Credential closure. Educational credentialism, skills, and wages in Europe.

Thijs Bol

University of Amsterdam, t.bol@uva.nl

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Abstract

Credentialist theory argues that education takes a central position in systems of stratification because educational degrees restrict access to highly-rewarding labor market positions. In sociology credentialism has become an important explanation for the positive association between education and wages. According to the theory educational degrees are important barriers in the labor market. However, very few studies have empirically tested if workers' wages are indeed higher when they work in an occupation where access is regulated by educational credentials. No study so far has been able to rule out that educational entry restrictions might also increase the skills of workers, potentially refuting credentialist theory. In this article I investigate if wages are higher in occupations that are by law only accessible when workers have a specific educational credential. I combine new data on formal educational requirements for 12 European countries with individual level labor market data from the *Programme for the International Assessment of Adult Competencies* (PIAAC). By comparing (a) different occupations within the same country, and (b) the same occupations across countries, I estimate the wage effects of formal educational restrictions. The results show that educational credentialing increases wages, but the effects are modest. Interestingly, this wage premium is not explained by skill-differences between workers in occupations with and without educational requirements. This suggests that educational barriers have a direct – but small – effect on workers' labor market returns.

1 Introduction

There is broad consensus on the positive relation between education and wages. With each year of education average wages rise, and college educated workers get higher returns in the labor market than their less educated counterparts (Card, 1999; Hout, 2012). In contrast, the debate on the mechanisms that explain this education effect is still wide open (Bills, 2003; Van de Werfhorst, 2011). While economists have mostly relied on human capital and signaling explanations to understand why higher educated earn more (Becker, 1962; Spence, 1973), in the 1970s sociologists proposed credentialist theory (Collins, 1971, 1979; Dore, 1976; Berg, 1970). A core argument of credentialist theory is that education affects wages because educational degrees (or credentials) are used to restrict access to well-paid and high-status occupations. Educational degrees are a means of social closure, and a primary reason for their existence is to restrict access (Bills et al., 2017, p. 194).

According to credentialist theory the wage premium to education is not primarily explained by skill acquisition. Instead, education yields positive returns because it is "an artificial device for monopolizing access to lucrative occupations." (Collins, 1979, p. 9) Credentialist theory as proposed by Collins and others has gained a lot of attention from sociologists in the past decades. At the same time, the theory has received fairly little empirical attention. As Bills (2003) writes in a review: "sociologists have, thus far, rarely specified or tested credentialist models" (p. 456). Does one of the primary predictions of credentialist theory, namely that monopolizing access with educational degrees increases wage returns, holds?

In this article I will study how occupations' formal educational requirements affect workers' wages. The general hypothesis is that restricting access pays off: by monopolizing certain job tasks, economic rents are created for occupational workers (Weeden, 2002; Sørensen, 1996). An educational credential can be used to monopo-

lize job tasks. By restricting occupational access to those with the right credential, monopoly rents will accrue to those with the educational degree. The majority of published studies on occupational closure and rents find positive associations (Bol and Weeden, 2015; Kleiner and Krueger, 2010), although some others report null findings (Redbird, 2017). In this study I will evaluate to what extent educational entry restrictions increase wages.

In contrast to existing studies I will use a direct measure of formal educational entry restrictions. This measure of educational credentialing captures if there are legal educational requirements that need to be met before workers can find employment in a given occupation. This direct measure is an improvement over the indirect measures that have been used in earlier studies. Existing work has - for example - measured educational credentialing by using the proportion of occupational workers with a college degree (Weeden, 2002), the effects of educational degrees on top of years of schooling ("sheepskin effects", Hungerford and Solon (1987)) or the workers' perceived educational requirements (Bol and Weeden, 2015).

A standing discussion in credentialist theory is whether restricting access by educational degrees might be functional (Murphy, 1984). Even if educational degrees are used to legally restrict access to lucrative positions, at the same time these barriers might result in more skilled and more productive workers. This could in turn increase the quality of the services or products. On the one hand, there are scholars that argue that educational credentials are not related to job-skills and productivity (Collins, 1979, p.21). Imposing educational entry restrictions will not increase the quality of workers. On the other hand, scholars argue that educational credentials potentially monopolize access to relevant job skills (Murphy, 1984; Bol and Weeden, 2015). Credentialing might increase earnings, but it also guarantees a higher level of quality. Le Grand and Tåhlin (2013) give the example of medical doctors, stating that it would be absurd to argue that the monopolization of the job

tasks of medical doctors has no basis in real competence.

A final contribution of this study is that I will explicitly test if educational restrictions affect wages because of the selection of high-skilled workers in closed occupations. Using direct measures of workers' cognitive skills as well as the job tasks they perform, I can distinguish between these two contradictory explanations. Is the wage premium associated with educational entry restrictions potentially explained by skill differentials?

I analyze 11 European countries using newly gathered data on educational requirements from the European Regulated Professions Database (ERPD) combined with individual level data from the Programme for the International Assessment of Adult Competencies (PIAAC). Following the current literature, I will first estimate the wage effects of educational requirements by comparing different occupations that vary in whether they require a degree (e.g., Kleiner and Krueger, 2010; Bol and Drange, 2017). However, unobserved confounder bias is problematic in these models: it is likely that the studied occupations differ on other aspects than just the educational requirements and the factors that we are able to control for. For this reason I also estimate regression models where I compare the same occupation across countries. Here I exploit cross-national variation in educational requirements: the same occupation is regulated in some countries but not in others.

2 Credentials, skills, and wages

2.1 Credentialist theory

A central goal of stratification research is to understand the educational payoff in the labor market. There is a plurality of mechanisms that are proposed by earlier studies (Bills, 2003): education increases skills, or human capital (Becker, 1962), education is a signal for employers (Spence, 1973), education is a positional good

(Thurow, 1976), and so on. The most dominant perspective comes from human capital theory. Individuals acquire skills in education, and those with higher degrees have more skills and will be more productive in the labor market. Insofar skills and productivity are observable by employers (cf. Spence, 1973; Arrow, 1973), it makes sense that those with higher degrees have higher wages: Education increases the marginal productivity of workers and will therefore increase their earnings.

