percentile of the distribution of observed levels of education in the given occupation. As a first (second) sensitivity check, we additionally report results based on the modal value of attained education in the occupational group (based on the "ISCO measure").

The choice of reference point can potentially have a sensitive impact on the measurement, depending on the specific distributions of educational levels within an occupation group. Preferring the 80th percentile over the mode follows the idea that the mode regularly relates to higher overeducation rates in the same methodological setting and based on the same data (see for a literature overview Cedefop, 2010, pp. 18–20). This particularly applies when the underlying distribution of the dependent variable is fairly even; in this case, depending on the exact position of the most frequent single value the observations above (or below) this threshold may cover a quite high population share.

With the "ISCO measure," we define those graduates to be overeducated who exhibit an ISCO one-digit level of 4 or higher (ISCO-08 = International Standard Classification of

6 Studies that compare educational groups stress the higher magnitude of overeducation for graduates. For Germany for example, a study based on the Socio-economic Panel (SOEP) estimated a 30% (41%) risk for West (East) German male graduates and a 36% (38%) risk for West (East) German female graduates of statistical overeducation in 2011, whereas the corresponding figures for workers with medium education are 8% (12%) for men and 14% (10%) for women (Boll et al., 2016).

7 The mean value is not an available option since the data provides us with educational categories only. Hence, the main advantage of the mode over the mean that it is less sensitive to outliers (Kiker et al., 1997) does not apply in our data context.

Occupations, cf. ILO, 2016). In other words, individuals working as managers (ISCO-08 level 1), professionals (ISCO-08 level 2), technicians, and associate professionals (ISCO-08 level 3) are considered not to be overeducated. The assumption underlying the ISCO measure is that demanding jobs require a certain educational level. Note, however, that the ISCED levels define the skill requirements of major occupational groups. Particularly, ISCO-08 level 3 (2) corresponds to ISCED-2011 level 5 (6, 7, and 8). It becomes evident that the ISCO measure deviates from the realized matches approach in that it defines educational mismatch from theoretical reasoning whereas the 80th percentile and the modal value both rely on the realized statistical distribution of education among employees within an occupation. Principally, the median would have been another default option, but as a 50th percentile criterion, it is technically similar to our 80th percentile benchmark measure. The only difference is that it sets a lower hurdle, which unsurprisingly leads to very high and rather unplausible overeducation rates. Therefore, we refrain from implementing it.

We implement the field of study indicator provided in the EU-LFS data as an explanatory variable. Following the classification scheme ISCED 2013-F, it distinguishes 11 field categories. In our estimation model, the single categories are coded as categorical dummy variables, choosing the category "Social Sciences, Journalism and Information" to be the omitted reference category. Additionally, in order to illuminate potential gender differences in the role of the single fields, we include interaction terms of the field category with a dummy measuring sex (female = 1; male = 0).

The associations of fields of study are isolated by controlling for personal and job characteristics. Personal characteristics include sex and foreign nationality. Furthermore, we consider the impact of age within our already narrow sample of 20–34 years old by introducing dummies referring to the 25–29 years old and the 30–34 years old, respectively, with the 20–24 years as a reference.

Among job characteristics, usual working hours are given as the number of hours that a respondent is usually working per week in her main job. Tenure is defined as the number of years since a person started to work with her current employer or as self-employed. In order to shed light on potential nonlinearities, tenure is also included as squared term. Further, we include a temporary contract dummy. Firm size is split into three dummy variables, namely 11–19, 20–49, and more than 50 employees, respectively. Smallest firms with 10 employees or less serve as a reference. Finally, we include 20 sector dummy's (sections according to NACE Rev. 2) and country dummies in our regressions.

In a preceding Heckman correction for employment selection (see Estimation method), we use a set of household characteristics which are deemed to exert an influence on employment propensity but not on overeducation probability. The household characteristics compose of the spouse's educational level (ISCED) and dummys for unemployed or inactive adults. Based on assortative mating (Mare, 1991), workers living together with unemployed might on average be less productive themselves, a fact that reduces their chances to find a job. Further, we account for elderly persons (aged 75 and older) and children by age of the youngest one (0–5, 6–11, and 12–17 years) in the same household. As recent research still identifies a strong gender bias in the labor market implications of children (Waldfogel, 1998), interaction terms with sex are included for this last indicator.

4 Estimation method

The most simple (and also most common) approach to analyze impact factors on overeducation risk is to implement a Probit model (see Judge et al., 1988). The target variable y_i classifies a respondent either to be overeducated ($y_i = 1$) or not ($y_i = 0$). In the Probit model, the probability of $y_i = 1$ is modelled as follows:

$$p = Pr(y_i = 1|X) = \phi(X\beta)$$

where ϕ (.) is the cumulative distribution function of the standard normal distribution and X is the set of covariates presented above. The model can be estimated with the Maximum-Likelihood-Method, which yields consistent, asymptotically efficient and asymptotically normal distributed estimates. Due to the nonlinearity of the model, marginal effects are not simply given by the estimated coefficients $\hat{\beta}$, but depend on the level of the covariates. In the Results section, we report average marginal effects, that is, averages of the specific marginal effects determined for each observation. In comparison to the estimated coefficients as such, this facilitates interpretation, as the actual distributions of the explanatory factors are accounted for.

A drawback of this simple approach is that it neglects a potential estimation bias due to self-selection into employment. It rests the analysis purely on those individuals having a job at the time of observation. However, intuition suggests that overeducation risk could well be correlated with employment selection, for instance if the prospect of entering into a skill mismatch induces job seekers to rather stay unemployed to circumvent expected earnings drawbacks or other disadvantages like job dissatisfaction. Under such circumstances, employed and nonemployed individuals systematically differ in their risk levels. Results based on estimations not accounting for the impact of employment selection will then be biased in the sense that the overeducation risk of persons affiliated to high-risk fields would be underestimated. To correct for selection bias, we use the two-step correction mechanism (Heckman, 1979) where some household variables serve as identification variables (see Section 3). Specifically, we assume that the absence of further adults in the household increases the employment propensity of the person since he or she is more likely to rely on own earned income whereas this factor should not be directly related to the risk of being overeducated (cf., for example, Ghignoni and Verashchagina, 2014 for a similar approach). The opposite holds true for the presence of small children in the household (although differently motivated via an increased household productivity which lowers employment propensity).[8]

5 Results and discussion

5.1 Descriptive results

Overeducation magnitude heavily depends on the methodology used, that is, the chosen educational standard. It furthermore differs by individuals' educational attainment and moreover,

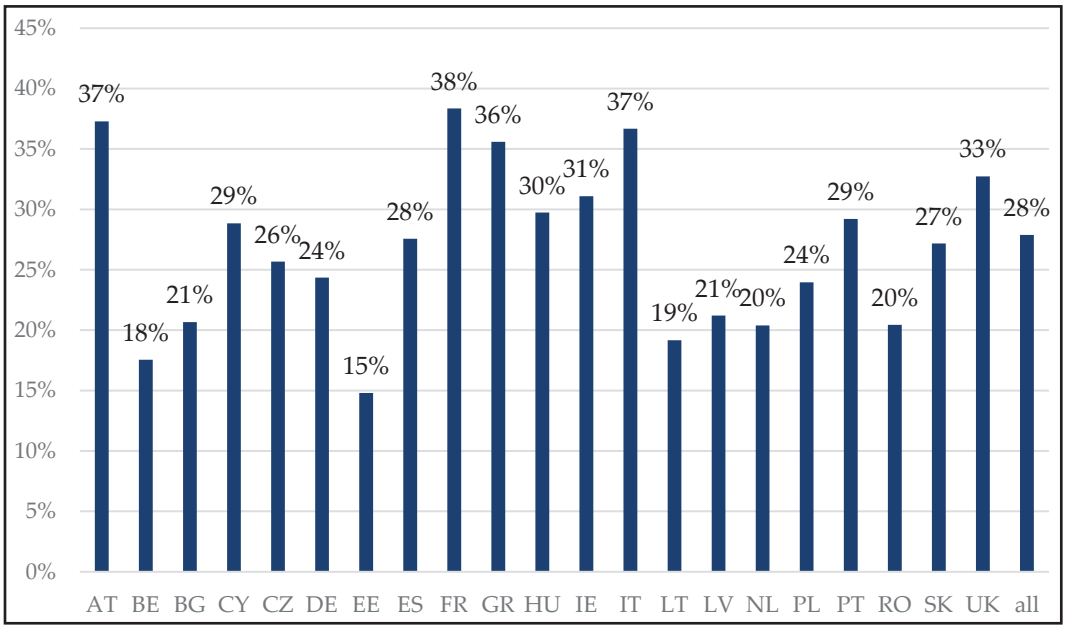
8 As a first step, based on a sample of workers and nonworkers, a Probit model is specified estimating the likelihood of being in employment at the time of observation as a function of individual and household-related characteristics (as well as country dummies in the cross-country estimation), wherein the household characteristics serve as identification variables. As a second step, based on a sample restricted to workers, the Probit model for overeducation can be estimated, including the inverse mills ratio computed from the results of the first step as an additional control variable, reflecting the impact of employment selection to the overeducation equation.

there is notable country variation within the same educational group. For instance, in a sample across all skill levels, Davia et al. (2017) recently reported a share of overeducated male workers of 16% for Germany and of 32% for Spain. For workers with medium education, Boll et al. (2016) estimated the share of overeducated workers to amount 20% for Germany, but 52% for Spain (Boll et al., 2016). However, the picture for workers with tertiary education is completely different. For instance, in the named study, the overeducation share of German graduates stands at 43%, compared to 24% for Spanish graduates.

