



OVER-EDUCATION AMONG ITALIAN
PH.D GRADUATES.
DOES THE CRISIS MAKE A DIFFERENCE?

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Over-education among Italian Ph.D graduates. Does the crisis make a difference?

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Abstract

The paper examines the determinants of over-education among Italian Ph.D graduates drawn from the four cohorts 2004, 2006, 2008, 2010 surveyed by the Italian National Institute of Statistics (ISTAT). We attempt to disentangle the differentiated effects of the economic crisis and the university reform that recently hit the Italian labour market. We examine over-education through the definitions of over-skilling, over-qualification and a combination of the two. The results show that socio-demographic variables do not exert a relevant influence on over-education. Conversely, job attributes such as working in academia or carrying out R&D activities reduce the likelihood of incurring into over-education. Instead, accessing the job via informal channels or working as self-employed increase the risk of over-education, with a stronger effect during the recession. Among Ph.D related features, visiting abroad is always a driver to overcome any kind of job mismatch. Generally, benefiting from financial support is a propelling factor to reduce over-education; it is effective in reducing qualification mismatch especially during the downturn. In the light of the above findings, some policy advices are proposed.

Keywords: over-education, over-skilling, over-qualification, Ph.D graduates, crisis

JEL Classification: C2, I2, I23, J24.

1 Introduction and related literature

Traditionally, Ph.D education has been considered as the main route to get a position in academia or research institutions. In recent years the international perspective on the nature and goals of Ph.D programs has evolved significantly producing a growing consensus and a common vision on what a Ph.D program is supposed to encompass. The Ph.D should produce knowledge, not only developing original research and attributes subject-specific (hard skills), but

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also promoting both more general and transferable soft skills, as well as building up individuals with creative and inquisitive mindsets (EUA, 2005). All this should facilitate the entry of Ph.D graduates in the labor market recognizing the multiplicity of employment trajectories outside academia.

Following this approach, Ph.D holders should have a strategic role in contributing to the emergence and consolidation of the so-called knowledge economy and to promote the creation of a learning society. Actually, higher education, especially by developing the ability to learn, is perhaps the overarching determinant of individuals' human capital. In recognition of this crucial role of the very educated people, and on the basis of the presumption that market failure in learning might be pervasive in the society (Stiglitz and Greenwald, 2014), many countries have taken action expanding and reforming their Ph.D programs.

The result has been a widespread increase in the number of Ph.D students, well above the demand for academic positions, with Ph.D supply probably outstripping demand, despite the contribution of a growing technical progress in demanding skilled workers. In the light of these dynamics, a possible consequence is the potential emergence of a widespread over-education at Ph.D level, intended either as a phenomenon of over-skilling or over-qualification among Ph.D recipients (Leuven and Oosterbeek, 2011; Quintini, 2011; Hartog, 2000).

These two phenomena can be explained through a combination of different approaches imported from labor market theories. First of all, from the point of view of Ph.D students and in line with the human capital theory (Becker, 1964; Mincer, 1974), entering a Ph.D program can be seen as a rational investment which should produce high level of future satisfaction. Satisfaction may have different dimensions, included a pecuniary premium. In this model the first key assumption is that workers are paid their marginal product which in turn is a function of their level of accumulated human capital. The second assumption is that firms are always willing to adapt their production processes to the skills of their workers. By the same token, in relation to this approach over-education - which implies workers under-utilization and wages lower than workers' marginal product - should represent purely temporary and frictional mismatches between Ph.D graduates' human capital and firms' objectives (Leuven and Oosterbeek, 2011).

Similarly, according to the career mobility and search theory (Sicherman, 1991), over-education might be the result of Ph.D holders' search for professional experience considered as needed to get a job position more consistent with their education and skills in a near future. In this case as well, over-education should emerge as a short time phenomenon at the individual level, but, in aggregate, as a constant feature of today society.

On the other hand, the high number of over-educated Ph.D graduates could be related to a variety of labor market imperfections and to the imbalance between demand and supply of qualified labor. This is particularly relevant for Ph.D graduates in view of the widespread and growing saturation of academic positions. Moreover, as stated by the job competition theory (Thurow, 1975) - according to which job characteristics are the only element affecting earnings - in presence of poor employment prospects and rigidity of the demand for highly educated workers, individuals tend both to over-invest in education to enhance their position in the job market and to accept even a job for which they are overqualified. Similar to the job competition model is thus the signaling theory where education performs a mere signaling role (Spence, 1973). In both cases, qualifications become important for jobs allocation, but not for earnings,

and significant and persistent over-education is the result; consequently, we should observe Ph.D graduates partially under-employed with limited or no monetary premium, and hence the occurrence of structural and persistent over-education.

An intermediate explanation between the human capital theory and the job competition theory is provided by the so-called assignment model (Sattinger, 1993; Belman and Heywood, 1997) where both the characteristics of workers and those of jobs available in the economy explain the possible labor mismatches.

Over-education is also a potential source of considerable individual, firm and societal costs. At the individual level, overqualified workers undergo salary penalties, and lower job satisfaction (Battu et al., 2000; Verhaest and Omey, 2006; Badillo-Amador and Vila, 2013). Overqualified workers also tend to show higher turnover and absenteeism (Allen and van der Velden, 2001), and lower participation in training (Hersch, 1995; Sloane et al., 1999; Buchel and Mertens, 2004). On the other side of the coin, these features and behaviors entail costs at the firm level, with repercussions in terms of lower productivity and product quality (Tsang, 1987; Kampelmann and Rycx, 2012). At the societal level, given the high levels of public funding devoted to Ph.D programs in most countries, over-education is associated with a sub-optimal human resources allocation implying significant waste of public resources, higher unemployment (Jackman et al. (1991), Olitsky 2008), lower tax revenues and national income (Mavromaras et al., 2007).

To limit these negative consequences, it becomes important to investigate the main causes of labor mismatch and identify effective policy actions to address them. By the same token, determinants of over-education have been targets of various studies producing mixed empirical evidence. Results are sensitive both to the definition of labor mismatch and also to many supply and demand side heterogeneities (see Leuven and Oosterbeek (2011), Quintini (2011) and Caroleo and Pastore (2013) for recent in-depth reviews). Furthermore, the empirical literature comprises mainly studies applied to first university degree graduates.

By contrast, over-education among Ph.D recipients has been given short shrift and only few recent empirical studies have investigated the issue. As a matter of fact, measuring skill mismatch between Ph.D workers and job attributes is a complex issue. Detailed information on competencies and skills possessed by educated workers and those requested by their jobs is limited. Even Ph.D recipients' self-assessments of skill mismatch are quite rare. This is why most of the over-education academic literature focuses on qualification mismatch. While the number of years of education is undoubtedly a good proxy for skills, a small part of literature has investigated the difference between qualification and skill mismatch. Within this recent literature some studies have examined occupational outcomes and labor mismatches of Ph.D graduates in some countries. The US is the most analyzed case with papers on causes and consequences of educational mismatch (Bender and Heywood, 2011), on the adequacy of Ph.Ds supply (Stephan, 1996; Larson et al., 2014) and on the rewards of Ph.D programs (Stephan and Everhart, 1998). For the UK similar issues are dealt with in Dany and Mangematin (2004) and Stephan et al (2004). For Spain we refer to Di Paolo and Mañé (2014) who analyze which factors influence the qualification and skills mismatch among Ph.D holders and the relationship between mismatches on the one hand and wages and job satisfaction on the other. Some recent papers have also investigated the Italian case drawing data from partial surveys covering only some

subsets of Ph.D graduates (Ballarino and Colombo, 2010) and more often with data coming from a single university (Campostrini, 2011; D'Agostino and Ghellini, 2011). In this respect the only exception that we are aware of is Gaeta (2015) who however uses only the first Ph.D national survey published in 2009 by the Italian National Institute of Statistics (hereafter, ISTAT).