Credentialist theory has a different view on the educational payoff in the labor market. Education is not rewarded because it increases skills or makes workers more productive (Berg, 1970), it is rewarded because it gives those with an educational degree access to high-status positions. The educational system's main function is to create insiders (those with a credential) and outsiders (those without the credential). One of the founders of credentialist theory is Randall Collins. In his book *The Credential Society* (1979), he investigates the pivotal role of education in systems of social stratification. According to Collins, education functions primarily as a means of social closure (Weber, 1978), and he refutes that education increases productivity - the basic premise of human capital theory.

2.2 Credentialing and wages

Credentialism is an "elastic concept" (p. 1 Bills and Brown, 2011), and is used to explain widely different processes: from educational expansion (e.g., Boylan, 1993), to status reproduction in higher education (e.g., Brown, 2001), to social closure on the labor market (Weeden, 2002; Rivera, 2011). My focus is on the latter: does regulating occupational access with educational credentials increase wages?

Several theoretical mechanisms would expect this to be the case. First, by restricting access, economic rents are argued to be generated (Sørensen, 1996; Weeden, 2002). When there is more demand than supply, workers in closed positions will be able to get higher returns to their work than they would have gotten in a fully

competitive market. The basic argument is that a monopoly - only those with the degree are allowed to perform the occupational tasks - increases returns for workers with access.

Weeden (2002, p. 69) argues that there is another reason why formal educational credentialing might pay off. Having educational requirements sends a signal of quality of the service or product. Essentially this idea is similar to the argument by Spence (1973): when individuals are uncertain about the quality of something they are purchasing, they will rely on signals when making their decision. When a service or product is offered by an occupation with educational restrictions, individuals might be willing to pay more than they would have when such restrictions would have been absent. In this study I am not able to distinguish these two mechanisms (restricting access and signaling quality), but the general expectation from both is that formal educational restrictions will increase workers' wages (*hypothesis 1*).

Several studies have looked at how educational credentialing affects labor market returns, although all of them have used very indirect measures of formal entry restrictions. Weeden (2002) uses the proportion of occupational workers with a college degree as an indicator of credentialing, and finds that workers in occupations with a high level of educational credentialing earn on average 40% higher wages than similar workers in occupations that have few college graduates. The "sheepskin" literature uses a different approach, and analyzes the effects of educational degrees on top of years of schooling (Hungerford and Solon, 1987; Jaeger and Page, 1996). These degree effects, or so it is argued, can be interpreted as returns to educational credentials net of skills, since the variation in skills is already captured by years of schooling. Bol and Weeden (2015) measure educational credentialing by asking workers what the educational requirements are for the job they are currently working in. By aggregating this to the occupational level, they find that in occupations where a large proportion of the workers believe that a high degree is required, earnings are higher.

The wage returns are similar to the results found by Weeden (2002): around 40% higher wages for occupations that score high on educational credentialing compared to occupations without any (perceived) educational requirements.

The summary of the existing literature makes clear that, while important accomplishments were made, a fundamental proposition of credentialist theory remains untested. Studies aimed to measure the wage returns to credentialing, but did so using very indirect measures of educational requirements. What people *perceive* to be educational requirements does not necessarily correspond with reality. Similarly, the fact that a lot of workers in an occupation have a college degree, does not mean that a college degree is required to obtain access to that job. In this article I improve on this by using a direct measure of educational barriers.

2.3 Skills

While the existing literature suggests that educational credentialing increases wages, it is unclear what the role of skills is. Collins argues that "education is often irrelevant to on-the-job productivity, and sometimes even counterproductive" (1979:21). This implies that individuals do not actually learn anything during their education that makes them better workers. The findings above, however, do not allow for drawing this conclusion. Weeden (2002) finds that wages are higher when more occupational workers have a degree, but this might actually be because workers in those occupations have higher skills. Rivera (2011) finds that having a degree from a top four U.S. university is crucial in getting access to elite firms, but we do not know if graduates from these top four universities are more skilled. Bol and Weeden (2015) find that wages are higher in occupations where workers' perceived educational requirements are higher, but maybe this is because workers in those occupations have more skills.

Even if educational credentialing affects wage returns, this does not mean that imposing formal educational restrictions is unrelated to workers' skills. Right now,

we do not know if credentialing is, in a way, functional: it might create rents for workers with a degree, but it also guarantees a higher skill level of the workers. Current studies have been unable to really disentangle the two ways by which educational credentialing might increase increases: (1) just by restricting access, or (2) by restricting access to relevant skills.

The more critical studies of Collins (1979) and Berg (1970) would predict the first variant. In those studies educational degrees are a means of social closure and do not affect (or even negatively affect) workers' skills. Imagine that we would compare the same occupation in context A and context B, but in context A there are educational restrictions to access, whereas these restrictions are not there in context B. The main argument would be that workers in context B would not be more skilled or more productive. More formally, we would expect that the positive effect of formal educational restrictions would not be mediated by the skills of the workers (*hypothesis 2a*).

The second variant of credentialist theory nuances this idea. Educational credentials might not only restrict access to occupations, but they might also restrict access to relevant skills (Bol and Weeden, 2015). Rents would still accrue to those with degrees: medical doctors might get higher wages than they would have in a scenario where everyone would have access to getting a medical degree, but medical doctors would also learn skills that are relevant (Le Grand and Tåhlin, 2013). If we would again compare context A and B, we would expect that the average skill level of workers in context A (regulated) would be higher than in B (not regulated). The fact that workers earn higher wages when their occupation regulates access by educational credentials is explained by the higher skills of those workers, and not the educational restrictions itself. For our analyses this would mean that the positive effect of formal educational restrictions would be mediated by workers' skills (*hypothesis 2b*).

3 Data and variables

For the analyses I use two main sources of data: (a) newly gathered data on formal educational requirements and (b) the Programme for the International Assessment of Adult Competencies (PIAAC).

3.1 Data and sample

Data on occupations' formal educational restrictions are obtained from the European Union (EU) regulated professions database.[1] The database contains the names of all occupations across European countries that require a specific educational degree or professional qualification to obtain access to. The EU set up the database in order to enhance the international mobility of workers within European countries. If workers want to find employment in another country, the regulated professions database informs them on the occupations that require a formal qualification. For the purpose of this study all occupations in the database are coded to the most detailed (4-digit) ISCO-08 scheme (see below). This means that for each country I have a list of ISCO-08 categories that legally require a formal qualification to obtain access to. In the EU regulated professions database, for some countries information on educational entry restriction to occupations is absent. For these occupations the regulation variable is coded as missing. This concerns only a small fraction of all occupations: for 2% of the total observed occupations over all 11 countries (66 out of 3372) information on regulation was absent.