Figure 1 depicts the share of overeducated workers among workers with tertiary education at country level obtained by applying the 80th percentile as the standard education to the 2016 wave of EU-LFS. While about 28% of workers are considered overeducated in total, country variation is quite substantial. The highest rates are measured for France, Austria, Italy, and Greece where more than 35% of highly educated workers are overeducated, whereas the lowest rates are observed for Estonia, Belgium, and Latvia with rates below 20%. This high degree of heterogeneity suggests that either in the single countries different impact factors are at work or that workers from different countries systematically differ in relevant characteristics or both. This can be examined based on the results of our econometric analysis discussed in the next section.

As the 80th percentile sets a fairly high threshold for being overeducated, our expectation was that using the mode instead of the 80th percentile should relate to a comparatively higher magnitude of overeducation. The same should apply for the ISCO measure. This is confirmed by the descriptive overeducation frequencies graphed in Fig. A1 in Appendix. A share of 49% (36%) of workers is considered overeducated in the pooled sample when the mode (the ISCO measure) is used as the educational standard. Moreover, the distribution among countries shows quite a different picture. Using the mode, Italy, Ireland, and the Netherlands represent the countries with the highest overeducation rates, whereas the lowest rates are observed for

Figure 1 Percentage of overeducated workers on all highly educated workers in EU-LFS 2016, based on the 80th percentile as standard education



Source: EU-LFS (2016).

Table 1 Regression results for fields of study based on the 80th percentile as the standard education

Overeducation measure: 80th percentile	Cross-country sample			
	Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE
Sex	−0.004	*0.060*		
Field of study				
General programs	−0.041	*0.114*	0.094	*0.139*
Education	−0.055*	*0.033*	−0.013	*0.037*
Arts and humanities	−0.045	*0.032*	0.066*	*0.037*
Business and law	−0.017	*0.024*	0.037	*0.029*
Natural sciences	0.097***	*0.032*	−0.073*	*0.041*
ICT	−0.097***	*0.029*	0.008	*0.053*
Engineering	−0.052**	*0.024*	0.039	*0.032*
Agriculture	0.019	*0.042*	−0.001	*0.054*
Health and welfare	−0.102***	*0.034*	0.026	*0.038*
Services	0.069**	*0.031*	−0.087**	*0.040*
Observations	34,627			

Notes: Reference category: Social Sciences and Journalism and Information.
*Statistical significance at 10%; **statistical significance at 5%; ***statistical significance at 1%.

Luxembourg and Denmark. For Germany and Spain, the respective rates are 50% and 40%. Hence, similar to the above-named study which also relies on the modal value (Boll et al., 2016), German graduates exhibit higher rates than their Spanish counterparts. When deploying the ISCO measure as the educational standard, Italy, Greece, and Cyprus represent the top three countries, whereas Denmark and Luxembourg mark the lower bound of the scale. In the ISCO scenario, overeducation magnitude peaks among the three measures of standard education in eight countries (Portugal, Poland, Greece, Finland, Spain, Estonia, Cyprus, and Bulgaria), whereas in the majority of countries, the modal value is associated with the highest levels of overeducation.

5.2 Regression results

5.2.1 Impact of educational field

Table 1 presents estimation results for educational fields obtained in the overeducation regression at the cross-country level. Sign and significance of the single coefficients need to be interpreted relative to the reference category "male graduates from Social Sciences, Journalism and Information," respectively.[9] Table A1 in Appendix reports the country-specific results.

9 We abstain from reporting results for the category of General Programmes as this applies only to a very small share of graduates in the tertiary segment.

For a correct interpretation, it is important to be aware that the 80th percentile measure represents a more restrictive criterion under most circumstances. Hence, persons classified as overeducated by this criterion can be considered severely overqualified. In what follows, we discuss the results of the cross-country estimation together with country-specific results.

5.2.1.1 *Base term effects*

We start with the base term which represents the field impact for male graduates. Compared to the reference category, graduates from Education, ICT, Engineering, and Health and welfare exhibit a significantly lower risk of overeducation, whereas graduating in Natural sciences and Services is associated with a higher risk in the cross-country comparison. Arts and humanities, Business and law as well as Agriculture are not significantly different from Social sciences in terms of overeducation risk in the cross-country perspective. The results based on the country-pooled sample are to a notable extent confirmed at the country-level, which means that there is hardly any counterevidence. For Health and welfare, by contrast, only one significantly positive estimate can be observed at country level, but five negative ones. Similarly, negative estimates dominate for engineering (significantly positive: two, significantly negative: six). For ICT and Business and law, no significantly positive results can be found at all. As in the cross-country estimation, Natural Sciences (six positives, no negative) and Services (three positives, one negative) tend to be related to a higher risk compared to social sciences also on the country level. The only exception refers to Education, where country results do not give a clear impression (estimates are significantly negative in six, but at the same time significantly positive in five countries, with the rest remaining insignificant). Arts and humanities that do not significantly deviate from the reference category in the country-pooled estimation, turn out to be associated with a lower risk in quite a few countries (six), and in only one with a higher risk. The opposite holds for agriculture, which exhibits a comparatively higher risk in most countries (three positives, one negative).[10] Concerning statistical significance, the roles of ICT, Engineering, and Natural sciences mark the most clear-cut results.

The obtained relationships between field of study and vertical educational mismatch broadly fit our expectations: The identified low-risk fields are for the most part associated with comparatively specific job profiles (with physicians in Health and welfare being the most rigorous example). In this regard, arts and humanities seem to represent an exemption. However, beside traditionally less job-specific programs like history and philosophy, this ISCED-F category also includes more labor-market oriented subjects like handicrafts and design studies, possibly explaining the surprisingly low overeducation risk of the main group. By contrast, programs in the benchmark field of Social sciences are traditionally much less job-specific, forcing their graduates to compete with a range of applicants with other educational backgrounds when entering the labor market. Hence, it is no surprise to see a comparatively large share of them to be drawn into mismatches. The particularly high risk detected for graduates from Services is also as expected, given that it includes areas like Catering, Travel and Personal services in which competition by nonacademic applicants is tough. More surprising is the positive coefficient on Natural sciences. It might be in so far explicable as this field not only

10 We also checked whether the picture of dominating field effects across countries is driven by weakly significant single effects. It turned out that the reported direction of the field effect that dominates the country-specific results applies also when all of the coefficients, including the ones which lack significance, are taken into account.

contains disciplines with the reputation of setting high demands regarding analytical skills like mathematics and physics, but also several forms of environmental studies, whose marketability tends to be more limited. All in all, the achieved marginal effects of fields of study match the hypothesized directions.

Unsurprisingly, the comparability of our results with the literature is limited, due to notable differences regarding methodology and data. The differences refer to the selected benchmark education, the choice of the field reference category, or sample features such as age restrictions. However, we notice some parallels and discrepancies to other studies based on EU-LFS. This foremost concerns Ortiz and Kucel (2008) as well as Ghignoni and Verashchagina (2014), the only other studies we are aware of that investigate the impact of study choice on overeducation with the help of EU-LFS. The analysis of Ortiz and Kucel (2008) is based on an older version of ISCED-F with slightly different categorization. This is already visible in a distinctly composed reference category: Social sciences, Business, and law. In their analysis, tertiary graduates from the reference category represent the group with the lowest overeducation risk. In our country estimations, the field Business and law is nowhere associated with a higher overeducation risk compared to Social sciences, and in the country-pooled estimation, it was statistically insignificant. Thus, it can be expected that combining Social sciences, Business and law to the reference category decreases the overeducation risk of the reference which might explain the comparatively higher risks of all other fields, for example, Humanities and arts and even Engineering and Health and welfare.

The more recent study of Ghignoni and Verashchagina (2014) also comes to results comparable to Ortiz and Kucel (2008) for Germany and Spain, especially concerning the detected high risk for graduates from Engineering, compared to Services. This is contradictory to our results for Germany for our main educational standard measure (identical with the one in Ortiz and Kucel, 2008) as well for the modal value of education (which is the measure used by Ghignoni and Verashchagina, 2014), whereas for Spain these two fields do not produce any significant marginal effects under the named two measures for the educational standards. Note however that Ghignoni and Verashchagina (2014) use older data (LFS, 2003). Moreover, the list of covariates differs from ours and the age range of the graduate sample remains unclear. Tarvid (2012) also makes comparisons among European countries, but based on another dataset, the European Social Survey (ESS). His results are quite similar to ours. He finds a particularly high risk for graduates from Services, and low risks for graduates from Education and health. Green and McIntosh (2007) with their analysis for the UK base their overeducation measure on workers' self-assessment which hampers comparability of results with not only our study but also the aforementioned ones. Furthermore, they make a more detailed distinction of fields. However, some parallels to our results are noteworthy, especially concerning the low risks measured for workers with degrees in Physical sciences, in Computing and in Arts. The results of Berlingieri and Zierahn (2014) and Capsada-Munsech (2015) are of limited comparability to our analysis, because they differ too much in the way they delimit and aggregate fields. Nevertheless, some degree of consistency with our results can be observed by the facts that Berlingieri and Zierahn (2014) predict a lower overeducation risk for engineers than for graduates from Business and Social sciences. As our result for business is less clear-cut than the result for engineering, their results are in line with ours. Similarly, the findings of Capsada-Munsech (2015) are in accordance with our results in the sense that they also show a low overeducation risk for engineers, albeit

compared to another reference category (humanities). To sum up, despite partially notable differences in methodology and data between our study and previous findings, we can detect some similarities referring to fields-of-study associations with overeducation risk.

5.2.1.2 *Gender-specific effects*

The marginal effects of the interaction terms of field-of-study with gender are to a large par insignificant. At the same time, the base term for sex is also insignificant. Together, this implies that no difference in the overeducation risk of male and female graduates within the corresponding fields can be statistically proven. The exceptions are Services, where female graduates are assessed to be at significantly lower risk than male graduates. The same is true for Natural Sciences (significant only at the 10% level though), whereas women are more at risk then men in Arts and Humanities (albeit significant also at the 10% level only). The highly negatively significant association of Services supports our expectations.