Mixed results have also been produced by those studies that have analyzed the relationship between over-education and cyclical economic fluctuations; this literature has not focused on Ph.D graduates and the investigation has been conducted at a cross-country perspective. By means of a meta-analysis of studies on over-education in the labor market, Groot and Van Den Brink (2000) conclude that fluctuations through the unemployment rate has a negative effect on the rate of return to education. However, as in Di Pietro (2002), the authors conclude that cross-country differences in over-education are due more to structural changes such as the changes in the labor force growth rather than cyclical economic fluctuations. More recently, adopting a sample of European overeducated workers with a tertiary degree (or more), Croce and Ghignoni (2012) suggest that cyclical conditions matter with regard to over-education incidence from 1998 to 2006. They found that the percentage of overeducated graduates reacts significantly to cyclical movements in GDP and when a cyclical downturn hits the economy, an increase in the incidence of over-education can be expected. In a summary report for OECD, Quintini (2011) concludes that skill mismatch is procyclical. A more detailed empirical analysis is proposed by Verhaest and Omey (2006) that returns that business fluctuation at the time of graduation appears to be a driving factors behind over-education among graduates of European countries and Japan. That is, business cycle impacts especially on over-education among new labour market entrants. Using data on Norwegian college graduates, Liu et al. (2015) find a countercyclical trend of skill mismatch. They also show that labour market conditions have a declining but persisting effect on the likelihood of mismatch at early stages of working career. This may be problematic especially in those countries, such as Italy and Germany, where there is evidence of higher persistence of over-education (Scherer, 2004). Finally, Zago (2015) documented that job polarization accelerates during recession with a general up-skilling requirements across jobs during downturn while the difference attenuates once the recession is over thus recession led to downward education-to-job mismatch.

Our study adds to the existing literature on over-education of Ph.D graduates in several respects. First, we provide fresh evidence of the Italian Ph.D graduates' situation; based on our knowledge, our study is the first to use the recently issued survey of professional outcomes built on all Italian Ph.D graduates and carried out by ISTAT (2014). This recent survey of Ph.D graduates offers an in-depth and wide observation point allowing a valuable contribution to the growing, but still limited, international literature on career patterns and labor mismatches of Ph.D graduates. More precisely, we analyze the medium term doctoral impact on the career tracking of four cohorts of Ph.D recipients at about three and five years after graduation, over a long period which also includes the recent economic downturn. Second, we also focus on the issue of over-education distinguishing over-qualification from over-skilling on the basis of a Ph.D graduates' self assessments. Finally, we investigate the effects of the recent financial and economic crisis on Ph.D mismatch in the labour market. To our knowledge, the literature on the correlation between over-education and economic fluctuations, especially when Ph.D are concerned, has received little attention. In the current paper we attempt to evaluate the impact

of cyclical fluctuations examining differences in the propensity of over-education for graduated that entered the market before and after the economic crisis.

The remaining of the paper is organized as follows. Section 2 provides a description of the data and the econometric approach. It also introduces a distinction between two measures of over-education: over-skilling and over-qualification. Section 3 discusses the findings obtained by estimating a model for over-skilling determinants, investigating separately the pre- and post-crisis periods. Section 4 presents a robustness analysis, where results for different concepts of over-education are presented as well as those produced by considering different samples. Finally, concluding remarks follow in Section 5.

2 Data and methodology

In what follows we provide a description of the data. We then introduce the econometric approach and the set of the explicative variables.

2.1 Data

The data used in the analysis come from two cross-sectional surveys on the professional outcome of Italian Ph.D graduates carried out by ISTAT in 2009 and 2014¹. The surveys are based on interviews directed to all those individuals who got a doctoral degree in Italy in 2004 and 2006 (first survey) and in 2008 and 2010 (second survey), for a total of 41,037 graduates. Among the recipients, the respondents are 12,964 (out of 18,568) in 2009 and 16,322 (out of 22,469) in 2014, with an average response rate of approximately 70%.

The surveys report information on four main issues: personal details and education; job and job search; mobility; family-related characteristics. Since the employment conditions of Ph.D holders are assessed some years after graduation (that is, in the years when the surveys are conducted), the present analysis focuses on the possible mismatch between education and professional outcome in the medium-term².

As for the investigated years, almost 93% of the respondents are employed at the time of the survey and, among them, about 90% of them work in the Services sector (which includes also the academic sector and other research-based occupations). Concerning the distribution of the graduates among the scientific fields of study, the highest number of titles was awarded in Medicine (more than 14% of the respondents), in Industrial and Information Engineering (more than 11%) and in Biology (10%), while the number of Ph.D holders in Math and Computer Sciences and in Earth Sciences are the lowest (3.1% and 2.6% respectively).

In the present analysis, over-education is measured primarily in terms of skill mismatch. The variable of interest, denoted as *over-skilling*, has been defined on the basis of a question of the ISTAT survey asking about the utility of the competences acquired during the doctoral program

¹Indagine sull'inserimento professionale dei dottori di ricerca (ISTAT, 2009, 2014). The present analysis uses the ISTAT Microdata for research purposes, available from ISTAT upon request.

²In the first survey the employment conditions of the respondents are assessed 3 and 5 years after Ph.D graduation (for those who were awarded the title in 2006 and 2004 respectively), while in the second survey the professional outcome is examined 4 and 6 years after graduation (for those who were awarded the title in 2010 and 2008 respectively).

Table 1: Over-education among Italian Ph.D graduates

Over-qualification	Over-skilling		Total
	Yes	No	
Yes	3,404	248	3,652
No	4,977	9,935	14,912
<i>Not applicable*</i>	5,175	3450	8,625
Total	13,556	13,633	27,189

*Not entitled to answer about over-qualification as employed already before Ph.D attainment.

to carry out the job. More specifically, the question is the following: “*According to you*, in order to carry out your current job is getting a Ph.D necessary in fact?” and the possible answers are: “Yes, it is”/“No, it isn’t”.

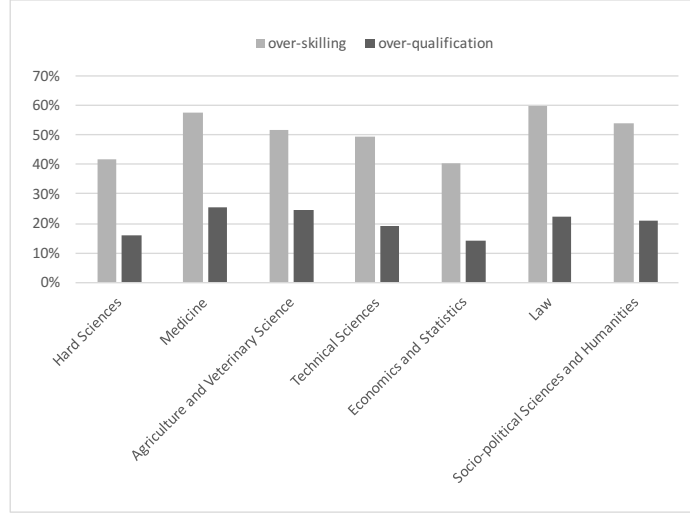
The question is asked to all the respondents who were employed at the time of the survey. On the basis of the 27,189 collected answers, a dummy variable has been defined and used as dependent variable in the present analysis: it is equal to one when respondents report that the skills and competences acquired during the Ph.D are not useful to perform the job, and zero otherwise.