Country- and occupation-specific information on the formal educational restrictions is merged to the PIAAC data. Data collection was organized by the Organisation for Economic Coordination and Development (OECD, 2013) and took place

[1] This database can be accessed at http://ec.europa.eu/growth/tools-databases/regprof/ (last visited September 13, 2018. We created the dataset on educational regulation in July 2017.

in 2011/2012 for 24 first-round countries and in 2014/2015 for 9 second-round countries. PIAAC contains high quality information on demographic, educational, and labor market characteristics of the respondents, as well as direct measures of cognitive ability. Data collection and the sampling framework are harmonized across the 33 participating countries (OECD, 2013).

For this article I only use the data for 12 of the 33 countries for two main reasons. First, some countries did not include detailed information on the respondents' occupation (4 digit ISCO-2008). Since I map the measure of educational restrictions to this scheme (see below), countries without information on the occupations of respondents are not in the sample. Second, many countries cannot be analyzed because the European Union did not provide information on educational entry restrictions. This can either be because the participating country in PIAAC is not in Europe (e.g., United States, Canada) or because the database on educational regulations did not (yet) provided data for that country. The analytical sample from the PIAAC is 32,190. Table A1 shows the steps that were taken to get from the raw data to the analytical sample.

3.2 Variables

3.2.1 Wages

The dependent variable is the natural logarithm of gross hourly wages. In the PIAAC wages are corrected for purchasing power parity and expressed in United States 2012 dollars. Missing data on the wage variable is relatively uncommon (see Table A1. Due to outliers, the bottom and top 1% of earners were removed (cf. Lancee and Bol, 2017).

3.2.2 Formal educational requirements

The main independent variable indicates if there are any formal educational requirements to work in the occupational category, as measured by the 4 digit ISCO-2008 classification. The variable is a binary indicator that takes 1 if the occupation is regulated and 0 if it is not regulated. There are some differences in the extent to which access is regulated by educational degrees. In the EU register for regulated professions a distinction is made between occupations where activities are reserved for those with credentials, titles are reserved for those with credentials, or both the activities and title are reserved for those with a credential. Due to too little variation in these three different options, I focus on the most crucial distinction between the regulated (regulation of activities and/or title) and not regulated.

3.2.3 Cognitive skills

A unique feature of the PIAAC survey is that it contains rich information on both the cognitive skills of individuals and the tasks that they perform in the labor market. All participants of the PIAAC survey participate in a numeracy test, which is defined as being able to interpret, use, and apply mathematical ideas and information (OECD, 2013). Following earlier research I interpret the measure of numeracy as an indicator of general cognitive skills (Hanushek et al., 2015). With this measure I will be able to find out if the reason why educational requirements affect earnings is that higher-skilled workers are found in occupations that require an educational credential (hypothesis 2).

The numeracy test consists of 52 different items. The test is adaptive, which means that the difficulty of the questions is adapted to the score of the respondents on earlier questions. Because of time-constraints respondents did not answer the all questions but instead answered a random set. The numeracy score is then included in the PIAAC as 10 plausible values (Rubin, 1976). I follow common practice and

account for the within and between variance in plausible values in the regression models (cf. Heisig and Solga, 2015)[2]

3.2.4 Job tasks

Next to general cognitive skills, I also control for the tasks that workers perform in their occupation (Liu and Grusky, 2013). Even if individuals work in occupations that do or do not require educational credentials are similar with respect to their general cognitive skills, it might be that workers in regulated occupations perform different tasks. For this reason I include five different scales to capture diversity in the tasks that are performed. The five types of job tasks that I measure are: (a) problem-solving tasks, (b) planning tasks, (c) people contact, (d) physical tasks, and (e) mathematical tasks. In contrast to numeracy, these indicators measure the tasks that workers actually perform in their current occupations: not all workers who score high on numeracy perform mathematical tasks in their job. The five scales are created by taking the standardized mean over several underlying items. All items and the internal reliability can be found in Table B1.

3.2.5 Controls

Besides the job tasks scales and numeracy indicator, all models include sex, age and age^2 to take the age composition and sex composition (e.g., Bayard et al., 2003) of the occupation into account. Second, I control for the educational attributes of the respondents. Dummy variables for five ISCED 1997 levels are added: (1) ISCED 1,2, 3C, (2) ISCED 3AB, (3) ISCED 4, (4) ISCED 5B, and (5) ISCED 5A, 6. The predicted effect of the "regulation" variable thus captures the effect of working in an occupation with educational entry restrictions *net* of the level of educational attainment of the individual. Finally a series of labor market controls is included:

[2]This is done by using the -mi- package of Stata. Using -mi- the 10 different plausible values are treated as 10 imputations of the real score respondents would have on their numeracy test.

Table 1: Descriptive statistics of the analytical sample

	Mean	SD
ln gross hourly wages	2.51	0.57
Regulated by degree	0.22	0.42
Female	0.48	0.50
Age	40.26	11.55
Age^2	1754.43	937.71
Level of education		
ISCED 1, 2, 3C	0.19	0.39
ISCED 3A, 3B	0.47	0.50
ISCED 4	0.02	0.14
ISCED 5B	0.10	0.30
ISCED 5A, 6	0.22	0.42
Tenured	0.80	0.40
Numeracy skills	2.72	0.50
Problem-solving tasks	-0.01	0.89
Physical tasks	0.01	1.00
Planning tasks	-0.02	0.81
Mathematical tasks	-0.01	0.86
People contact	-0.04	0.78

Note. - Source is the PIAAC data, N = 32,190. Analytical weights are used in calculating the descriptive statistics.

tenure (1 = yes) and self employment (1 = yes). Descriptive statistics for all variables can be found in Table 1.

4 Methods

The main challenge of this study is to estimate the effect of regulation. That is, to what extent do we expect wages to be affected by formal educational requirements. I analyze this effect in two different empirical designs.