5.2.2 **Country Dummies**

The country dummies report country-specific risks that cannot be explained by the controlled individual characteristics of the national sample members (Table A2 in Appendix). Interestingly, Latvia (Ireland, Cyprus, Spain, Slovakia) exhibit a magnitude of overeducation in the descriptive analysis (see Fig. 1), which is clearly below (above) that of Germany (as a reference in the multivariate analysis) although the country dummies are insignificant. This means that the low (high) overall magnitude of Latvia (Ireland, Cyprus, Spain, Slovakia) compared to Germany is fully explained by individual characteristics or (dis-)advantageous individual portfolios are perfectly balanced with advantageous (disadvantageous) country-level effects. Poland exhibits a significantly negative country dummy although the magnitude of overeducation in Poland is quite similar to the German case, meaning that some macro-level factors in Poland outweigh the effects exerted by individual characteristics in the Polish subsample. By contrast, the significantly positive (negative) parameters of the country dummys of Austria, France, Hungary, Portugal, and the United Kingdom (Belgium, Bulgaria, Estonia, Lithuania, the Netherlands, and Romania) clearly indicate that beyond individual factors, some meta factors on the country level hold responsible for their comparatively higher (lower) magnitude of overeducation.

The country-specific effects may refer to country differences in Higher Education (HE) attainment rates, the skill structure of national labor markets but also to special features of educational systems, that is, regarding selectivity of entry, drop-out rates, and the reputation of different branches of HE (masters vs. bachelors in sequential systems and universities vs. vocational schools in binary systems). According to Barone and Ortiz (2011), comparatively low attainment rates in HE in the Czech Republic, Italy, Austria, and Germany should relate to relatively low overeducation rates in these countries. This holds true for the Czech Republic in our study, which exerts an insignificant country dummy (compared to Germany as a reference) and displays an only slightly higher overeducation rate than Germany in the descriptive analysis. Low tertiary attainment rates and a highly stratified HE system in the Czech Republic (OECD, 2006) should play out in terms of low overeducation rates of graduates. However, Czech graduates from Agriculture suffer a significantly higher risk than Social scientists which does not apply to Germany. However, the Czech Republic is in a more advantageous position related

to Germany in terms of overall overeducation magnitude than Spain. Spain turns out to be a country with high vertical mismatch that might be explained by mass enrollment in a sequential, HE system generating particularly high numbers of bachelors without exhibiting a suitable absorption capacity of the high-skilled on the labor market (Barone and Ortiz, 2011). Second, in the highly segmented Spanish labor market with a high share of temporary jobs, a suboptimal match is deemed the 'price' for a permanent job (Ortiz, 2010). By contrast, the Dutch labor market accommodates the high supply of graduates leaving the HE system. In line with this, the Netherlands is the only West European country whose country-level factors operate more strongly against overeducation than in the German case.

With Austria and Italy however, two countries exhibit clearly higher magnitudes of overeducation than Germany and their country-level effects seem to contribute to this result. This is astonishing since Austria's HE system is highly stratified (OECD, 2006). One reason might be that vocational schools which have a shorter tradition than in Italy still send out a negative productivity signal (compared to universities), despite posing high entry barriers. Secondly, single fields of study might drive the overall result in Austria and also in Italy. Compared to Austrian and Italian ones, German graduates from Education and Health and welfare are at significantly lower risk than graduates from Social sciences. This view is supported by Barone and Ortiz (2011) who state that Education and Health and welfare are among the employment areas that drive cross-country differences in overeducation.

Table A3 in Appendix presents the marginal effects of the remaining explanatory variables at cross-country level.[11] First, we notice the highly positive association of the inverse mills ratio, implying that a higher employment propensity is related to a higher overeducation risk at the European level. Individuals with are under high financial pressure might be more willing to accept jobs with suboptimal skill matches. This is also confirmed by the country results. The mills ratio shows a significantly positive association with overeducation risk in six countries, in no country it is detected to be significantly negative.

Among the individual characteristics, only nationality is estimated to be of statistical influence at the European level. Other factors being equal, foreigners are at higher risk than domestic citizens. However, although this result is mostly confirmed on the country level, there are some exceptions where nationality does not contribute to explaining overeducation (Czech Republic, France, Latvia. Lithuania, Portugal, and Slovakia), while in one country (Poland) the overeducation risk of foreigners is even slightly lower than for domestic citizens. Being female is not related to a higher overeducation risk per se (although on the country level, six countries show significant associations for gender, but in both directions).

With respect to the *job variables*, merely the size of the firm and the type of the work contract are determined to be of relevance at cross-country level. Workers in very small firms have the highest risk, but workers in large firms (50 and more employees) rank second. At country level, the picture is diverse, however. In line with Green and McIntosh (2007) and Ortiz (2010), we find that workers with temporary contracts face a higher risk than workers in permanent positions. In this regard, there is no contradictive evidence on the country level although sometimes significance is lacking. Working hours are associated with a lower overeducation risk in the cross-sectional estimation, which is widely confirmed on the country level with only

11 Results for these impact factors at country level are available upon request.

two countries showing significant opposite effects (Estonia and Poland). A quite robust result is the decreasing effect of tenure; in only four countries results allow for the possibility of an opposite effect, due to strongly positive estimates obtained for the squared term. Furthermore, many industry effects turn out to be highly significant in the aggregate estimation, with diverse patterns on the country level.

5.2.3 **Sensitivity analysis**

Tables A4 and A5 in the Appendix list the estimates for the fields of study obtained under the mode (ISCO) scenario for the cross-country sample and Tables A6 and A7 in the Appendix display the country-specific results for the mode (ISCO) measure. Tables A8 and A9 in the Appendix depict the results for the country dummys and Tables A10 and A11 in Appendix for the remaining individual characteristics in the mode (ISCO) scenario. In our following interpretation we focus on fields of study as our key variables of interest.

We begin with the *mode scenario*. In comparison of measures and in terms of the basic effect, the pattern of fields derived from the mode is almost identical to the one derived from the 80th percentile, both for the cross-section and the country-specific results. That is, our sensitivity analyses confirm the main results regarding the base term. Not a single field is changing sign due to the measure change. Directly compared based on significant results, the switch from the 80th percentile to the mode is accompanied with even more clear-cut results with respect to Education, Engineering, Services and Arts and humanities whereas results for Health and welfare are a bit less clear-cut.

Most of the country heterogeneity regarding overeducation however concerns the interaction term (*gender-specific effects*) although most of them are still insignificant at cross-country level. Exceptions refer to the interaction terms of General Programmes and Engineering with gender, which both turn significant under the mode scenario. Here, females participating in General programmes face a lower overeducation risk than men. Amongst all variables included in the regression, this is the only change of effect sign compared to the main regression.

Concerning the *country dummies*, more deviating results can be detected compared to the main analysis. The changes mostly refer to changes in the significance level. Only for Portugal (the Netherlands), the effect sign switches from positive (negative) to negative (positive). As the associations of fields of study are robust against the measure change, the deviations in country-fixed effects have to be attributed to deviating associations of individual characteristics and/or country-specific meta-factors with overeducation under the mode scenario.

With respect to the "ISCO measure" of the educational standard, most changes regarding fields of study refer to their significance level. The only field for which a change in the direction of the effect has to be acknowledged is General programmes, which turn positive. The same is true under the ISCO measure for the interaction term of General programmes with gender which was also the case under the mode scenario. Amongst all variables incorporated in the regression analysis, only the named two experienced a change of effect sign under the ISCO measure. Additionally, the effect size of ICT (Health and welfare) has increased (diminished). Changes are more substantial with respect to country dummys of which five turn from positive to negative (Austria, France, Hungary, Portugal, and United Kingdom) compared to Germany as a reference country. Whereas this is in line with a lower overall overeducation magnitude (see Fig. A1 in the Appendix) for Austria, Hungary, Portugal, and the United Kingdom, the

more advantageous country-specific effect of France is obviously offset by more disadvantageous associations of individual factors beyond field of study with this alternative educational standard.

Finally, we also undertook additional estimations including further explanatory factors at the regional level (NUTS 2), such as the regional unemployment rate and the employment-to-population ratio. However, due to the large share of missing values, models including this regional information did not yield reliable results for the population as a whole.

6 Conclusions

The purpose of this paper was to conduct a comprehensive econometric analysis of potential determinants of overeducation among graduates in 21 EU countries in a unified framework. A special focus was set on the role of field of study for graduates' vertical mismatch incidence. It turned out that both in the cross-country estimation and at country-level differences in overeducation risk between graduates from different fields are significant. Furthermore, gender discrepancies in the impact of certain fields are noticeable. At the European level, graduates from Services, Natural sciences, and Agriculture are found to exhibit the highest risk among men. At the same time, male graduates from fields like ICT, Health and welfare, Education, Engineering but interestingly also Arts and humanities, are exposed to a rather low risk. The field-specific risks apply for the majority of countries and are robust against measure changes regarding the educational standard. We suggest that the degree of job-specifity of study programs significantly shapes the cross-field differentials in overeducation risks.

Gender differences in field-specific overeducation risks mostly lack statistical significance, with Services and Natural sciences, where female graduates are assessed to be at significantly lower risk than male graduates and Arts and humanities, where the opposite is true marking the exceptions. The highly negatively significant association of Services supports our expectations. We suggest that gender differences in preferences, field-specific productivity signals, and demand/supply ratios on the labor market might answer for the comparatively lower overeducation risk of women in the field of Services.

Moreover, country fixed effects point to relevant structural differences between national labor markets and educational systems. As we included, a selection correction in our estimation approach, country differences concerning employment selection should not be the source of this heterogeneity. Rather, differences in educational systems, in the capacities of labor markets to absorb young tertiary graduates as well as in culture- and tradition-based attitudes seem likely candidates. Although we made some references to the literature here, disentangling these different national-aspects and utilizing them for an analysis of country patterns represents a second interesting avenue for future research.