Moreover, in order to check the robustness of our results, a second proxy for over-education is used, assessing the utility of the Ph.D title to get the job. In this case, respondents were asked the following question: “Was the Ph.D title an explicit requirement to get the current job?” and the possible answers: “explicitly required”, “not required but useful”, “neither required nor useful”. Differently from the question about over-skilling, the latter is asked only to those individuals who got their job after the completion of their Ph.D. The relevant sample counts 18,564 respondents; they represent about 68% of the Ph.D graduates who are employed at the time of the survey. A dummy variable denoted as *over-qualification* has been defined, taking the value of one when respondents declare that the Ph.D title was neither required nor useful to get the current job and zero if the Ph.D was required or at least useful, even if not formally required.

The total distribution of over-skilling and over-qualification resulting from the two ISTAT surveys is presented in Table 1. About 50% of the respondents who were employed declare to be over-skilled. As for those who got their job after the completion of the Ph.D studies, about 20% refer that the Ph.D title was not required neither useful to get their job, thus resulting over-qualified. Moreover, among those who respond to the two questions, just over 53% are found to be adequately matched in terms of job entry requirements and skills required for the job, while 18% result both over-qualified and over-skilled (3,404 out of 18,564). While these features resemble those emerged with reference to Spanish Ph.D (Di Paolo and Mañé, 2014), Croce and Ghignoni (2012) show that the average level of over-education among tertiary graduates in Italy over the period 1998-2006 is about 40%. By using the Survey on Adult Skills (OECD, 2012), McGowan and Andrews (2015) report that the proportion of workers aged 16-65 with skill mismatch in Italy for the years 2011-12 is slightly lower than 35%. Eventually, it appears that over-education is a crucial concern also for highly educated workers.

Figure 1 illustrates the distribution of over-skilling and over-qualification among fields of

Figure 1: Over-education by study field



Source: ISTAT, 2009, 2014

study³.

2.2 Methodology and variables

To explore the determinants of over-education, we used a probit model. Our dependent variable has a binary outcome, $y_i \in (0, 1)$, where y_i denotes over-skilling or over-qualification. Therefore, given some regressors $\mathbf{x}_i$, our goal is to describe $Pr(y_i = 1|\mathbf{x}_i)$ through a function of the form $Pr(y_i = 1|\mathbf{x}_i) = F(\mathbf{x}_i'\boldsymbol{\beta})$, where $F(\cdot)$ is assumed to be normal.

As a binary outcome model, the probit model can be given a latent variable interpretation, by assuming that the variable y_i is linked to an unobserved variable y_i^* according to the following equations:

$$\begin{aligned} y_i^* &= (\mathbf{x}_i'\boldsymbol{\beta}) + e_i \\ e_i &\sim F(\cdot) \end{aligned} \quad (1)$$

$$y_i = \begin{cases} 1 & \text{if } y_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

In addition, our sample is a non-random selection of potential observations, since the probability of being over-educated is assessed only for those who are employed at the time of the

³As to the definition of the fields of study, *Hard Sciences* includes Mathematics and Computer Science, Physics, Chemistry, Earth Sciences, Biology; *Technical Sciences* includes Civil Engineering and Architecture, Industrial and IT Engineering; *Socio-political Science and Humanities* includes Philology and Literature, History Philosophy and Psychology, Political and Social Sciences.

survey. That is, the dependent variable is observed if and only if $T_i = 1$ and it is unobserved otherwise:

$$T_i = 1(\mathbf{z}_i' \boldsymbol{\gamma} + u_i > 0) \quad (3)$$

being $1(\cdot)$ the indicator function (in our analysis, the equation for T_i is the selection equation specifying the probability for the respondent to be employed). In view of that, we should be aware of the fact that if the correlation ρ between the error terms e_i and u_i is different from zero, ignoring the selection into the labour market by using a simple probit model would produce biased estimates of the determinants of the probability of being over-educated.

In our empirical specification, three different categories of covariates ($\mathbf{x}_i$) are included in the main equation: socio-demographic information, Ph.D features and job attributes.

The first group includes a dummy variable for sex (*sex*) and one for citizenship (*citizenship*). To investigate the impact of social mobility on labour market outcomes, the social background of the graduates' family of origin is proxied by parents' educational level (*parents edu*) and social class (*parents class*)⁴. Definitions adopted to identify the categories of the latter variables are briefly illustrated in Table 2.

Among the features concerning Ph.D programs, we consider the age at completion of Ph.D (*Ph.D age*)⁵, the scientific field of study (*study field*) and the duration of the Ph.D course (*Ph.D end*), the latter taking the value of one if the Ph.D has been completed in three years, that is, the legal duration of doctoral programs in Italy, and zero in case of extra-time. Furthermore, we include a dummy for Ph.D funding (*financial support*) describing whether graduates benefited from some economic resources (scholarships or other incomes) during the Ph.D, a dummy for the completion of a visiting period abroad (*visiting abroad*)⁶ and also a variable (*recent cohort*) accounting for the distance between the year of the survey and the year of Ph.D completion in order to identify the most recent cohort of graduates that enter the labour market in each survey. The dummy *recent cohort* is equal to one for those who were awarded the title in 2006 and in 2010, and zero for the others. Finally, to control for institutional characteristics at university level, and mainly the Ph.D quality effect, we used the province where the university awarding the Ph.D title is located (*province*)⁷.

As for the job attributes of Ph.D graduates, we first consider whether family networks or other informal channels helped in getting the job (*informal access*). In addition, we control for the economic sector of employment by using a dummy taking value of one if the respondent works in the academic sector and zero otherwise (*academic*). We also assess whether the job is mainly based on R&D activities (*R&D*). Furthermore, we take into account if Ph.D recipients

⁴For the definition of the variable *parents class* we followed ISTAT (2003).

⁵The format of microdata used in this analysis does not report the puntual age of respondents; it reports age by class at the time of Ph.D completion. Because of different coding of age classes across surveys, we have been only able to build a dummy variable taking value of one if the title has been obtained at the age of 29 or earlier and zero otherwise.

⁶The first survey (2009) reports some information about the courses and other activities (workshops, seminars, etc.) attended during the doctoral program. Unfortunately, the second survey (2014) does not contain any information on these aspects.

⁷In the dataset of micro-data used in this analysis, the only information available at the university level is the province where the university awarding the title is located.

work as employed or self-employed workers (*selfemployed*) and we include a variable describing whether the job is full or part-time (*part time*). Finally, we consider the number of professional experiences between the year of Ph.D end and the year of the survey (*jobexp*) and we use the region of residence (*macroarea*) as a proxy for those labour market conditions not captured by the previous variables (to account for unobserved heterogeneity).

Concerning the selection equation, the estimation procedure requires the inclusion among the $\mathbf{z}_i$ covariates of Equation (3) of some variables that can be legitimately excluded from the $\mathbf{x}_i$ of Equation (1). In other words, we need to find some variables influencing the probability of being employed at the time of the survey, but not the probability of being over-educated. Following the reference literature, we used two variables pertaining to the graduate's own family as exclusion restrictions for the employment equation: marital status (*married*) and children (*children*). More specifically, studies on the reliance of wage premium for married men have confirmed that married men are, or are perceived to be, more valuable employees as more stable and committed workers (see de Linde Leonard and Stanley (2015) for a recent survey). This prejudice may help married men to outperform in employment selection. Additionally, it is well documented the inertia of sociological models such as "male bread winner", that assign more financial responsibility on man, within Italian families (Naldini and Jurado, 2013). Besides the marital status, also to have children may have some bearing on the motivation of the Ph.D graduate towards paid employment, as pointed out in Dolton and Vignoles (2000) and Di Pietro and Cutillo (2006) and, also in this case, the influence of childcare may be different between men and women. In the light of the arguments just illustrated, the variables chosen as exclusion restrictions have been included in the selection equation both directly and interacted with the variable *sex*. Additionally, socio-demographic information, Ph.D-related features and the variable on the area of residence are included among the regressors of the employment status in the selection equation.