First, I use a within-country, between-occupation design. Here I compare *different* occupations within one country, where some of the occupations have specific educational requirements but others do not. This method has been employed by

most studies looking at the effects of credentialism on wages (Weeden, 2002; Bol and Weeden, 2015; Bol and Drange, 2017). The strong assumption is that by adding individual controls on competencies, job tasks, age, and so on, all relevant differences between occupations are captured. Only then we are able to interpret the remaining mean difference in wages between regulated and unregulated occupations as a true effect of formal educational restrictions. The notation for this design is as follows:

$$y_i = \alpha + \beta_1 REG_j + \delta X_{ij} + \varphi C_i + \varepsilon_{ij} \tag{1}$$

In Equation 1, I estimate the predicted effect of regulation (β) on wages (y_i), adding individual controls (δ) and a set of fixed effects for the 11 countries under study (φ). This equation thus provides the average within-country return to regulation by educational degrees across the 12 countries under study.

In a second design I relax the strong assumption that the added control variables pick up all relevant differences between occupations, and instead use a between-country, within-occupation design. Here I compare the *same* occupation across countries, where in some countries that occupation is not regulated by educational restrictions but in other countries it is. This model estimates if – on average – occupational wage returns are higher in countries where that occupation has formal educational requirements. The notation for this design is as follows:

$$y_i = \alpha + \beta_1 REG_j + \delta X_{ij} + \varphi C_i + \zeta O_j + \varepsilon_{ij} \tag{2}$$

The main difference between Equation 1 and Equation 2 is that the second equation includes a fixed effect for occupation as well (ζ). I argue that this will give a much more reliable estimate of the true effect of educational restrictions on wages, since all unobserved differences in job tasks between occupations are accounted for. The estimates will only be biased upwards if workers in countries

where an occupation requires a degree perform completely different job tasks that are not captured by our measures. While this is still an assumption that might be violated, it is a much weaker assumption than prevails in the majority of the literature, where control variables are argue to pick up all relevant variation across occupations. A downside of the occupation fixed effects model (Equation 2) is that the estimate is only based on occupations that vary in their practices across countries. There are a lot of occupations that do not require an educational degree in any country (e.g., cleaner), and there are a few occupations that require a degree in all countries under study (e.g., medical doctors). I will discuss this issue in more detail below (see also Figure 1).

Both Equations 1 and 2 are estimated in OLS regression models with robust standard errors. Since the models include country and occupation fixed effects, standard errors are not clustered at the country or occupation level. All models are estimated by using the probability weights that are provided by the (OECD, 2013).

5 Results

5.1 Descriptive results

How many occupations have formal educational requirements, and what types of occupations have such requirements? Table 2 shows the percentage of workers in an occupation where access is regulated by an educational degree according to the EU regulated professions database. First, I find that in all countries there are occupations that require educational credentials, ranging from 13.7% (Spain) to 33.7% (Czech Republic). Similar to previous studies I find cross-national variation in the extent to which access to occupations is regulated (Bol and Weeden, 2015). While the main interest in this article is not in the cross-national variation in educational credentialism, for the empirical strategy it is important to note that such variation

Table 2: Percentage of regulated occupations by country

	mean
Belgium	23.6
Czech Republic	33.7
Denmark	23.5
France	24.1
Germany	22.5
Italy	18.6
Netherlands	17.5
Poland	24.7
Slovak Republic	23.5
Slovenia	22.2
Spain	13.7
United Kingdom	25.6

Note. - Percentages of workers are calculated for the full sample, without the restriction of 15 workers for each occupation.

is present.

Figure 1 provides a complete overview of all occupations across the 12 countries. Each tile represents an occupational category in the ISCO-08 scheme, and the color of the tile denotes if it requires formal educational requirements (green) or not (red), or if the information for that occupation was missing in the EU database (gray). When a tile is absent in a country it means that the occupation was not observed in the PIAAC database. The occupations are clustered by their major occupational group, to give an idea of where most educational credentialism is observed.

First, it becomes clear that by far most regulation with educational degrees is found among professionals and associate professionals. There are some professions that require and educational degree in all countries under study, for example medical doctors, surgeons, or dentists. Educational professionals also require a degree in most countries, but certainly not all. Among the associate professionals there is a large chunk of green tiles as well, again indicating the medical associate professionals: nurses, dental assistants and medical technicians. At the same time, there are

many occupations where there is substantial cross-national variation in educational requirements. Real-estate agents require an educational degree in 5 out of the 11 countries, and the same goes for electrical engineers: in 6 out of 10 countries the EU lists an educational degree that is required to access the occupation.

It is also important to note that educational credentialism is not restricted to the professions. In some countries (particularly those with a strong dual system (Shavit and Muller, 2000)), the skilled trades are quite heavily credentialized as well. In Belgium, Germany, and Slovakia, a substantial number of occupations in the skilled trades have educational requirements. Skilled trades in Spain and the United Kingdom (countries without a strong dual system) often do not have any formal educational requirements.

Figure 1 makes clear is that there is plenty variation to study the effects of educational credentialing. The first empirical design (Equation 1) exploits the rows in Figure 1, and models if – on average – within each country workers in the green tiles obtain higher wages than the workers in the red tiles. The second empirical design (Equation 2) exploits the columns in Figure 1, and models if – on average – workers in the green tiles in each occupational category (each column) obtain higher wages than workers in the red tiles.

Finally, the figure provides information about the sample of occupations that are being analyzed. In some countries much fewer occupations are observed. This has two sources. First, the sample size in the given country was smaller, or fewer people were asked about their occupation. In this case the missing occupations are caused by absent information by the PIAAC. Second, and more prominent, some occupations do not exist in some countries, or at least do not have the size to be observed among a survey in which 5,000 individuals are sampled. This becomes most apparent in occupations in the primary sector: in most countries there are only very few hunters left, and certainly not enough to make it likely that they are drawn in

a random sample of 5,000 citizens. In all multivariate analyses, I only compare the green tiles with the red tiles: missing information because the occupation was not observed by the PIAAC or because information on regulation is excluded from the analysis.

Educational entry restrictions vary across countries and within countries, but to what extent do I find that this variation affects the wages of workers? Table 3 shows the mean differences on several variables for workers in occupations where access is and is not restricted by an educational credential. Log hourly wages is standardized within countries, to take cross-national differences in mean earnings and regulation (see Table 2) into account.[3]

Table 3 shows that on average wages are higher for workers in jobs that require an educational degree. Workers in credentialized occupations earn a quarter of a standard deviation (0.25) above the mean country wage, workers in open occupations a bit under the mean (-0.08 *sd*). There is a substantial wage gap of about one third of a standard deviation. Of course this might be related to other factors that differ between jobs that do and do not require an educational degree. There are no differences between the sexes and only a very small difference in age. There are – not surprisingly (Brown, 1995) – large differences in the proportion of workers with a tertiary degree. In jobs with educational restrictions the proportion of workers with a college degree is about 1.5 times higher (0.34) than in jobs without educational restrictions (0.21). Still, it is important to note that many individuals with a college degree work in occupations that do not formally require such a degree. Of course it is likely that there are informal restrictions that might increase the earnings of degree-holders versus non-degree holders. I will get back to this in the discussion.