Further arguments add to the limitations of our study. Despite the wide range of individual covariates, we are aware of missing factors that proved to be relevant for overeducation propensity like paternal background (Jackson et al., 2008) or students' academic ability before enrolling in higher education (Barone and Ortiz, 2011). With the underlying econometric approach, causal interferences must not be drawn.

7 Methods

We make use of the 2016 wave of the European Labour Force Survey, a quarterly household sample survey that covers approximately 1.8 million individuals aged 15 years or older. This data set provides rich information on the respondent's demographic background, labor status, employment characteristics, and educational attainment. It allows us to assess and compare the impact of a large variety of potential determinants of overeducation, both separately for single countries and in a cross-country estimation (21 EU countries). Our particular interest lies in the role of fields of study for vertical educational mismatch. Therefore, we restrict our sample to highly educated individuals, as the issue of overeducation is by definition most relevant for members of this group. Highly educated individuals are defined as persons who have completed tertiary education. This corresponds to educational levels 6, 7, and 8 of the ISCED 2011 classification included in the dataset. Furthermore, the sample is restricted to respondents aged 20–34 years. We refer to overeducation as a vertical inadequacy and adopt the realized matches approach Kiker et al. (1997). We code a person as being overeducated if his or her highest educational attainment level is higher than the 80th percentile of the distribution of observed levels of education in the given occupation. As sensitivity checks, we additionally report results calculated based on the mode as the educational standard as well as based on an "ISCO measure."

In order to analyze the impact factors on overeducation risk, we estimate Probit models via maximum–likelihood method. Furthermore, in order to control for self-selection into employment, we apply the two-step Heckman approach (Heckman¸ 1979). As a first step, based on a sample of workers and nonworkers, a Probit model is specified estimating the likelihood of being in employment at the time of observation as a function of several individual and household context variables. As a second step, based on a sample restricted to workers, the Probit model for overeducation can be estimated, including the inverse mills ratio computed from the results of the first step as an additional control variable, correcting for the impact of employment selection in the overeducation equation.

Abbreviations

AT, Austria; BE, Belgium; BG, Bulgaria; CY, Cyprus; CZ, Czech Republic; DE, Germany; EE, Estonia; ES, Spain; ESS, European Social Survey; EU, European Union; EU-LFS, European Labour Force Survey; FR, France; GR, Greece; HE, Higher Education; HU, Hungary; ICT, Information and Communication Technologies ; IE, Ireland; ISCED, International Standard Classification of Education; IT, Italy; LT, Lithunia; LV, Latvia; NACE, "*nomenclature statistique des activités économiques dans la Communauté européenne*" (Statistical classification of economic activities); NL, Netherlands; NUTS, "*Nomenclature des unités territoriales statistiques*" (Nomenclature of Territorial Units for Statistics); OECD, Organisation for Economic Co-operation and Development; PL, Poland; PT, Portugal; RO, Romania; SK, Slovakia; SOEP, German Socio-Economic Panel; UK, United Kingdom.

Declarations

Availability of data and materials

The data that supports the findings of this study is available from Eurostat but restrictions apply to the availability of this data, which was used under license for the current study, and so is not publicly available. Any request for access to microdata must be submitted directly to Eurostat.

Competing interests

The authors declare that they have no competing interests.

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Authors' contribution
AR generated and analyzed the data set at hand. AW and CB motivated the paper, interpreted the results and wrote the manuscript. All authors approved the final manuscript.

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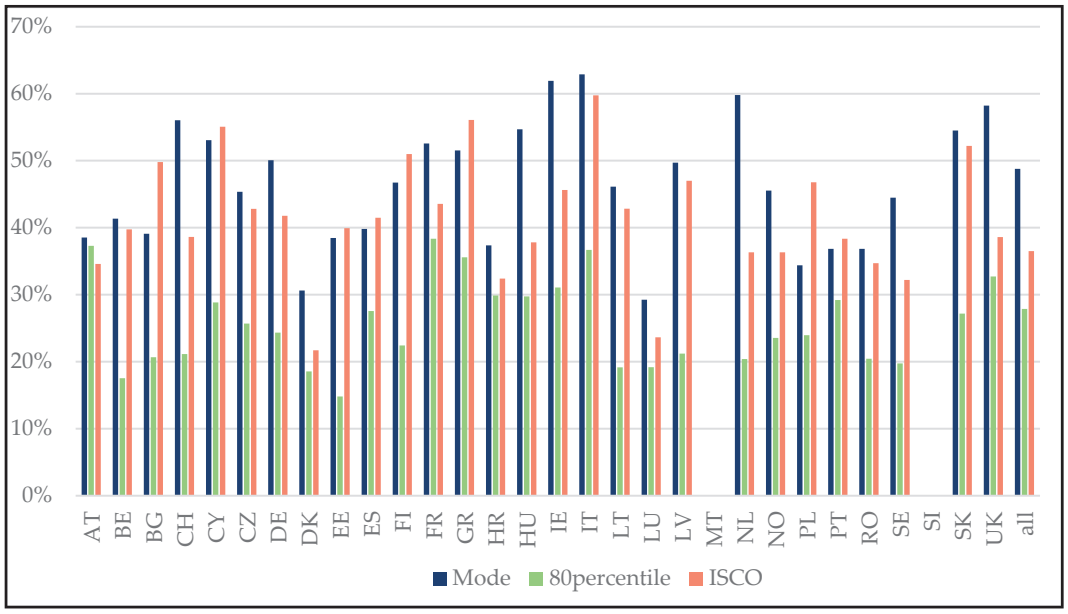
Appendix

A.1 **Descriptive analysis**

Figure A1 Distribution of overeducation rates under different measures of standard education



Source: EU-LFS (2016).

A.2 **Main multivariate analyses**

Table A1 Country-specific regression results—average marginal effects of the field-of-study dummy variables based on the 80th percentile as the standard education

	Austria				Belgium				Bulgaria			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.042	*0.200*			0.083	*0.082*			0.124	*0.264*		
Field of study												
General programmes												
Education	−0.201*	*0.105*	0.193*	*0.114*	0.094*	*0.055*	−0.114*	*0.061*	1.152***	*0.245*	−1.025***	*0.259*
Arts and humanities	−0.142	*0.103*	0.267**	*0.119*	0.076	*0.048*	0.004	*0.058*				
Business	−0.032	*0.080*	0.088	*0.094*	−0.065	*0.040*	0.027	*0.049*	0.853***	*0.159*	−0.629***	*0.174*
Natural sciences	0.030	*0.101*	0.083	*0.129*	0.185***	*0.053*	−0.167**	*0.074*	0.766***	*0.185*	−0.328	*0.270*
ICT	−0.337***	*0.092*	0.470***	*0.154*	−0.153***	*0.056*	0.037	*0.116*	0.046	*0.193*	0.238	*0.272*
Engineering	−0.181**	*0.078*	0.180*	*0.101*	0.080**	*0.037*	0.003	*0.059*	0.943***	*0.147*	−0.652***	*0.215*
Agriculture	0.251*	*0.135*	−0.195	*0.172*	0.092	*0.072*	−0.080	*0.114*				
Health and welfare	−0.181*	*0.101*	0.075	*0.111*	0.076	*0.054*	−0.165***	*0.060*	−0.015	*0.144*		
Services	−0.064	*0.148*	0.004	*0.186*	0.040	*0.069*	−0.031	*0.086*				
Observations	1,536				2,650				124			

(*Continued*)

Table A1 Continued

	Cyprus				Czech Republic				Estonia			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.934				−0.743***	*0.184*			0.500**	*0.219*		
Field of study												
General programmes												
Education	−3.692		3.838		0.074	*0.144*	-0.273*	*0.158*	−0.686***	*0.141*	0.947***	*0.181*
Arts and humanities	0.197		−0.141		0.122	*0.160*	−0.218	*0.184*	0.015	*0.163*	0.301	*0.227*
Business	−0.103		0.136		0.028	*0.130*	−0.170	*0.149*	−0.111	*0.097*	0.306*	*0.174*
Natural sciences	0.707		−0.689		0.466***	*0.156*	−0.515***	*0.184*	0.218	*0.155*	0.058	*0.229*
ICT					0.037	*0.120*						
Engineering	−0.050		0.090		0.107	*0.105*	−0.043	*0.137*	0.096	*0.089*	0.243	*0.175*
Agriculture					0.386***	*0.148*	−0.293	*0.195*	0.222	*0.167*		
Health and welfare	−0.064		−1.293		−1.022***	*0.133*	0.866***	*0.152*	0.151	*0.144*	0.178	*0.201*
Services	−0.144				0.391***	*0.119*	−0.197	*0.185*	−0.014	*0.116*	0.057	*0.193*
Observations	562				449				378			

(*Continued*)

Table A1 Continued

	France				Germany				Greece			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.139	*0.158*			0.016	*0.068*			−1.513***	*0.119*		
Field of study												
General programmes					−0.080	*0.153*	0.188	*0.188*				
Education	−0.086	*0.216*	−0.035	*0.231*	−0.137***	*0.048*	−0.010	*0.056*	−0.202*	*0.120*	0.269**	*0.125*
Arts and humanities	−0.088	*0.178*	0.139	*0.188*	−0.029	*0.051*	0.032	*0.060*	0.038	*0.088*	0.032	*0.104*
Business	−0.035	*0.110*	0.118	*0.121*	−0.011	*0.041*	0.007	*0.047*	0.098	*0.072*	−0.173*	*0.089*
Natural sciences	0.336***	*0.128*	−0.222	*0.155*	0.094**	*0.046*	−0.105*	*0.059*	−0.110	*0.119*	0.085	*0.147*
ICT	−0.002	*0.122*	−0.253	*0.245*	−0.147***	*0.045*	0.023	*0.073*	0.144*	*0.074*	−0.168	*0.103*
Engineering	−0.017	*0.110*	−0.062	*0.129*	−0.086**	*0.040*	−0.009	*0.053*	−0.141**	*0.066*	0.238***	*0.086*
Agriculture	0.176	*0.214*	−0.168	*0.250*	0.022	*0.069*	−0.169*	*0.090*	−0.133	*0.127*	0.226	*0.149*
Health and welfare	−0.044	*0.137*	0.191	*0.148*	−0.181***	*0.055*	0.013	*0.061*	0.057	*0.091*	0.032	*0.103*
Services	0.057	*0.128*	−0.091	*0.160*	0.110**	*0.051*	−0.082	*0.065*	−0.315***	*0.085*	0.232**	*0.102*
Observations	1,088				7,379				1,443			