All the dependent and independent variables outlined above are briefly defined in Table 2, which also reports the relevant summary statistics.

We deepen our analysis on employment outcomes of Ph.D holders by assessing their performance in two very different periods. We evaluate drivers of over-education according to whether Ph.D graduates were awarded their degree before or after the global financial and economic crisis that hit dramatically the labour market. As we know, starting in 2007-2008, the financial crisis rapidly propagated around the world. Its effects on economic performance, labour productivity and employment reached a peak in the big recession dated 2008-2009 but all negative effects are still ongoing because of even longer lags and hysteresis phenomena. In addition, in some European countries the financial crisis was followed by the sovereign debt crisis which first involved Greece and then affected Italy as well, assuming a systemic dimension with negative impact on the level of the economic activity (Alessandrini et al., 2014). Eventually, these two crises worsened the performance of the labour market in several ways: people worked fewer hours, the number of jobs available fell, unemployment rose, expectations deteriorated, wages hardly rises if not shrunk and labour market turnover slowed. With regard to these scenarios, some efforts have been devoted by scholars to evaluate the impacts of the crises on the weakest segments (young people, old workers, women, etc) of the labour market (Choudhry et al., 2012; Signorelli et al., 2012; Barakat et al., 2010). However, effects on high skilled human resources,

Table 2: Variables and summary statistics

Variable (<i>label</i>)	Description	Obs	Mean	Std. Dev.	Min	Max
DEPENDENT VARIABLES						
Over-skilling (<i>oversk</i>)	dummy=1 if over-skilled	27189	0.499	0.500	0	1
Over-qualification (<i>overqual</i>)	dummy=1 if over-qualified	18564	0.197	0.398	0	1
Employment (<i>employ</i>)	dummy=1 if employed	29286	0.928	0.258	0	1
SOCIO-DEMOGRAPHIC VARIABLES						
Sex (<i>sex</i>)	dummy=1 if female	29286	0.521	0.500	0	1
Citizenship (<i>citizenship</i>)	dummy=1 if Italian	29286	0.984	0.126	0	1
Marital status (<i>married</i>)	dummy=1 if married or living together	29286	0.523	0.499	0	1
Children (<i>children</i>)	dummy=1 if having at least one child	29286	0.377	0.485	0	1
Parents education (<i>parents edu.i</i>)	Parents' highest educational level:					
	.1: junior high school diploma or lower*	29286	0.253	0.435	0	1
	.2: high school or post-high school diploma	29286	0.378	0.485	0	1
	.3: degree or post-graduate	29286	0.369	0.483	0	1
Parents class (<i>parents class.i</i>)	Parents' highest social class:					
	.1: bourgeoisie*	29286	0.301	0.459	0	1
	.2: middle class	29286	0.400	0.490	0	1
	.3: petite bourgeoisie	29286	0.170	0.376	0	1
	.4: working class	29286	0.101	0.301	0	1
	.5: other	29286	0.027	0.164	0	1
Ph.D-RELATED VARIABLES						
Recent cohort(s) (<i>recent cohort</i>)	dummy=1 if most recent cohort of graduates	29286	0.536	0.499	0	1
Age at graduation (<i>Ph.D age</i>)	dummy=1 if 29 (or younger)	29286	0.284	0.451	0	1
Ph.D end (<i>Ph.D end</i>)	dummy=1 if regular duration of Ph.D (3 years)	29286	0.860	0.347	0	1
Visiting abroad (<i>visiting abroad</i>)	dummy=1 if visiting abroad for at least 1 month	29286	0.350	0.477	0	1
Financial support (<i>financial support</i>)	dummy=1 if funding during Ph.D	29286	0.918	0.274	0	1
Study field (<i>study field</i>)	Ph.D scientific field of study:					
	- Hard sciences	29286	0.257	0.437	0	1
	- Medicine	29286	0.143	0.350	0	1
	- Agriculture and Veterinary sciences	29286	0.067	0.250	0	1
	- Technical Sciences	29286	0.191	0.393	0	1
	- Economics and Statistics*	29286	0.059	0.236	0	1
	- Law	29286	0.072	0.259	0	1
	- Socio-political sciences and humanities	29286	0.210	0.407	0	1
JOB-RELATED VARIABLES						
Self-employment (<i>selfemployed</i>)	dummy=1 if self-employed	27189	0.138	0.345	0	1
Informal access (<i>informal access</i>)	dummy=1 if informal channels to find job	27189	0.078	0.267	0	1
Academic (<i>academic</i>)	dummy=1 if academic sector	27189	0.342	0.474	0	1
R&D (<i>R&D</i>)	dummy=1 if R&D prevalent in job	27189	0.431	0.495	0	1
Part time (<i>part time.i</i>)	Part-/Full-time contract:					
	.0: Full-time*	27189	0.895	0.306	0	1
	.1: Part-time (no full-time opportunities)	27189	0.063	0.244	0	1
	.2: Part-time (by choice)	27189	0.041	0.199	0	1
Job experience (<i>jobexp.i</i>)	Number of jobs:					
	.0: One job (current) started before Ph.D completion*	27189	0.317	0.465	0	1
	.1: One job (current) started after Ph.D completion	27189	0.299	0.458	0	1
	.2: More than one job after Ph.D completion	27189	0.384	0.486	0	1
Macroarea (<i>macroarea</i>)	Macroarea of residence:					
	- North-West	29286	0.206	0.404	0	1
	- North-East	29286	0.173	0.379	0	1
	- Centre	29286	0.254	0.435	0	1
	- South	29286	0.180	0.384	0	1
	- Islands	29286	0.092	0.289	0	1
	- Abroad*	29286	0.095	0.293	0	1

* denotes the reference category in the estimation.

Table 3: Over-education before and after the crisis (%)

		Before the crisis	After the crisis	Total
Over-skilling	No	54.7	46.5	50.1
	Yes	45.3	53.5	49.9
	Total	100.0	100.0	100.0
Over-qualification	No	80.8	79.9	80.3
	Yes	19.2	20.1	19.7
	Total	100.0	100.0	100.0

Source: ISTAT 2009, 2014

and specifically Ph.D holders, have received little attention. Indeed, the placement of workers became a crucial issue which invested also high skilled labour force.

Moreover, in the case of Italy the law 240/2010, which came into force on 2010, has reformed profoundly the university system as it hampered the perspective of stable and permanent occupations and careers for academic personnel⁸. Focussing on the effects that mostly affect Ph.D recipients, who largely ended up working into the academia, the access system towards an academic career has been modified causing a greater precariousness for newcomers. Positions to enter the academic career are generally more scarce and researchers are forced to attain a professorship by a few years in order to avoid losing their job⁹.

As a matter of fact, our data, as shown in Table 3, report that the incidence of over-skilling substantially increases during the crisis, while the proportion of over-qualified appears to be more stable across the two periods.

The above considerations led to pursue a comparative analysis of drivers of over-education before and after the economic crisis and the Italian university reform assuming that the labour market operates in significantly different economic conditions and with different opportunities to the newcomer Ph.D holders. We separately estimate the general model outlined by equations 1-3 distinguishing the two sub samples of Ph.D graduates, those who obtained a doctoral degree in years 2004 and 2006 and those who got it in 2008 and 2010. Eventually, it should help also to gain some suggestions as to conceive public policies that could prevent the waste and underutilization of highly qualified human resources.

⁸Among other things, the new law changed the model of governance for universities, the recruitment and the career system of professors and the assessment model to evaluate universities and courses' performance.