A potential explanation for the observed wage gap is that those in credentialized jobs have more skills. With respect to numeracy, I indeed find that on average

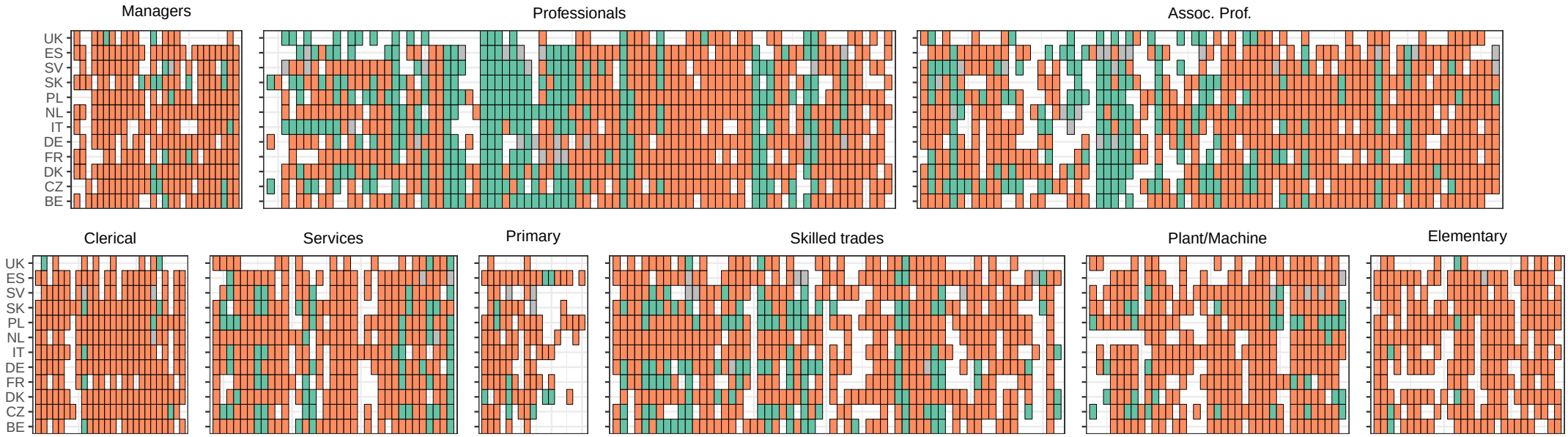
[3]Please note that the regression models (Tables 4 and 5) model cross-national differences in log hourly wages by the inclusion of country fixed effects.

Table 3: Differences between credentialized and non-credentialized workers

	No requirements	Requirements	Δ	p-value
Gross hourly wages (std.)	-0.08	0.25	-0.33	0.00
Female	0.50	0.51	-0.01	0.33
Age	39.51	40.16	-0.65	0.00
College degree (ISCED 5/6)	0.21	0.34	-0.13	0.00
Numeracy skills	2.72	2.80	-0.08	0.00
Problem-solving tasks	-0.05	0.16	-0.21	0.00
Physical tasks	0.01	-0.02	0.03	0.04
Planning tasks	-0.04	0.14	-0.18	0.00
Mathematical tasks	-0.03	0.09	-0.11	0.00
Client contact	0.00	-0.01	0.01	0.24
Observations	32190			

Note. - Gross hourly wages are standardized within countries to take cross-national differences in wages into account. All tasks variables (problem-solving, physical, planning, mathematical, client contact) are standardized over the full sample.

Figure 1: Occupations that require formal educational requirements by major occupational group



Note. - Each rectangle depicts an ISCO-08 occupational category. When the rectangle is missing, that occupation was not measured in the PIAAC for that country. A green rectangle indicates that the occupation is regulated, a red rectangle indicates it is not regulated. A gray rectangle indicates that information for that occupation was missing from the EU regulated professions database.

numeracy is higher for workers in jobs with educational requirements (0.12 versus -0.04 *sd* from the mean). The jobs are also different with respect to their task profiles. When there are educational restrictions, jobs tend to require relatively more problem-solving, planning, and mathematical tasks, and relatively less physical tasks. There is no difference for contact tasks.

5.2 Regression models

Do the descriptive patterns in Table 3 hold in the different empirical designs? Table 4 presents the results from the between-occupations design (see Equation 2). Model 1 indicates that on average wages of workers in occupations that are closed by educational credentials are 17% ($e^{0.159}$) higher than the average wages of workers in jobs without educational restrictions. Of course an important reason for this is because higher educated cluster in jobs with educational restrictions. Model 2 illustrates this point: after adding the controls and the individual level educational information to the equation, the effect of educational restrictions decreases to 6% ($e^{0.059}$). This means that the highly educated earn the highest wages, even when working in jobs that do not require any educational degrees. These effect of education are large: on average wages of the college educated (ISCED 5A,6) are almost 50% higher than the wages of those with upper secondary degrees (ISCED 3AB).

When comparing different occupations with each other, the results indicate a substantial wage premium to social closure with educational credentials (*hypothesis 1.* But to what extent can cognitive ability and job tasks explain this effect? Do occupations that restrict access with educational credentials also attract more highly skilled workers that perform different tasks? Model 3 and 4 of Table 4 show that the answer to this question is no. Numeracy has a substantial positive association to log hourly wages: 8% for each standard deviation increase on the numeracy test.[4] The predicted effect of regulation is, however, unaffected and remains surprisingly stable. This indicates that the wage variation between workers in occupations with and without educational restrictions is not explained by variation in their ability levels.

[4]The standard deviation for numeracy is 0.50 (see Table 1), which gives a 1 standard deviation effect of 0.08 ($e^{0.16*0.50}$.