(*Continued*)

Table A1 Continued

	Hungary				Ireland				Italy			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	1.095***	*0.142*			0.335	*0.216*			0.066	*0.069*		
Field of study												
General programmes					0.193	*0.167*						
Education	0.201**	*0.087*	−0.134	*0.093*	0.030	*0.155*	−0.429**	*0.170*	−0.088	*0.164*	−0.111	*0.171*
Arts and humanities	−0.018	*0.080*	0.050	*0.106*	−1.120***	*0.156*	0.832***	*0.179*	−0.051	*0.093*	0.109	*0.103*
Business	0.104	*0.069*	0.016	*0.083*	0.024	*0.134*	−0.226	*0.154*	0.028	*0.077*	−0.018	*0.091*
Natural sciences	0.168*	*0.095*	−0.352**	*0.137*	0.184	*0.143*	−0.389**	*0.166*	0.121	*0.094*	−0.162	*0.118*
ICT	−0.152**	*0.074*	0.134	*0.160*	−0.098	*0.139*	−0.265	*0.177*	−0.415***	*0.094*	0.504***	*0.161*
Engineering	−0.059	*0.063*	−0.037	*0.098*	0.136	*0.133*	−0.297*	*0.172*	−0.012	*0.070*	−0.054	*0.096*
Agriculture	0.030	*0.091*	0.304**	*0.120*					−0.022	*0.136*	0.807***	*0.170*
Health and welfare	−1.582***	*0.149*	1.602***	*0.150*	0.093	*0.152*	−0.399**	*0.169*	0.083	*0.094*	−0.251**	*0.102*
Services	0.210**	*0.101*	−0.168	*0.122*	−0.169	*0.180*	−0.098	*0.222*	0.061	*0.125*	−0.010	*0.145*
Observations	1,458				939				1,943			

(*Continued*)

Table A1 Continued

	Latvia				Lithuania				Netherlands			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	0.380	*0.252*			−0.219	*0.194*			0.014	*0.131*		
Field of study												
General programmes									0.076	*0.159*		
Education	1.207***	*0.130*	−1.109***	*0.140*	0.468***	*0.156*	−0.470***	*0.170*	0.103	*0.081*	−0.027	*0.091*
Arts and humanities	0.163	*0.103*	−0.158	*0.118*	−0.879***	*0.122*	0.932***	*0.136*	−0.165*	*0.088*	0.331***	*0.101*
Business	1.019***	*0.099*	−0.930***	*0.104*	−0.009	*0.086*	0.064	*0.099*	−0.110*	*0.060*	0.159**	*0.074*
Natural sciences					0.006	*0.110*	0.127	*0.135*	0.013	*0.082*	0.150	*0.105*
ICT					0.025	*0.101*						
Engineering	0.806***	*0.117*	−0.540***	*0.137*	0.090	*0.084*	0.046	*0.104*	−0.136*	*0.070*	0.126	*0.121*
Agriculture	−0.104	*0.102*	0.143	*0.195*					−0.045	*0.130*	0.014	*0.166*
Health and welfare	0.082	*0.090*	−0.138	*0.130*	−0.752***	*0.109*	0.815***	*0.128*	−0.118	*0.089*	0.098	*0.099*
Services	0.992***	*0.135*	−1.070***	*0.188*	0.013	*0.100*	0.112	*0.127*	0.011	*0.070*	0.010	*0.091*
Observations	440				914				1,422			

(*Continued*)

Table A1 Continued

	Poland				Portugal				Romania			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.021	*0.085*			0.634***	*0.139*			0.208	*0.151*		
Field of study												
General programmes												
Education	−0.006	*0.036*	0.076*	*0.043*	−0.211*	*0.108*	0.426***	*0.118*	−0.331***	*0.073*	0.644***	*0.091*
Arts and humanities	−0.048	*0.046*	0.072	*0.056*	−0.233***	*0.079*	0.226**	*0.105*	0.002	*0.105*	0.068	*0.111*
Business	−0.043	*0.029*	0.085**	*0.036*	−0.139*	*0.076*	0.181*	*0.096*	0.132***	*0.045*	−0.098*	*0.056*
Natural sciences	0.044	*0.043*	0.116**	*0.052*	−0.237	*0.163*	0.270	*0.188*	0.135	*0.095*	−0.026	*0.115*
ICT	−0.154***	*0.036*	0.005	*0.070*					0.053	*0.068*	0.041	*0.112*
Engineering	−0.076**	*0.030*	0.191***	*0.042*	−0.251***	*0.074*	0.222**	*0.101*	−0.024	*0.049*	−0.039	*0.066*
Agriculture	0.033	*0.082*	0.078	*0.095*	0.222	*0.137*	−0.273*	*0.161*	0.067	*0.088*	0.001	*0.183*
Health and welfare	0.020	*0.048*	−0.033	*0.057*	−0.230**	*0.090*	0.191*	*0.101*	0.225**	*0.104*	−0.216*	*0.118*
Services	0.034	*0.040*	0.067	*0.050*	0.059	*0.085*	−0.089	*0.115*	0.054	*0.064*	0.007	*0.098*
Observations	5,749				1,063				1,626			

(*Continued*)

Table A1 Continued

	Slovak Republic				Spain				United Kingdom			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.256***	*0.085*			−0.106	*0.115*			0.062	*0.138*		
Field of study												
General programmes												
Education	−0.891***	*0.110*	0.909***	*0.131*	−0.247**	*0.117*	−0.148	*0.156*	−0.191	*0.138*	0.091	*0.152*
Arts and humanities	−0.957***	*0.124*	1.172***	*0.137*	0.288	*0.215*	−0.341	*0.236*	−0.051	*0.076*	−0.029	*0.091*
Business	−0.094	*0.071*	0.357***	*0.109*	−0.143	*0.100*	0.141	*0.126*	−0.000	*0.075*	−0.038	*0.091*
Natural sciences	0.205*	*0.113*	0.062	*0.141*	−0.115	*0.135*	0.161	*0.180*	0.018	*0.079*	−0.111	*0.099*
ICT	−0.144	*0.100*			−0.278**	*0.121*	0.035	*0.190*	0.003	*0.085*	−0.186	*0.136*
Engineering	0.066	*0.078*	0.266**	*0.114*	−0.160	*0.121*	−0.080	*0.175*	0.069	*0.079*	−0.054	*0.115*
Agriculture	0.237**	*0.108*	0.124	*0.161*	−0.209	*0.187*	0.001	*0.262*	−1.231***	*0.100*	1.180***	*0.138*
Health and welfare	0.065	*0.119*	0.093	*0.120*	−0.221	*0.150*	0.125	*0.162*	−0.149	*0.126*	−0.097	*0.136*
Services	0.026	*0.082*			−0.029	*0.129*	−0.188	*0.177*	0.075	*0.105*	−0.147	*0.138*
Observations	565				417				1,462			

Notes: Reference category: social Sciences, journalism and information.

*Statistical significance at 10%; **Statistical significance at 5%; ***Statistical significance at 1%.

Table A2 Regression results—Average marginal country effects in the cross-country sample based on the 80th percentile as the standard education

Overeducation measure: 80th percentile	Cross-country sample	
Country dummy	ME	SE
Austria	0.067***	0.012
Belgium	−0.074***	0.011
Bulgaria	−0.101***	0.032
Cyprus	−0.001	0.017
Czech Republic	0.029	0.021
Estonia	−0.101***	0.026
France	0.096***	0.015
Greece	0.071***	0.014
Hungary	0.059***	0.013
Ireland	−0.004	0.016
Italy	0.121***	0.012
Latvia	−0.019	0.023
Lithuania	−0.097***	0.017
Netherlands	−0.093***	0.015
Poland	−0.066***	0.009
Portugal	0.048***	0.015
Romania	−0.071***	0.014
Slovak Republic	−0.030	0.020
Spain	−0.002	0.023
United Kingdom	0.059***	0.013
Observations	34,627	

Notes: Reference category: Germany. *Statistical significance at 10%; **statistical significance at 5%; ***statistical significance at 1%.

Table A3 Regression results—Average marginal effects of non-field-of-study-related variables in the cross-country sample based on the 80th percentile as the standard education

Overeducation measure: 80th percentile	Cross-country sample			
	Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE
Inverse mills ratio	0.053***	0.018		
Individual variables				
Sex	−0.004	*0.060*		
Age group (reference: 20–24 years)				
25–29 years	−0.053	*0.051*	0.018	*0.057*
30–34 years	−0.017	*0.050*	−0.033	*0.056*
Foreigner	0.152***	*0.014*		
Job variables				
Firm size (ref: < 10)				
11–19 persons	−0.055***	*0.015*		
20–49 persons	−0.056***	*0.013*		
50 and more persons	−0.036***	*0.012*		
Temporary contract	0.059***	*0.011*		
Working hours (in 10 hours)	−0.046***	*0.005*		
Tenure (in 10 years)	−0.108***	*0.033*		
Tenure squared (in 10 years)	0.047*	*0.025*		
Observations	*34,627*			

Notes: *Statistical significance at 10%; **Statistical significance at 5%; ***statistical significance at 1%. Dummies for nationality and industry (sections NACE Rev.2) included.