⁹In particular, the law 240/2010 envisages two different kinds of researcher (*ricercatore*, who represents the first position of the Italian academic career): researchers of type A who can be hired only for a maximum of 5 years and researchers of type B to whom instead is recognized a tenure track subject to the attainment of the national scientific diploma within a three-year period.

3 Results and discussion

This section presents the empirical results of the econometric model for over-skilling determinants. Firstly, we consider the whole sample of Ph.D recipients. Then, we distinguish between the two sub-samples of doctoral graduates, i.e. those who were awarded their degree before and after the crisis.

Table 4 reports the estimates of the probability of being over-skilled for all the Ph.D recipients obtained by using a probit model (column 1) and a probit model with sample selection (columns 2 and 3). As the coefficient of the selection term is statistically different from zero, we focus on the estimates of the probit model with sample selection¹⁰. The variables chosen as instruments in the selection equation are significant and show the expected sign: having children and being married increase the probability of getting a job, denoting a relatively higher urgency to provide family sustenance. However, when also the sex variable is taken into account, a disadvantage for women emerges: being a woman with children or being a married woman reduces the probability of finding a job, confirming our theoretical predictions. Overall, results of the whole selection model return to be almost stable across all the estimations.

Focussing on the main model, our results report a weak impact of the socio-demographic characteristics of Ph.D holders, a piece of evidence already emerged in previous studies (Gaeta, 2015; Di Paolo and Mañé, 2014). Only the citizenship variable shows a significant coefficient, providing evidence of the higher probability of incurring into over-skilling for Italian citizens. This finding is not common in the literature about over-education (Dell’Aringa and Pagani, 2011; Beckhusen et al., 2013; Green et al., 2007) even if Lindley (2009) finds some positive returns to occupational skills for some minority ethnic and immigrant groups. Some explanations could be provided for this evidence. Those graduates having a non-Italian citizenship may decide to enter the Italian labour market and work in Italy only for employment opportunities that are particularly worthy and that are characterized, indeed, by a proper match with their educational profile. Otherwise, going back to the country of origin or working elsewhere may be an option. Social background, as proxied by parents’ education and class, provides to be not significant in predicting over-skilling for the whole sample. This finding diverges from previous empirical evidence of positive correlation between higher socio-economic family endowment and job-education matching observed with regard to workers in general (Di Pietro and Cutillo, 2006), a result which adds evidence to those studies that affirmed that, especially in Italy, intergenerational social mobility is persistently low (Checchi, 2010; Causa and Johansson, 2011)¹¹.

¹⁰Nevertheless, the probit model and the probit model with sample selection return similar estimated coefficients in terms of sign and significance.

¹¹Nevertheless, we cannot exclude that socio-economic background influences labor market outcomes in a more indirect way. For example, by influencing the probability of getting a job as, according to our estimates, parents’ social class is highly significant in the selection equation. In addition, the indirect impact of socio-economic background may reveal by influencing the channels to access work (Gaeta, 2015) or the educational choice pattern starting already from high school (Brunello and Checchi, 2007; Caroleo and Pastore, 2013).

Table 4: Determinants of over-skilling. All, before and after the crisis.

	All			Before the crisis			After the crisis		
	<i>Probit</i>	<i>Probit with sample sel.</i>		<i>Probit</i>	<i>Probit with sample sel.</i>		<i>Probit</i>	<i>Probit with sample sel.</i>	
	(1) oversk	(2) oversk	(3) employm	(4) oversk	(5) oversk	(6) employm	(7) oversk	(8) oversk	(9) employm
Sex	0.049** [0.019]	-0.003 [0.019]	-0.009 [0.033]	0.055** [0.028]	-0.002 [0.027]	-0.031 [0.054]	0.041 [0.027]	0.052* [0.028]	0.023 [0.042]
Citizenship	0.263*** [0.079]	0.261*** [0.075]	0.168* [0.093]	0.470*** [0.162]	0.455*** [0.156]	0.070 [0.212]	0.183** [0.089]	0.176** [0.089]	0.159 [0.100]
Parents edu_2	-0.026 [0.028]	-0.035 [0.027]	-0.054 [0.035]	0.004 [0.041]	-0.005 [0.039]	-0.026 [0.054]	-0.035 [0.041]	-0.032 [0.041]	-0.069 [0.047]
Parents edu_3	0.001 [0.032]	-0.002 [0.031]	-0.002 [0.041]	-0.015 [0.047]	-0.009 [0.044]	0.039 [0.063]	0.041 [0.047]	0.042 [0.047]	-0.023 [0.055]
Parents class_2	0.030 [0.024]	0.012 [0.023]	-0.088*** [0.030]	0.038 [0.034]	0.025 [0.032]	-0.054 [0.047]	0.040 [0.034]	0.044 [0.034]	-0.096** [0.041]
Parents class_3	0.035 [0.034]	-0.001 [0.033]	-0.161*** [0.043]	0.010 [0.048]	-0.014 [0.045]	-0.125** [0.062]	0.095* [0.050]	0.103** [0.050]	-0.179*** [0.058]
Parents class_4	-0.003 [0.041]	-0.026 [0.039]	-0.126** [0.051]	0.025 [0.061]	-0.010 [0.057]	-0.155** [0.077]	-0.003 [0.059]	0.001 [0.059]	-0.068 [0.070]
Parents class_5	0.021 [0.063]	-0.042 [0.060]	-0.251*** [0.072]	0.017 [0.131]	0.020 [0.122]	0.001 [0.145]	0.022 [0.078]	0.038 [0.079]	-0.307*** [0.086]
Ph.D age	-0.006 [0.022]	0.007 [0.021]	0.067** [0.029]	-0.051 [0.032]	-0.033 [0.030]	0.040 [0.044]	0.054* [0.031]	0.050 [0.031]	0.118*** [0.038]
Financial support	0.100*** [0.036]	0.109*** [0.034]	0.067* [0.041]	-0.129*** [0.041]	-0.155*** [0.038]	-0.207*** [0.055]	-0.146* [0.084]	-0.187** [0.092]	0.606*** [0.065]
Recent cohort	-0.026 [0.019]	-0.045** [0.018]	-0.105*** [0.024]	0.033 [0.028]	0.006 [0.026]	-0.142*** [0.037]	-0.043 [0.027]	-0.036 [0.027]	-0.107*** [0.032]
Ph.D end	-0.099*** [0.029]	-0.081*** [0.027]	0.022 [0.034]	-0.086* [0.045]	-0.075* [0.042]	-0.005 [0.058]	-0.088** [0.038]	-0.088** [0.038]	0.020 [0.043]
Visiting abroad	-0.143*** [0.020]	-0.116*** [0.020]	0.063** [0.026]	-0.126*** [0.031]	-0.085*** [0.030]	0.139*** [0.043]	-0.161*** [0.028]	-0.163*** [0.028]	0.052 [0.034]
Hard Sciences	0.107** [0.044]	0.068 [0.042]	-0.178*** [0.056]	0.133** [0.063]	0.088 [0.060]	-0.177** [0.086]	0.131** [0.063]	0.137** [0.063]	-0.158** [0.076]
Medicine	0.245*** [0.047]	0.227*** [0.045]	0.021 [0.062]	0.302*** [0.069]	0.270*** [0.065]	0.030 [0.096]	0.271*** [0.067]	0.268*** [0.067]	0.015 [0.084]
Agric. and Veter. Sc.	0.191*** [0.055]	0.134** [0.053]	-0.211*** [0.069]	0.305*** [0.079]	0.237*** [0.075]	-0.144 [0.106]	0.116 [0.079]	0.126 [0.080]	-0.241*** [0.093]
Technical Sciences	0.154*** [0.045]	0.149*** [0.043]	0.087 [0.060]	0.203*** [0.065]	0.196*** [0.062]	0.140 [0.093]	0.176*** [0.062]	0.173*** [0.064]	0.056 [0.082]
Law	0.281*** [0.053]	0.234*** [0.051]	-0.133** [0.067]	0.083 [0.076]	0.070 [0.072]	-0.038 [0.106]	0.494*** [0.078]	0.500*** [0.078]	-0.214** [0.089]
Soc.-Pol. Sc. and Hum.	0.147*** [0.044]	0.064 [0.043]	-0.346*** [0.055]	0.125** [0.064]	0.053 [0.060]	-0.322*** [0.086]	0.173*** [0.063]	0.190*** [0.064]	-0.343*** [0.075]
Job exp_1	0.132*** [0.025]	0.124*** [0.023]		0.576*** [0.037]	0.529*** [0.034]		-0.259*** [0.036]	-0.257*** [0.035]	
Job exp_2	0.042* [0.024]	0.041* [0.022]		0.550*** [0.037]	0.507*** [0.034]		-0.345*** [0.033]	-0.342*** [0.033]	
Selfemployed	0.095*** [0.029]	0.083*** [0.027]		0.035 [0.043]	0.031 [0.038]		0.227*** [0.043]	0.227*** [0.042]	
Informal access	0.062* [0.035]	0.058* [0.032]		-0.006 [0.051]	0.006 [0.047]		0.158*** [0.048]	0.157*** [0.047]	
Academic	-1.102*** [0.023]	-1.046*** [0.022]		-1.002*** [0.034]	-0.950*** [0.032]		-1.211*** [0.033]	-1.203*** [0.035]	
R&D	-1.150*** [0.020]	-1.085*** [0.020]		-1.021*** [0.031]	-0.956*** [0.029]		-1.291*** [0.029]	-1.284*** [0.031]	
Part time_1	0.259*** [0.039]	0.224*** [0.035]		0.138** [0.064]	0.096* [0.055]		0.316*** [0.050]	0.315*** [0.049]	
Part time_2	0.268*** [0.052]	0.222*** [0.047]		0.174*** [0.067]	0.120** [0.057]		0.537*** [0.079]	0.535*** [0.079]	
North-West	0.520*** [0.044]	0.505*** [0.042]	0.060 [0.058]	0.595*** [0.075]	0.575*** [0.072]	0.036 [0.104]	0.514*** [0.057]	0.510*** [0.057]	0.030 [0.072]
North-East	0.567*** [0.046]	0.536*** [0.044]	0.017 [0.061]	0.641*** [0.080]	0.608*** [0.077]	-0.092 [0.111]	0.542*** [0.059]	0.538*** [0.059]	0.018 [0.074]
Centre	0.460*** [0.041]	0.433*** [0.040]	-0.027 [0.054]	0.563*** [0.073]	0.530*** [0.070]	-0.086 [0.100]	0.418*** [0.053]	0.417*** [0.053]	-0.041 [0.066]
South	0.361*** [0.048]	0.287*** [0.046]	-0.296*** [0.061]	0.465*** [0.079]	0.406*** [0.076]	-0.267** [0.107]	0.320*** [0.064]	0.337*** [0.065]	-0.381*** [0.078]
Islands	0.424*** [0.060]	0.364*** [0.057]	-0.221*** [0.071]	0.456*** [0.098]	0.398*** [0.094]	-0.318** [0.127]	0.424*** [0.080]	0.431*** [0.079]	-0.225** [0.088]
Children			0.202*** [0.053]			0.049 [0.084]			0.398*** [0.069]
Sex*children			-0.375*** [0.062]			-0.309*** [0.098]			-0.451*** [0.084]
Married			0.313*** [0.045]			0.337*** [0.071]			0.218*** [0.062]