Table 4: Between-occupations regressions

	(1)	(2)	(3)	(4)
Regulated by degree	0.154**	0.059**	0.062**	0.068**
	(21.43)	(9.18)	(9.75)	(10.98)
Level of Education (Ref= 1,2,3C)				
3AB		0.141**	0.093**	0.055**
		(19.21)	(12.35)	(7.45)
4		0.237**	0.163**	0.100**
		(12.28)	(8.24)	(5.28)
5B		0.350**	0.267**	0.169**
		(36.99)	(26.41)	(16.81)
5A,6		0.533**	0.428**	0.290**
		(60.29)	(42.85)	(28.14)
Numeracy skills			0.160**	0.090**
			(22.18)	(12.43)
Planning tasks				0.044**
				(12.04)
People contact				-0.002
				(-0.58)
Problem-solving tasks				0.035**
				(10.38)
Physical tasks				-0.065**
				(-22.97)
Mathematical tasks				0.050**
				(14.37)
Constant	2.870**	1.608**	1.203**	1.569**
	(385.00)	(51.32)	(34.10)	(43.32)
Country FE	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes
N	32190	32190	32190	32190

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$

Model 4 tells a similar story, but now for job tasks. In line with earlier studies, I find that the tasks that workers perform in their job partly explains their labor market returns. Jobs with a lot of planning, problem-solving and mathematical tasks tend to pay more, jobs with a lot of physical tasks tend to pay a bit less. People contact is not associated to wage returns in this equation. While most tasks are associated to wages, the predicted effect of educational entry restrictions remains relatively stable. There is even a slight increase compared to Model 2: after adding the numeracy and job task variables the wage premium associated with restricting access with educational credentials is 7%. The first empirical design thus refutes *hypothesis 2b*: educational credentialing is associated to higher wages, but not because workers in "closed" jobs have – on average – more capabilities or perform different job tasks.

Of course it is likely that in Table 4 not all relevant differences across occupations with and without educational requirements are accounted for. The predicted effect mainly rests on the comparison of professional with non-professional occupations (see Figure 1), that differ on more factors than included as controls in Table 4. In order to interpret the 0.068 as a causal effect of educational entry restrictions on wages, the strong assumption is that all relevant differences across occupations are accounted for.

The within-occupation regressions depicted in Table 5 relax this assumption. Here again log hourly wages are regressed on educational entry requirements, but now with the inclusion of occupation fixed effects. Table 5 makes clear that even when we compare average wages among the *same* occupations there is a wage effect of restricting access with educational degrees. In the specification without any controls (Model 1), the predicted effect is 0.022, or a 2% wage increase. That effect remains stable when adding all individual control variables to the regression (Model 2). It is important to note that by eliminating all between-occupational differences the

Table 5: Within-occupations regressions

	(1)	(2)	(3)
Regulated by degree	0.019*	0.020*	0.002
	(2.02)	(2.15)	(0.15)
Country FE	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Numeracy skills	No	Yes	Yes
Job tasks	No	No	Yes
N	32190	32190	7727

t statistics in parentheses

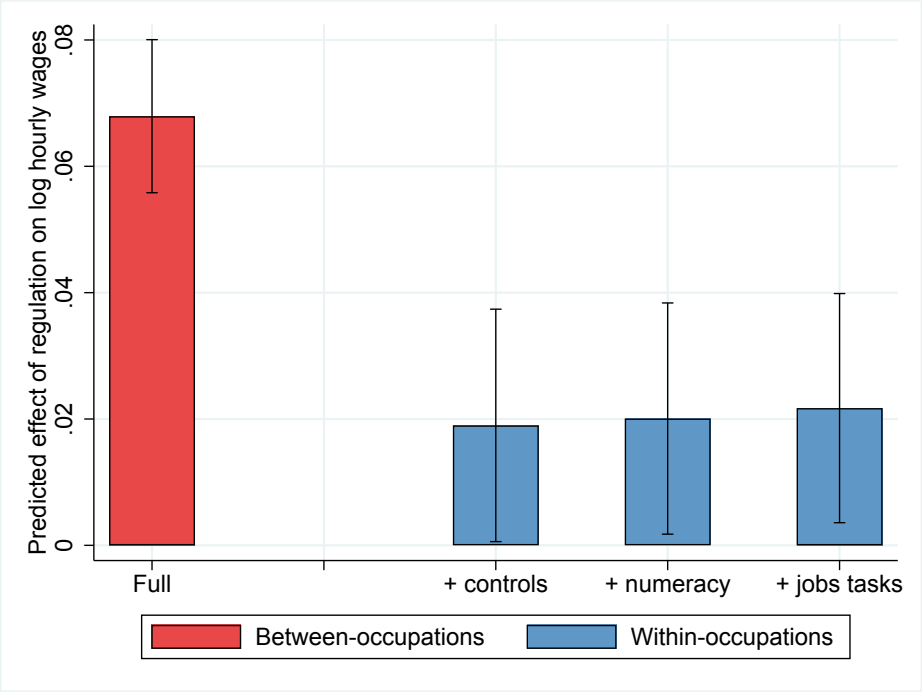
* $p < 0.05$, ** $p < 0.01$

effect of educational entry restrictions becomes much smaller. A 2% wage increase is still an increase, but it is obvious that it comes nowhere near to estimates found in earlier studies (e.g., Bol and Weeden, 2015). The within-occupation design still confirms *hypothesis 1*, but substantially the effect is much smaller than found in the between-occupation design.

Again, the question is whether the (relatively small) wage difference between identical occupations that do restrict entry in country A but not in country B can be explained by the skill and task composition of workers (*hypothesis 2b*. Do the same jobs attract different types of workers when workers are formally required to have a degree, or do workers perform different tasks when this is the case? Similar to the results in Table 4, I find skills and job tasks to not matter at all for the effect of educational entry restrictions. Apparently regulating entry to occupations with educational credentials results in a wage premium *without* affecting the type of workers that are attracted and the type of work that is performed.

This main finding is depicted graphically in Figure 2. The left bar indicates the effect obtained from the first set of within-country regressions, the blue bars

Figure 2: Predicted effects from regression models



Note. - The first bar is obtained from Model 4, Table 4. The last three bars correspond to Models 2-4 from Table 5. Whiskers depict 95% confidence intervals.

from the between-country design. First, the figure makes clear that the between-occupation design that has been employed in most studies vastly overestimates the effect of educational credentialing. I find that educational credentialing most likely generate economic rents, but the effect size obtained from the within-occupation design is about a third of the effect size obtained from the between-occupation design. Hypothesis 1 is confirmed, but we should not overstate the importance of educational credentialing for wage returns. Second, it becomes clear that the effect of educational credentialing is unrelated to human capital explanations. Wages are higher in occupations that require an educational credential, and this is not because workers in those occupations have more human capital or perform different tasks.