A.3 **Multivariate analyses—robustness check for the standard education**

Table A4 Regression results—average marginal effects of fields of study based on the mode as the standard education

Overeducation measure: Mode	Cross-country sample			
	Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE
Sex	−0.021	*0.060*		
Field of study				
General programmes	0.159	*0.138*	−0.288*	*0.172*
Education	−0.075**	*0.034*	−0.054	*0.038*
Arts and humanities	−0.069*	*0.036*	0.071*	*0.043*
Business and law	0.008	*0.026*	0.015	*0.031*
Natural sciences	0.102***	*0.036*	−0.045	*0.045*
ICT	−0.097***	*0.030*	−0.003	*0.058*
Engineering	−0.086***	*0.026*	0.081**	*0.039*
Agriculture	−0.034	*0.054*	0.026	*0.068*
Health and welfare	−0.083**	*0.037*	−0.025	*0.041*
Services	0.110***	*0.034*	−0.053	*0.046*
Observations	34,624			

Notes: Reference category: social sciences and journalism and information. *Statistical significance at 10%; **statistical significance at 5%; ***statistical significance at 1%.

Table A5 Regression results—Average marginal effects of fields of study based on the ISCO-criterion

Overeducation measure: ISCO	Cross-country sample			
	Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE
Sex	0.065	*0.061*		
Field of study				
General programmes	0.257**	*0.121*	−0.277*	*0.148*
Education	−0.032	*0.029*	0.017	*0.033*
Arts and humanities	−0.003	*0.035*	0.020	*0.041*
Business and law	0.002	*0.023*	0.037	*0.029*
Natural sciences	−0.034	*0.038*	−0.032	*0.046*
ICT	−0.127***	*0.029*	−0.023	*0.055*
Engineering	−0.043*	*0.023*	−0.053	*0.032*
Agriculture	−0.008	*0.044*	−0.021	*0.061*
Health and welfare	−0.066*	*0.036*	−0.037	*0.040*
Services	0.170***	*0.032*	−0.095**	*0.044*
Observations	34,624			

Notes: Reference category: social sciences and journalism and information. *Statistical significance at 10%; **statistical significance at 5%; ***statistical significance at 1%.

Table A6 Country-specific regression results—Average marginal effects of the field-of-study dummy variables based on the mode as the standard education

	Austria				Belgium				Bulgaria			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.038	0.202			−0.045	0.108			−0.065	0.351		
Field of study												
General programmes												
Education	−0.224**	0.105	0.219*	0.114	0.024	0.071	−0.162**	0.079	0.787**	0.333	−0.365	0.354
Arts and humanities	−0.167	0.105	0.280**	0.121	0.123*	0.066	0.016	0.082	0.285	0.335	0.129	0.400
Business	0.020	0.079	0.035	0.093	−0.018	0.053	0.031	0.065	0.110	0.192	0.180	0.230
Natural sciences	0.019	0.100	0.095	0.129	0.230***	0.077	−0.107	0.102	0.271	0.292	−0.026	0.336
ICT	−0.363***	0.091	0.511***	0.154	0.050	0.063	−0.223*	0.134	0.063	0.237	0.445	0.274
Engineering	−0.188**	0.078	0.203**	0.101	0.140***	0.053	0.021	0.085	0.105	0.193	0.519**	0.243
Agriculture	0.253*	0.134	−0.191	0.171	0.173*	0.105	0.152	0.176				
Health and welfare	−0.203**	0.101	0.094	0.111	0.068	0.075	−0.122	0.083	0.269	0.176		
Services	−0.083	0.146	0.010	0.185	0.139	0.088	0.070	0.117	−0.585**	0.282	1.046***	0.363
Observations	1,536				2,650				199			

(*Continued*)

Table A6 Continued

	Cyprus				Czech Republic				Estonia			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−1.307***	0.243			0.258	0.260			−0.648***	0.213		
Field of study												
General programmes												
Education	−0.933***	0.216	0.870***	0.235	0.025	0.161	−0.246	0.184	−0.932***	0.146	0.936***	0.161
Arts and humanities	−0.289*	0.172	0.320*	0.189	−1.444***	0.180	1.395***	0.223	−0.233	0.168	0.129	0.209
Business	−0.420***	0.111	0.382***	0.135	0.021	0.141	−0.042	0.171	−0.241**	0.099	0.177	0.149
Natural sciences	−0.070	0.210	0.089	0.229	0.630***	0.189	−0.731***	0.225	−0.032	0.189	0.031	0.243
ICT					−0.050	0.145	−0.215	0.311	−0.671***	0.119		
Engineering	−0.511***	0.129	0.195	0.211	−0.004	0.121	−0.074	0.166	−0.146	0.091	0.386**	0.151
Agriculture					0.262	0.177	−0.367	0.239	−0.062	0.188		
Health and welfare	−0.347**	0.141	0.183	0.160	0.342**	0.153	−0.421**	0.167	−0.182	0.141	0.412**	0.163
Services	−0.291*	0.163			0.526***	0.165			−0.011	0.111	0.422***	0.156
Observations	642				446				405			

(*Continued*)

Table A6 Continued

	France				Germany				Greece			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.014	0.181			0.010	0.079			−1.317***	0.143		
Field of study												
General programmes					−0.083	0.161	0.021	0.205				
Education	0.412**	0.199	−0.238	0.214	−0.254***	0.052	0.084	0.061	−0.379***	0.144	0.268*	0.149
Arts and humanities	0.305*	0.174	−0.260	0.189	−0.174***	0.057	0.180***	0.067	−0.177	0.128	0.079	0.141
Business	0.142	0.115	−0.039	0.128	0.006	0.046	0.105*	0.054	0.161	0.103	−0.420***	0.115
Natural sciences	0.467***	0.134	−0.428***	0.160	0.128**	0.053	−0.014	0.066	−0.282*	0.158	0.170	0.179
ICT	0.102	0.124	−0.346	0.231	−0.082*	0.049	0.110	0.076	0.138	0.108	−0.303**	0.131
Engineering	0.057	0.117	−0.110	0.144	−0.158***	0.045	0.183***	0.058	−0.298***	0.088	0.162	0.111
Agriculture	0.469*	0.254	−0.491*	0.289	−0.055	0.085	−0.007	0.106	−0.282*	0.162	0.281	0.186
Health and welfare	−0.019	0.147	0.016	0.159	−0.194***	0.055	0.024	0.063	−0.186	0.119	−0.012	0.129
Services	0.249*	0.138	−0.262	0.169	0.145**	0.061	0.016	0.078	−0.325***	0.090	0.013	0.109
Observations	1,088				7,379				1,443			

(*Continued*)

Table A6 Continued

	Hungary				Ireland				Italy			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.108	0.218			0.599**	0.242			0.009	0.081		
Field of study												
General programmes					0.437**	0.221						
Education	0.092	0.103	−0.184*	0.111	0.095	0.179	−0.664***	0.210	−0.166	0.136	−0.019	0.144
Arts and humanities	−0.138	0.107	0.144	0.129	−0.142	0.206	−0.256	0.248	−0.183*	0.097	0.217**	0.109
Business	−0.069	0.098	0.184	0.112	0.090	0.161	−0.339*	0.201	−0.047	0.086	0.089	0.100
Natural sciences	0.092	0.140	−0.167	0.164	0.148	0.172	−0.415*	0.217	0.117	0.112	−0.159	0.133
ICT	−0.276***	0.092	−0.024	0.207	−0.019	0.165	−0.309	0.222	−0.054	0.123	0.178	0.163
Engineering	−0.105	0.080	−0.141	0.116	0.116	0.159	−0.520**	0.216	−0.158**	0.076	−0.059	0.101
Agriculture	−0.229*	0.126	0.621***	0.154					−0.155	0.137	0.707***	0.164
Health and welfare	−3.517***	0.148	3.487***	0.152	0.067	0.180	−0.488**	0.215	0.008	0.099	−0.016	0.107
Services	0.168	0.118	−0.259*	0.151	0.133	0.195	−0.435*	0.264	0.217	0.141	0.125	0.173
Observations	1,445				941				1,858			

(*Continued*)

Table A6 Continued

	Latvia				Lithuania				Netherlands			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		wBase term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−2.308***	0.293			−0.409	0.260			0.479**	0.198		
Field of study			0.231	0.249								
General programmes			1.791***	0.197					−0.488	0.309		
Education	−0.195	0.229	0.181	0.158	0.418*	0.230	−0.408*	0.246	0.253**	0.126	−0.361***	0.137
Arts and humanities	−1.744***	0.162			−0.316	0.199	0.241	0.214	0.007	0.130	0.094	0.155
Business	−0.087	0.138			−0.060	0.106	0.209*	0.123	0.073	0.099	−0.115	0.115
Natural sciences			0.083	0.200	−0.074	0.151	0.295	0.189	0.201	0.130	0.059	0.181
ICT			2.205***	0.350	0.020	0.131	−0.060	0.197				
Engineering	0.155	0.158	−0.179	0.289	0.074	0.101	0.160	0.138	−0.037	0.105	0.104	0.152
Agriculture	−2.016***	0.195	0.275	0.275					0.123	0.207	−0.306	0.263
Health and welfare	0.055	0.281			1.598***	0.123	−1.443***	0.140	0.206*	0.119	−0.201	0.130
Services	−0.321*	0.187	0.231	0.249	−0.257*	0.146	0.400**	0.185	0.110	0.121	−0.083	0.150
Observations	430				944				1,419			

(*Continued*)