Table 4: continued from the previous page

	All			Before the crisis			After the crisis		
	Probit (1) oversk	Probit with sample sel. (2) (3) oversk employm		Probit (4) oversk	Probit with sample sel. (5) (6) oversk employm		Probit (7) oversk	Probit with sample sel. (8) (9) oversk employm	
Sex*married		-0.275*** [0.057]			-0.265*** [0.089]			-0.282*** [0.077]	
Constant	-0.071 [0.112]	-0.121 [0.107]	1.550*** [0.137]	-0.620*** [0.210]	-0.571*** [0.200]	2.066*** [0.272]	0.494*** [0.160]	0.550*** [0.166]	0.945*** [0.167]
Province dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	27,185	29,286	29,286	12,098	12,964	12,964	15,087	16,322	16,322
Wald test of $\rho = 0$ (p-value)		49.58 (0.000)			25.10 (0.000)			1.21 (0.272)	

Legend: Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.

As for the Ph.D-related features, quite surprisingly the estimates show that the occurrence of financial support during the doctoral studies increases the probability of incurring into over-skilling. Differently, the other variables concerning the graduate course turn out to be negatively associated with over-skilling. More recent cohorts of graduates have a higher probability to get a job adequately matching their educational profile in terms of skills and competences. The labour market seems to reward those who are endowed with more updated skills. This result is at odds with studies that predict over-education as a temporary status. Indeed, it hits more older graduates (Rubb, 2003). Similarly, Ph.D graduates who finish their doctoral course without asking for extra-time register a lower risk of mismatch. Moreover, Ph.D graduates who have done research abroad are found to be at lower risk of mismatch relatively to their non-internationally mobile peers. Even if we cannot disregard that this difference may depend on unobserved individual features, nevertheless the experience of a visiting abroad may integrate the educational training, therefore constituting a signal of a better-quality educational pattern. Among the scientific fields of study, Economics and Statistics (the reference category) turns out to be the discipline associated with the lowest probability of incurring in over-skilling with the only exception of Hard Sciences and Socio-political Sciences and Humanities, whose coefficients are not statistically different from the reference field of study.

Looking at the job-related variables, it emerges that self-employed workers are characterized by a higher risk of mismatch compared to those working as employees. Such a finding confirms that the Italian labour market still does not offer adequate opportunities to exploit the skills and competences acquired during the Ph.D. Getting additional insights into the indirect impact of the socio-economic background on labor-market outcomes, it emerges that Ph.D holders who declare they got a job through personal channels are more likely to incur into over-skilling. This result validates the conclusions put forward by Lin et al. (2001) according to which accessing a job via informal channels shortens the time of waiting but does not always yields better professional outcomes. Additional job-related attributes play a strong effect on over-skilling. Doctoral programs confirm to be a forge of qualified human capital particularly tailored for research activity. Those who are employed in the academic sector or conduct R&D activity within other institutions or firms do report a lower risk to be over-skilled as they can entirely take advantage of the knowledge acquired during their doctoral studies. Having a part-time job both by choice or due to the lack of full-time opportunities worsens the probability of finding the proper job-education matching compared to full-time contracts. In addition, when the whole sample is assumed, to start working after the completion of the Ph.D seems to increase the probability of incurring into over-skilling compared to start before the attainment of the doctoral title. Finally, local labour market conditions influence the likelihood of being mismatched. Accord-

ingly, we observe that people who live abroad (the reference category), in comparison to those living anywhere in Italy, have better chances to properly utilize their skills and competences.

In order to highlight the possible differences before and after the financial crisis and the university reform, we then move to estimate the model separately for the first two cohorts of graduates (2004 and 2006) and the latter two (2008 and 2010) in order to distinguish the pre- and after-crisis period respectively.

As to the choice of the relevant econometric model, we observe that the selection mechanism into the labour market is at work for those who graduated before the economic crisis, while it is not relevant afterwards. Moreover, as for the pre-crisis model, instruments prove to be relevant for the selection¹².