5.3 Robustness checks

I have performed several robustness checks for these results. First, although sample sizes in the PIAAC are substantial, there are several occupations with only very few observations. This might potentially affect the results: in some cases the comparison is really just between the wage of a handful of workers in countries where an occupation requires a degree versus a handful of workers in countries where occupations do not require a degree. There are more than 3,000 different country/occupation combinations for slightly over 30,000 respondents. To make sure that the results presented in this article are robust to the size of occupations, I have re-estimated Model 4 from Table 5 for different subsamples, each time only keeping country/occupation combinations with N observations or more. Figure C1 shows that the estimate presented in the main text (the most left marker) provides a conservative estimate of all possible obtained effects. When the smallest country/occupation combinations are removed from the analyses, the predicted effect size of educational entry restrictions on wage increases to a maximum of 4%.

Second, the results are not dependent on the inclusion of one of the twelve countries. Figure D1 shows that the effects remain when in turn one country is not included in the analysis. The effect size remains relatively stable across these different specifications, both when using the threshold of 0 and 5 observations within each country/occupation combination. These additional analyses support the main finding that there is a positive - but small - effect of educational entry regulation on wages.

Third, educational entry regulations might have changed over time. It might be that the results only hold for the relatively younger workers who entered their occupations under these restrictions. When the regressions are estimated for workers of a different age range, the results remain the same. The point estimate of 0.022 is surprisingly stable across different age groups, indicating that all workers benefit

from educational credentialing. Only for the youngest group the t-value is lower than the conventional threshold, but this is explained by a power issue (smaller sample size, larger standard error of the regression estimate) and not by a smaller predicted effect size.

6 Conclusion

Educational credentialing theory has been a dominant mechanism to explain the link between education and wages. Individuals with a higher degree are argued to obtain higher wages because their degree gives them access to lucrative positions in the labor market. Educational degrees are a barrier to access, and those with a degree will reap monopoly rents: a surplus of wages than they would have without the degree. In this article I investigated to what extent educational credentialing theory is supported by empirical data. Using new data on legal educational entry restrictions to occupations in 12 European countries, I investigated if wage returns are higher in occupations where access is only possible with a specific educational credential.

The main finding of the study is that there is indeed a positive wage effect. Depending on the specification, workers in jobs with educational entry restrictions obtain 2-7% higher wages than similar workers that work in non-credentialized parts of the labor market. While there is a positive effect, the effect is small – at least much smaller than what has been found in the few earlier studies that have studied educational credentialing. There are two explanations for this discrepancy. First, all studies have operationalized educational credentialing with indirect measure (% with a college degree, perceived degree requirements). No study so far has looked at the actual legal educational entry restrictions. Second, the vast majority of studies have looked at credentialing practices from a cross-sectional perspective. The current

study clearly indicates that comparing different occupations leads most likely to an overestimation of the true educational credentialing effect. When comparing workers in the same occupation across countries with different credentialing practices, I find that the effect of educational entry restrictions is about a third of what was found in the cross-sectional models.

A second goal of this article was to investigate if occupations with educational entry restrictions attract more high-skilled workers. The positive effect does not necessarily refute human capital theory when the educational barriers cause workers to have more skills. The debate on the (un)importance of education for skill acquisition started around the same time as the educational credentialing literature, and there are different takes on the importance of it. Collins (1979) argues that education affects earnings just because of social closure: it creates insiders and outsiders in the social system of stratification. Others argue that installing educational requirements might increase the quality of the service or product that workers provide.

The results from the current study provide support for Collins' perspective. While educational entry restrictions increase the earnings of workers, this is not explained because the workers have a higher level of ability or perform different job tasks. Educational credentialing has a small and positive effect which is not explained by human capital explanations for the education-wage link.

My results also add to the literature on occupational entry barriers. When using a model with much weaker assumptions (comparing the same occupations across countries) than has been dominant in the occupational closure literature (comparing different occupations), I find a much smaller effect. This result is similar to Redbird's (2017) study on occupational licensure, for which she found no effect in the United States when comparing the same occupation across time.

Do these combined findings provide support for educational credentialing theory? On the one hand, the answer to this question is affirmative: there is a positive wage

effect which I fail to explain with a large set of direct measures of the human capital of workers On the other hand, the effect in the most accurate estimation (within-occupation, between-country comparison) is very small. A 2% wage difference is not negligible, but when expressed in wages it is very little. The average worker in our analytical sample earns €2,604 gross a month. Imagine that this worker would now work in an occupation that requires educational entry restrictions, the wage increases by €50. The upper bound estimate of credentialing (7%) provides a more substantial gap of €180. Still, it should be clear that formal educational entry restrictions are not the main reason why education pays off in the labor market.

Higher educated earn a lot, irrespective of if their job actually requires a degree. This directly touches upon a limitation of the current study. Whereas many occupations might not have formal educational restrictions, there might be informal norms on what educational level employees should have. Many job vacancies explicitly list educational requirements even though formally anyone would be allowed to do the job. Informal restrictions are per definition difficult to measure, but the studies that look at this find that it matters. To the least this study nuances a common perception in the social closure and educational credentialing literature that setting up educational barriers increases wage inequality.