Table A6 Continued

	Poland				Portugal				Romania			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	0.082	0.108			0.844***	0.153			−0.060	0.175		
Field of study												
General programmes												
Education	−0.011	0.043	0.064	0.051	−0.306**	0.155	0.483***	0.165	−0.604***	0.104	0.999***	0.120
Arts and humanities	−0.133**	0.056	0.111*	0.066	−0.173**	0.087	0.191*	0.112	−0.126	0.115	0.305**	0.128
Business	−0.027	0.034	0.021	0.042	−0.057	0.080	0.102	0.100	0.091	0.056	−0.017	0.068
Natural sciences	0.064	0.053	0.081	0.064	−0.217	0.184	0.231	0.213	0.077	0.137	0.095	0.153
ICT	−0.175***	0.041	−0.105	0.098					−0.112	0.090	0.212	0.140
Engineering	−0.086**	0.035	0.175***	0.048	−0.188**	0.081	0.091	0.107	−0.172***	0.063	0.091	0.082
Agriculture	0.044	0.097	−0.018	0.113	0.276*	0.161	−0.197	0.184	0.076	0.097	0.038	0.174
Health and welfare	0.015	0.055	−0.125**	0.061	−0.130	0.091	0.076	0.100	−0.031	0.139	−0.019	0.142
Services	0.103**	0.049	0.034	0.063	0.074	0.091	0.032	0.132	0.000	0.084	0.168	0.128
Observations	5,747				1,063				1,641			

(*Continued*)

Table A6 Continued

	Slovak Republic				Spain				United Kingdom			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.176**	0.090			−0.105	0.181			−0.088	0.134		
Field of study												
General programmes												
Education	−0.142	0.106	0.065	0.135	−0.083	0.176	−0.090	0.220	−0.149	0.107	−0.075	0.125
Arts and humanities	−1.129***	0.110	1.429***	0.141	0.342	0.263	−0.402	0.300	−0.105	0.078	−0.007	0.097
Business	−0.140*	0.078	0.425***	0.109	−0.077	0.161	0.079	0.194	0.002	0.075	−0.089	0.095
Natural sciences	0.336**	0.146	−0.086	0.177	−0.105	0.211	0.183	0.278	0.005	0.084	−0.016	0.108
ICT	−0.353***	0.128			−0.225	0.170	0.118	0.257	−0.129	0.088	−0.194	0.147
Engineering	0.287***	0.081	−0.027	0.143	−0.041	0.184	−0.180	0.245	0.096	0.085	0.022	0.132
Agriculture	0.237*	0.133	−0.080	0.219	−0.335	0.243	−0.071	0.370	−0.386*	0.211	0.340	0.249
Health and welfare	−0.028	0.154	0.215	0.155	−0.263	0.209	0.162	0.226	−0.163	0.109	−0.115	0.121
Services	0.139	0.101			0.191	0.191	−0.232	0.256	0.183*	0.105	−0.277*	0.143
Observations	541				417				1,448			

Notes: Reference category: social sciences and journalism and information. *statistical significance at 10%; **statistical significance at 5%; ***statistical significance at 1%.

Table A7 Country-specific regression results—average marginal effects of the field-of-study dummy variables based on the ISCO criterion

	Austria				Belgium				Bulgaria			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	0.031	*0.180*			0.102	*0.357*			0.102	*0.357*		
Field of study												
General programmes												
Education	−0.082	*0.103*	0.117	*0.112*	1.092***	*0.372*	−0.068	*0.075*	1.092***	*0.372*	−0.724*	*0.402*
Arts and humanities	−0.086	*0.104*	0.196	*0.119*	0.467	*0.400*	−0.012	*0.075*	0.467	*0.400*		
Business	0.044	*0.079*	−0.012	*0.093*	0.355	*0.218*	0.109*	*0.058*	0.355	*0.218*	0.031	*0.267*
Natural sciences	−0.081	*0.103*	0.056	*0.131*	0.341	*0.293*	−0.060	*0.099*	0.341	*0.293*	−0.142	*0.352*
ICT	−0.242***	*0.089*	0.218	*0.156*	0.132	*0.278*	−0.019	*0.144*	0.132	*0.278*	0.331	*0.324*
Engineering	−0.092	*0.077*	0.023	*0.098*	0.258	*0.223*	−0.060	*0.076*	0.258	*0.223*	0.420	*0.284*
Agriculture	0.323***	*0.120*	−0.243	*0.153*			−0.003	*0.136*				
Health and welfare	−0.071	*0.098*	−0.040	*0.108*	0.351	*0.336*	−0.247***	*0.080*	0.351	*0.336*	−0.134	*0.351*
Services	0.060	*0.141*	−0.126	*0.177*			0.102	*0.109*				
Observations	1,536				2,650				124			

(*Continued*)

Table A7 Continued

	Cyprus				Czech Republic				Estonia			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.808***	*0.191*			0.294	*0.253*			−0.253	*0.213*		
Field of study												
General programmes												
Education	−0.067	*0.112*	−0.026	*0.125*	0.182	*0.162*	−0.199	*0.195*	−0.627***	*0.151*	0.621***	*0.171*
Arts and humanities	−0.042	*0.123*	0.103	*0.141*	−1.291***	*0.171*	1.267***	*0.217*	−0.101	*0.188*	−0.085	*0.226*
Business	−0.190**	*0.083*	0.129	*0.107*	−0.021	*0.141*	0.019	*0.168*	−0.287***	*0.105*	0.163	*0.148*
Natural sciences	0.199	*0.125*	−0.360**	*0.151*	−0.067	*0.178*	−0.114	*0.214*	0.036	*0.149*	−0.113	*0.204*
ICT					−0.050	*0.134*	−0.143	*0.330*	−0.650***	*0.118*		
Engineering	−0.105	*0.099*	−0.182	*0.140*	0.021	*0.114*	−0.077	*0.157*	−0.174*	*0.097*	0.290**	*0.147*
Agriculture					0.292*	*0.164*	−0.393*	*0.223*	−0.019	*0.199*		
Health and welfare	−0.171	*0.106*	−0.063	*0.129*	0.405***	*0.144*	−0.437***	*0.158*	−0.240	*0.153*	0.540***	*0.167*
Services	−0.014	*0.145*			0.493***	*0.145*			−0.056	*0.122*	0.371**	*0.170*
Observations	562				449				378			

(*Continued*)

Table A7 Continued

	France				Germany				Greece			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	0.077	*0.163*			0.082	*0.085*			−1.075***	*0.142*		
Field of study												
General programmes					0.253	*0.164*	0.006	*0.213*				
Education	0.062	*0.199*	−0.180	*0.217*	−0.106**	*0.052*	0.230***	*0.060*	−0.152	*0.136*	−0.025	*0.139*
Arts and humanities	0.152	*0.160*	−0.158	*0.173*	0.028	*0.058*	0.077	*0.069*	−0.153	*0.111*	0.019	*0.123*
Business	0.053	*0.105*	−0.007	*0.117*	0.064	*0.045*	0.124**	*0.055*	−0.061	*0.099*	−0.138	*0.112*
Natural sciences	0.124	*0.129*	−0.377**	*0.169*	−0.048	*0.054*	0.020	*0.071*	−1.495***	*0.110*	1.303***	*0.137*
ICT	−0.021	*0.113*	−0.264	*0.220*	−0.147***	*0.051*	0.054	*0.086*	0.044	*0.097*	−0.011	*0.139*
Engineering	−0.040	*0.105*	−0.171	*0.123*	0.104**	*0.045*	−0.050	*0.060*	−0.036	*0.095*	−0.047	*0.118*
Agriculture	0.098	*0.167*	−0.157	*0.207*	0.016	*0.077*	−0.108	*0.105*	−0.210	*0.153*	−0.110	*0.177*
Health and welfare	−0.059	*0.133*	0.014	*0.145*	−0.147**	*0.059*	0.094	*0.067*	−0.331***	*0.105*	0.101	*0.116*
Services	0.224*	*0.128*	−0.295*	*0.154*	0.306***	*0.061*	−0.056	*0.082*	−0.082	*0.096*	−0.148	*0.112*
Observations	1,088				7,379				1,443			

(*Continued*)

Table A7 Continued

	Hungary				Ireland				Italy			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	1.330***	*0.148*			0.411*	*0.219*			0.038	*0.079*		
Field of study												
General programmes					0.348*	*0.184*	−0.930***	*0.262*				
Education	0.008	*0.087*	0.017	*0.094*	−0.095	*0.173*	-0.386**	*0.191*	−0.152	*0.137*	−0.029	*0.146*
Arts and humanities	−0.272***	*0.086*	0.342***	*0.107*	0.117	*0.195*	−0.404*	*0.222*	−0.166*	*0.097*	0.208*	*0.110*
Business	0.070	*0.076*	0.066	*0.090*	0.066	*0.151*	−0.268	*0.175*	−0.046	*0.083*	0.074	*0.099*
Natural sciences	−0.011	*0.100*	−0.133	*0.131*	0.029	*0.159*	−0.338*	*0.187*	−0.130	*0.091*	0.018	*0.117*
ICT	−0.352***	*0.084*	0.215	*0.181*	−0.043	*0.155*	−0.219	*0.189*	−0.025	*0.118*	0.176	*0.156*
Engineering	−0.089	*0.066*	−0.081	*0.097*	0.003	*0.149*	−0.358*	*0.195*	−0.190***	*0.073*	−0.020	*0.101*
Agriculture	−0.148	*0.102*	0.306**	*0.126*					−0.154	*0.140*	0.205	*0.193*
Health and welfare	−1.895***	*0.159*	1.919***	*0.160*	0.010	*0.171*	−0.485**	*0.190*	0.004	*0.095*	−0.036	*0.104*
Services	0.197*	*0.114*	−0.181	*0.139*	0.127	*0.171*	−0.098	*0.222*	0.288**	*0.144*	0.054	*0.182*
Observations	1,458				939				1,943			

(*Continued*)