The separated estimates confirm a marginal relevance of the socio-demographic variables, with the exception of *citizenship*, in explaining the probability of being over-skilled, regardless of the examined period.

Not trivial to interpret is the result about the age at Ph.D completion. It does not represent a significant predictor of the mismatch for the years preceding the crisis. Differently, being awarded the doctoral title at the age of 29 or earlier is positively and significantly associated with the risk of over-skilling in more recent years, thus denoting a penalization for younger Ph.D graduates during the downturn. With regard to other Ph.D-related features, a striking difference with the full sample results is the evidence that, in both sub-samples, receiving a financial support during Ph.D studies enhances the probability for Ph.D graduates to find a proper job-education matching. Such a result may suggest that to benefit from some forms of income offers a better opportunity to concentrate efforts on studies by reducing the need of devoting time to income generating activities to support the doctoral course (Nisticò, 2014). Furthermore, having benefited from financial support during the doctoral studies may lower financial constraints of unemployed Ph.D graduates by strengthening their resilience during the job search, allowing them to await and carry on searching longer until they find a matched job. Finally, since Ph.D scholarships represent the source of income for the vast majority of the graduates of the sample¹³, the dummy for income may be also a proxy for the quality of Ph.D holders suggesting that more talented workers can achieve better positions in the job market. Moreover, we do not detect a differentiated propensity for over-skilling among cohorts of graduates. Interestingly enough, the *visiting abroad* variable plays a relevant role in contrasting over-skilling both in pre- and post-crisis, as already emerged with regard to the full sample.

A differentiated effect between the Ph.D graduates before and after the crisis emerges as to the job experience indicators. In the pre-crisis scenario, those who enter the labour market for the first time after the attainment of their Ph.D (*jobexp_1* and *jobexp_2*) encounter more difficulties in finding a matched job, while the opposite holds during the recession. Moreover, working as a self-employed or as an employee is not statistically different in the years preceding the crisis; on the contrary, being self-employed increases the risk of incurring in over-skilling during the recession. It could be assumed that in good economic times, financial constraints tend to be less

¹²We performed a Wald test for the joint significance of the coefficients of the variable *children* and of the interaction between *children* and *sex*, rejecting the null hypothesis that both the coefficients are simultaneously equal to zero.

¹³80% of Ph.D graduates with an income during the doctoral studies were granted a scholarship from the University.

binding and it could be more easy to start and run a business able to effectively exploit specialized skills and highly qualified human capital. Differently, during the crisis, investments may shrink and, especially if closing a business is costly in presence of a legislation that penalizes business failures and makes it difficult for firms to exit, valuable skills might be trapped in inefficient firms thus increasing the probability of mismatch (McGowan and Andrews, 2015; Bender and Roche, 2013). Also the variable *informal access* performs differently before and after the crisis. The estimated coefficients confirm that, during a downturn, informal networks may offer a useful contribution in finding a job without ensuring, however, a proper match. In fact, while in good times, when professional opportunities are more abundant, jobs can be found through several channels, during a recession workers may be forced to rely more on informal access which may represent an effective way to get a job but at the expense of possible unfavorable effects in terms of matching. As for the remaining determinants of over-skilling, no relevant differences emerge in the pre- and after-crisis periods and in comparison with the full sample.

4 Robustness

As a robustness check, we re-estimate our model of mismatch's determinants assuming an alternative measure of over-education, that is over-qualification, and different sub-samples.

4.1 Over-qualification

As a robustness check of the results discussed so far we assume a different definition of over-education, specifically over-qualification. As briefly described in Section 2.1, the survey's design produces this variable only for those Ph.D graduates who found a job after the attainment of the doctoral title. As a consequence, the use of over-qualification as a dependent variable does not allow anymore to include the variable *jobexp* in the empirical model.

To facilitate the comparison between the results for over-qualification and over-skilling, we have re-estimated the determinants of over-skilling by assuming the same sample for which the variable over-qualification is defined and, consequently, by excluding the variable *jobexp*. The resulting estimates for over-qualification and over-skilling are presented respectively in Table A.1 and Table A.2 in the Appendix.

The selection mechanism points out to rely on a probit with sample selection to study the determinants of both over-qualification (Table A.1, columns 2 and 3) and over-skilling (Table A.2, columns 2 and 3) for doctoral graduates who entered the labour market after the Ph.D¹⁴.

Focussing on the main equation, the estimates refer no association between socio-demographic variables and overqualification. With the exception of the variable *citizenship*, this result holds also for over-skilling.

Differently, a relevant contribution is offered by the Ph.D-related features. Firstly, it emerges that those who complete the doctoral course at the age of 29 or earlier reduce their risk of over-qualification. Interestingly, when over-skilling is considered, this variable proves to be not significant as it might not provide indications on the skills and competences possessed by the worker.

¹⁴The variables chosen as instruments perform as expected in predicting the probability of being employed: being married and having children prompt individuals to work but can be an obstacle if the worker is a woman.

On the contrary, if the title is a necessary condition to get the job and thus it is a yardstick to assess the job-education match, a lower age at Ph.D completion may reflect the ease of a successful educational trajectory. It could be interpreted as a proxy of students' ability but also as an indicator of steadfastness and motivation in finalizing the educational career without interruptions. It should favor, in turn, positive outcomes in the labour market. Second, in line with our expectations, it emerges that having benefited from some source of income enhances the probability for Ph.D graduates to find a proper job-education matching. In addition, having spent some period abroad during the doctoral studies reduces the risk of incurring into over-qualification. These pieces of evidence found for over-qualification do not differ from the results for over-skilling. Finally, concerning the Ph.D field of study, Economics and Statistics is the discipline associated with the lowest probability of incurring in over-education, while no significant difference between the reference category and both *hard science* and *technical science* is detected.

With reference to the job-related determinants, we observe a higher risk of being mismatched for self-employed workers and for those graduates who got their job relying on informal channels, and a lower likelihood of over-qualification in case of research-intensive occupations. Moreover, working full-time and living abroad ensure better chances in terms of finding a job in line with the educational profile. These findings obtained for over-qualification corroborate the evidence detected for over-skilling.

In order to investigate the possible impact of the crisis on over-qualification, the relevant econometric model for the pre-crisis period is a simple probit (Table A.1, column 4). Differently, for the years after the crisis we discuss the results obtained by estimating a probit model with sample selection (Table A.1, columns 8 and 9).

We confirm the absence of correlation between socio-demographic variables and overqualification in both the two subsamples. Concerning the Ph.D related attributes, while the negative and statistically significant coefficient of *visiting abroad* has not a differentiated impact across periods, the variables *financial support* and *recent cohort* turn out to gain significance solely during the years of the crisis. During the downturn, to benefit from some forms of financial support reduces the probability of incurring into over-qualification while belonging to the more recent cohort of graduates represents a source of penalization by increasing the risk of job-qualification mismatch. The latter result suggests that being newcomers in the job market and (possibly) less experienced Ph.D graduates does not exert any influence on the probability of finding the matched job in a well-functioning labour market. Differently, it represents a source of fragility in time of crisis, hopefully only temporary, worsening the risk of incurring in job-education mismatch. Additionally, a negative and significant association between the age at Ph.D completion and over-qualification is found only for the years preceding the crisis. Finally, no large differences across the two periods occur about the job-related variables.

Overall, the results for over-qualification substantially confirm the estimates of over-skilling across periods. Coefficients usually return the same sign even if sometimes the statistical significance is different (*citizenship*, *financial support*); the variable *recent cohort* turns out to play no role in influencing over-skilling in both periods (Table A.2, columns 5 and 7).