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A Sample selection

Table A1: Sample construction

	Cases lost	**Cases left**
Total PIAAC sample	-	190,258
+ Dropping non-EU countries	69,925	120,333
+ Keeping countries with detailed occupation and regulation information	43,824	76,509
+ Keeping respondents in the labor force	3,248	73,261
+ Removing non-specific occupations (n.e.c.)	31,087	42,174
+ Removing occupations with missing regulation data	810	41,364
+ Removing self-employed workers	5,529	35,835
+ Removing missings and top and bottom 1% on wages (DV)	3,481	32,354
+ Drop missings on independent variables	164	32,190
Final analytical sample	-	**32,190**

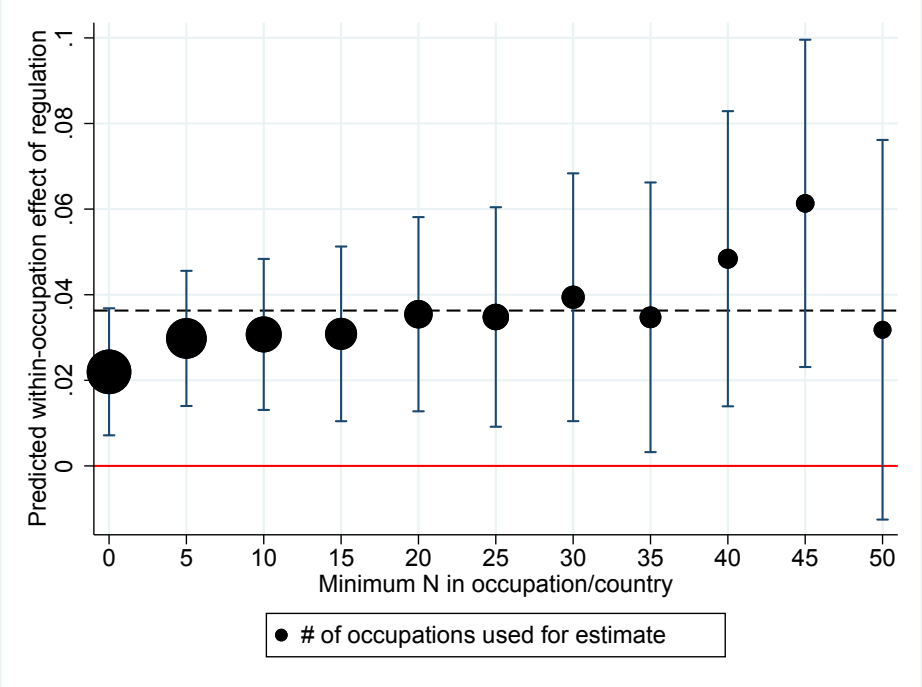
B Tasks scales

Table B1: Overview of task scales

Task scale	**Items**
Planning tasks	(1) How often does your job involve planning your own activities? (2) How often does your job involve planning the activities of others? (3) How often does your job involve organizing your own time? Answer options: 1 (Never) to 5 (Every day) *Standardized mean, Cronbachs* $\alpha = 0.71$
Contact tasks	(1) How often does your job involve selling a product or selling a service? (2) How often does your job involve persuading or influencing people? (3) How often does your job involve negotiating with people either inside or outside your firm or organization? Answer options: 1 (Never) to 5 (Every day) *Standardized mean, Cronbachs* $\alpha = 0.68$
Problem-solving	(1) How often are you usually faced by relatively simple problems that take no more than 5 minutes to find a good solution? (2) How often are you usually faced by relatively simple problems that at least 30 minutes to find a good solution? Answer options: 1 (Never) to 5 (Every day) *Standardized mean, Cronbachs* $\alpha = 0.69$
Physical tasks	(1) How often does your job involve working physically for a long period? Answer options: 1 (Never) to 5 (Every day) *Standardized to a z-score*
Mathematical tasks	(1) In your job, how often do you use simple algebra or formulas? (2) In your job, how often do you prepare charts, graphs or tables? Answer options: 1 (Never) to 5 (Every day) *Standardized mean, Cronbachs* $\alpha = 0.64$

C Size of occupations

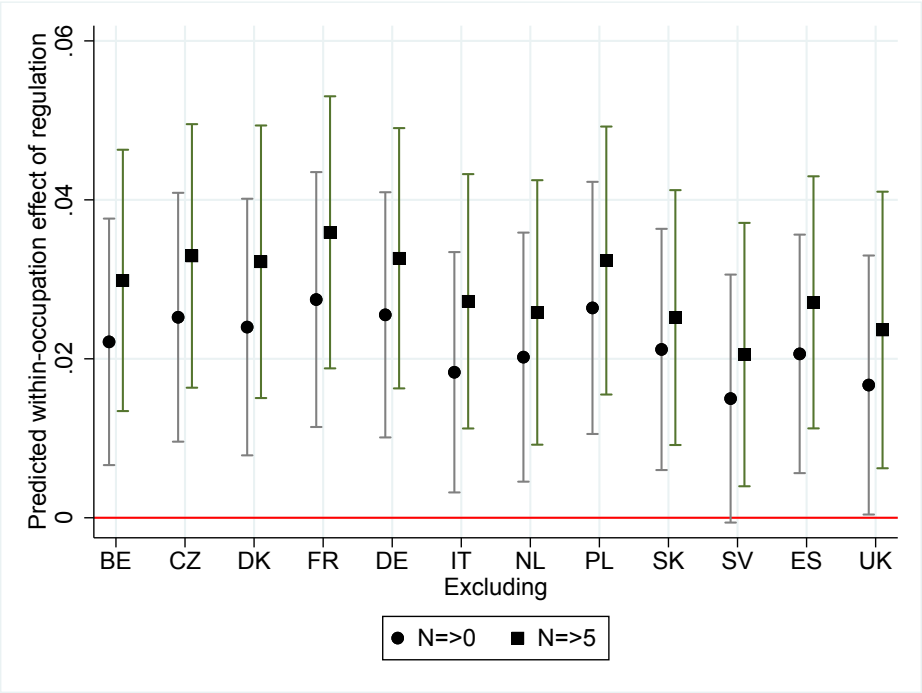
Figure C1: Influence of the observed size of the occupations in the model



Note. - The effects are obtained from Model 4, Table 5. The size of the markers represent the size of the sample. The dashed line is the average of all predicted effects in this figure. Whiskers depict 95% confidence intervals.

D Excluding countries from the analysis

Figure D1: Influence of different countries in the model



Note. - The effects are obtained from Model 4, Table 5. The x-axis lists the country that is removed from the analysis for the estimation of the shown effect. Whiskers depict 95% confidence intervals.

E Different age ranges

Table E1: Regressions for different age groups

	Age<=65	Age<=55	Age<=50	Age<=45	Age<=40	Age<=35
Regulated by degree	0.022*	0.020*	0.022*	0.024*	0.025*	0.023
	(2.35)	(2.06)	(2.03)	(2.07)	(1.98)	(1.54)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Numeracy skills	Yes	Yes	Yes	Yes	Yes	Yes
Job tasks	Yes	Yes	Yes	Yes	Yes	Yes
N	32190	28257	24729	20650	16656	12722

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$