Table A7 Continued

	Latvia				Lithuania				Netherlands			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−2.101***	*0.318*			−0.171	*0.235*			0.460**	*0.183*		
Field of study												
General programmes									−0.017	*0.208*		
Education	0.258	*0.233*	−0.286	*0.249*	0.511**	*0.216*	−0.449*	*0.234*	0.225*	*0.116*	−0.101	*0.129*
Arts and humanities	−1.278***	*0.176*	1.244***	*0.206*	−0.126	*0.201*	0.268	*0.213*	−0.072	*0.120*	0.229*	*0.138*
Business	−0.028	*0.122*	0.162	*0.140*	0.090	*0.102*	−0.028	*0.118*	0.048	*0.081*	0.114	*0.099*
Natural sciences					−0.058	*0.135*	0.016	*0.171*	−0.065	*0.114*	0.282*	*0.148*
ICT					−0.157	*0.132*	0.293	*0.198*				
Engineering	−0.051	*0.135*	0.251	*0.168*	0.095	*0.097*	−0.052	*0.128*	−0.017	*0.089*	0.118	*0.135*
Agriculture	−2.081***	*0.190*	1.966***	*0.285*					0.260	*0.191*	−0.337	*0.260*
Health and welfare	−1.611***	*0.140*	1.449***	*0.173*	−1.461***	*0.121*	1.522***	*0.148*	0.131	*0.104*	0.019	*0.117*
Services	0.066	*0.168*	−0.151	*0.256*	0.113	*0.123*	0.029	*0.170*	0.323***	*0.102*	−0.017	*0.130*
Observations	440				914				1,422			

(*Continued*)

Table A7 Continued

	Poland				Portugal				Romania			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	0.208*	*0.116*			0.789***	*0.157*			−0.021	*0.168*		
Field of study												
General programmes												
Education	0.162***	*0.046*	−0.196***	*0.054*	−0.198	*0.150*	0.370**	*0.157*	−0.847***	*0.110*	1.245***	*0.122*
Arts and humanities	−0.117*	*0.063*	−0.005	*0.073*	−0.133	*0.089*	0.243**	*0.116*	−0.061	*0.115*	0.202	*0.128*
Business	−0.047	*0.037*	0.000	*0.045*	−0.108	*0.084*	0.221**	*0.105*	0.123**	*0.056*	−0.054	*0.068*
Natural sciences	−0.024	*0.053*	−0.012	*0.064*	−0.217	*0.191*	0.227	*0.220*	0.136	*0.135*	0.039	*0.151*
ICT	−0.232***	*0.044*	−0.257***	*0.083*					−0.131	*0.094*	0.239*	*0.141*
Engineering	−0.195***	*0.037*	0.050	*0.052*	−0.188**	*0.084*	0.171	*0.112*	−0.122*	*0.064*	0.028	*0.082*
Agriculture	0.213*	*0.118*	−0.320**	*0.133*	0.310*	*0.166*	−0.168	*0.191*	0.085	*0.095*	−0.130	*0.151*
Health and welfare	−0.060	*0.063*	−0.262***	*0.069*	−0.134	*0.095*	0.154	*0.104*	0.006	*0.140*	−0.082	*0.143*
Services	0.126**	*0.055*	−0.085	*0.071*	0.235**	*0.111*	−0.031	*0.151*	−0.158*	*0.088*	0.344***	*0.127*
Observations	5,749				1,063				1,626			

(*Continued*)

Table A7 Continued

	Slovak Republic				Spain				United Kingdom			
	Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)		Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE	ME	SE
Sex	−0.176**	*0.089*			0.150	*0.154*			−0.097	*0.129*		
Field of study												
General programmes												
Education	−0.134	*0.105*	0.131	*0.135*	0.111	*0.141*	−0.247	*0.185*	−0.289**	*0.126*	0.165	*0.138*
Arts and humanities	−1.257***	*0.108*	1.598***	*0.135*	−1.001***	*0.162*	0.985***	*0.219*	−0.030	*0.072*	0.030	*0.088*
Business	−0.159**	*0.077*	0.448***	*0.107*	0.120	*0.131*	−0.109	*0.166*	−0.063	*0.069*	0.015	*0.087*
Natural sciences	0.163	*0.116*	0.010	*0.150*	−0.050	*0.165*	0.141	*0.223*	−0.082	*0.078*	0.005	*0.099*
ICT	−0.381***	*0.129*			−0.060	*0.142*	−0.050	*0.218*	−0.066	*0.081*	−0.168	*0.131*
Engineering	0.181**	*0.078*	0.082	*0.143*	0.113	*0.152*	−0.400*	*0.209*	−0.063	*0.074*	−0.038	*0.115*
Agriculture	0.107	*0.124*	0.124	*0.202*	−0.260	*0.195*	−0.136	*0.311*	−1.366***	*0.099*	1.397***	*0.149*
Health and welfare	−1.248***	*0.132*	1.432***	*0.129*	−0.063	*0.186*	−0.120	*0.202*	−0.224*	*0.118*	−0.009	*0.129*
Services	0.127	*0.101*			0.126	*0.156*	−0.256	*0.221*	0.154	*0.094*	−0.151	*0.135*
Observations	565				417				1,462			

Notes: Reference category social sciences and journalism and information. *Statistical significance at 10%; **statistical significance at 5%; ***statistical significance at 1%.

Table A8 Regression results—Average marginal country effects in the cross-country sample based on the mode as the standard education

Overeducation measure: Mode	Cross-country sample	
Country dummy	ME	SE
Austria	−0.172***	*0.015*
Belgium	−0.080***	*0.011*
Bulgaria	−0.245***	*0.035*
Cyprus	−0.003	*0.020*
Czech Republic	−0.035	*0.023*
Estonia	−0.134***	*0.025*
France	−0.011	*0.018*
Greece	−0.025	*0.016*
Hungary	0.040**	*0.016*
Ireland	0.069***	*0.017*
Italy	0.173***	*0.015*
Latvia	−0.052***	*0.018*
Lithuania	−0.004	*0.027*
Netherlands	0.071***	*0.015*
Poland	−0.249***	*0.010*
Portugal	−0.140***	*0.017*
Romania	−0.188***	*0.014*
Slovak Republic	−0.037*	*0.020*
Spain	−0.157***	*0.026*
United Kingdom	0.074***	*0.014*
Observations	34,624	

Notes: Reference category: Germany. *Statistical significance at 10%; **statistical significance at 5%; ***statistical significance at 1%.

Table A9 Regression results—Average marginal country effects in the cross-country sample based on the ISCO criterion

Overeducation measure: ISCO	Cross-country sample	
Country dummy	ME	SE
Austria	−0.104***	*0.014*
Belgium	−0.033***	*0.011*
Bulgaria	−0.061*	*0.032*
Cyprus	0.108***	*0.018*
Czech Republic	−0.004	*0.022*
Estonia	−0.067***	*0.025*
France	−0.030*	*0.016*
Greece	0.070***	*0.015*
Hungary	−0.056***	*0.015*
Ireland	−0.023	*0.016*
Italy	0.209***	*0.014*
Latvia	−0.095***	*0.017*
Lithuania	0.002	*0.027*
Netherlands	−0.124***	*0.015*
Poland	−0.035***	*0.010*
Portugal	−0.060***	*0.016*
Romania	−0.153***	*0.014*
Slovak Republic	0.015	*0.020*
Spain	−0.040	*0.026*
United Kingdom	−0.075***	*0.014*
Observations	34,624	

Notes: Reference category: Germany. *Statistical significance at 10%; **statistical significance at 5%; ***statistical significance at 1%.

Table A10 Regression results—Average marginal effects of non-field-of-study-related variables in the cross-country sample based on the mode as the standard education

Overeducation measure: Mode	Cross-country sample			
	Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE
Inverse mills ratio	0.047***	*0.018*		
Individual variables				
Sex	−0.021	*0.060*		
Age group (reference 20–24 years)				
25–29 years	−0.044	*0.047*	0.039	*0.056*
30–34 years	−0.026	*0.046*	−0.003	*0.055*
Foreigner	0.149***	*0.017*		
Job variables				
Firm size (reference: < 10 persons)				
11–19 persons	−0.021	*0.018*		
20–49 persons	−0.041**	*0.016*		
50 and more persons	−0.042***	*0.014*		
Temporary contract	0.055***	*0.013*		
Working hours (in 10 hours)	−0.037***	*0.006*		
Tenure (in 10 years)	−0.021	*0.038*		
Tenure squared (in 10 years)	−0.015	*0.028*		
Observations	*34,624*			

Notes: *Statistical significance at 10%; **statistical significance at 5%; ***statistical significance at 1%. Dummies for nationality and industry (sections NACE Rev.2) included.

Table A11 Regression results—average marginal effects of non-field-of-study-related variables in the cross-country sample based on the ISCO criterion

Overeducation measure: ISCO	Cross-country sample			
	Base term		Interaction with sex (female = 1)	
	ME	SE	ME	SE
Inverse mills ratio	0.055***	*0.018*		
Individual variables				
Sex	0.065	*0.061*		
Age group (reference 20–24 years)				
25–29 years	−0.093*	*0.051*	−0.007	*0.058*
30–34 years	−0.150***	*0.050*	−0.042	*0.057*
Foreigner	0.048***	*0.015*		
Job variables				
Firm size (reference < 10 persons)				
11–19 persons	−0.002	*0.016*		
20−49 persons	−0.033**	*0.014*		
50 and more persons	−0.063***	*0.012*		
Temporary contract	−0.004	*0.012*		
Working hours (in 10 hours)	−0.072***	*0.006*		
Tenure (in 10 years)	−0.051	*0.035*		
Tenure squared (in 10 years)	0.067***	*0.026*		
Observations	*34,624*			

Notes: *Statistical significance at 10%; **statistical significance at 5%; ***statistical significance at 1%. Dummies for nationality and industry (sections NACE Rev.2) included.