4.2 High mismatch: jointly over-skilling and over-qualification

As a second robustness check, we analyze the determinants of the job-education mismatch by using as dependent variable a dummy, denoted as *high mismatch*, taking value of one if the PhD graduates declare to be both over-skilled and over-qualified, and zero otherwise. Among the high-qualified workers, these individuals are the most penalized in the labour market. By definition of over-qualification, this dummy is computed for the restricted sample of those who started working after the Ph.D.

The selection mechanism indicates as reference model to evaluate the high mismatch the probit with sample selection. The corresponding results are shown in Table A.3, columns 2 and 3. Instead, we focus on a probit model for the years preceding the crisis and a probit with sample selection during the recession.

The above models return results that almost replicate the evidence obtained when over-qualification was examined. A notable exception can be appreciated with regard to the variable *sex*. Even if the gender variable plays usually a significant role in dampening the participation in the labour market¹⁵, it is the first time that the variable *sex* impacts significantly as an over-education determinant. If gender is usually not a factor that worsens the probability of good matching in the job market, being a woman turns out to be a penalty driver when instead we focus on the whole sample of the most mismatched workers. It suggests a possible segregation of women in the less rewarded positions. Moreover, when sub-samples are concerned, it emerges that the variable *sex* plays a role exclusively during the recession. It is not surprising given that in this period the labour market is more selective.

5 Final remarks

Over-education is still a persistent phenomenon of modern societies, which also concerns educated workers. This paper focused on Ph.D graduates in Italy aiming to discern the main drivers of over-education, distinguishing between over-skilling and over-qualification, and investigating the potential effects of both the financial crisis and the recent university reform. We apply our analysis to the two cross-sectional surveys of Italian Ph.D holders, released by ISTAT in 2009 and 2014. These surveys include the universe of Italian Ph.D recipients and allowed us analyzing a number of variables linked to over-education never investigated before. Based on these surveys over-education emerges as a widespread phenomenon among Italian Ph.D graduates. Almost 50% of the respondents declare to be over-skilled, whereas about 20% result over-qualified. These percentages increase during the recession, markedly in the case of over-skilling.

Our results highlight that socio-demographic variables have a different effect on Ph.D recipients compared with what the empirical literature has found for college graduates. As a whole, socio-demographic variables do not seem to affect significantly the probability of being over-educated. Being a woman, even if it affects the participation in the labour market, is not usually crucial for over-education but, as a remarkable exception, female workers appear to significantly

¹⁵The variable *sex* and the related interaction terms are statistically significant in the selection mechanism of the estimation framework outlined in Equations 1-3.

suffer from the mismatch when the group of both over-skilled and over-qualified Ph.D graduates are jointly considered, possibly signaling the occurrence of gender polarization in the less rewarded jobs. This effect is strengthened during the recession when the labor market might be more selective. It is also surprising that the family of origin of doctoral graduates does not influence over-education, a result which is unusual for the rest of the Italian labour force. In fact, several studies have acknowledged a deterministic relationship between socio-economic background and professional outcomes, with specific regard to graduates (Checchi, 2010; Groot and Van Den Brink, 2000). Conversely, our results suggest that when high levels of human capital are considered this rigidity of the Italian labour market is overcome.

More than the socio-demographic aspects, the doctoral educational path turns out to be strategic for the outcome in the labour market. Spending a visiting period abroad during the Ph.D represents a valuable investment in human capital which is very helpful to avoid over-skilling and over-qualification in future career. A similar effect is found if students have benefited from some financial support during the doctoral course. Additionally, the completion of Ph.D without extra-time may reduce the risk of over-skilling.

In terms of policy implications, over-education is not only a problem for individuals (dissatisfied workers) and firms (declining productivity) but should be also a concern for policy makers. First, governments devote growing amount of financial resources to Ph.D initiatives; consequently they have the duty of monitoring the real effect and the return of public investment in doctorate programs. Shedding light about over-education makes the government (and the PhD market) better decision makers. Second, policy makers can affect the over-education phenomenon by influencing both the demand for and the supply of Ph.D graduates. For instance, demand policies might provide tax incentives for hiring skilled workers, whereas, on the other hand, governments could affect the supply of PhD, for example, reducing the private costs of doctorates, or, if necessary, taking into consideration the distributional heterogeneity of over-education among different subjects. If so, the government has to face the issue of how to re-orientate the Ph.D system away from those areas where over-education is higher. Our findings also provide a strong support to design Ph.D courses with powerful incentives to do research activity abroad, not only to improve employability, but also to reduce over-education. Third, the public sector is the largest employer of Ph.D graduates. Our results corroborate the idea that providing public support does not necessarily imply a waste of public resources, as, among other things, it can favor better results in terms of matching. This indication proves to be relevant especially in a time of shortage of public funding of the academic sector. Moreover, the impact of ensuring funding to Ph.D students may reinforce their probability to avoid over-education as it helps to achieve the graduation day without extra-time.

More in line with the assignment model approach, job-related characteristics are strong drivers of over-education as well. The Italian Ph.D proves to be still a research oriented educational pattern, since working in academia or in research intensive sectors is a undeniable factor for a successful matching. This is partially due to the increasing competition in the academic job market which forces many good candidates to turn to positions outside the academia. In this respect if there is consensus that Ph.D programs should also favor the transfer of knowledge outside academia, our evidence calls out for more incisive policies to achieve such a mission. The current economic crisis makes this need even more urgent. Indeed our findings call for

some policy actions also promoting a more applicable type of knowledge, such as general analytical skills and general problem solving attitude, which might be more valuable outside the academia and pure research sectors. At the same time, attention should be paid to promoting a more knowledge-based development absorbing more high-skilled Ph.D graduates to foster higher value-added productions and reinforcing links between universities and other productive sectors. Given the industrial structure of the Italian economy, strongly based on small enterprises, accommodating a higher number of Ph.D holders represents another reason for a move towards a larger average size of Italian firms. Besides as most of Ph.D holders are usually employees, it is not surprising that working as self-employed does not provide a positive outcome in terms of job-education matching. In fact, we observe that self-employed workers face significant obstacles to find a job that properly matches their education profile in recession times. It may happen because they encounter difficulties to start and/or run an activity at a scale adequate to their skills. Financial constraints, that become more severe during crises, offer a plausible explanation for this occurrence. This opens the route for policy measures, such as broader credit facilities or business incubators, facilitating better future job education matching. Finally, since those who get a job via informal channel incur more likely into over-skilling, an intervention on the placement side is also advisable. It may constitute a suggestion to strengthen the placement services offered by universities in order to increase the employment prospects/match each job candidate with the best possible opportunity to fit her study achievement.

However, as usual, further research is needed not only to better explain our findings about the determinants of over-education, but also to investigate at the Ph.level the role of other variables as for instance the academic standing of teaching and research quality of the university that granted the doctorate. Besides further research should be devoted to better understand the consequences of over-education analyzing, for instance, the relationship between over-education on the one side and earnings and worker satisfaction on the other. There is also a need to study over-education dynamics over time once the great recession will be over, a piece of research that unfortunately we cannot do yet.

A Appendix

Table A.1: Determinants of over-qualification. All, before and after the crisis.

	All*			Before the crisis			After the crisis		
	<i>Probit</i> (1)	<i>Probit with sample sel.</i>		<i>Probit</i> (4)	<i>Probit with sample sel.</i>		<i>Probit</i> (7)	<i>Probit with sample sel.</i>	
	overqual	overqual	employm	overqual	overqual	employm	overqual	overqual	employm
Sex	0.012 [0.026]	0.038 [0.028]	0.005 [0.036]	-0.002 [0.039]	0.007 [0.042]	-0.025 [0.060]	0.020 [0.036]	0.059 [0.037]	0.029 [0.045]
Citizenship	0.089 [0.115]	0.076 [0.113]	0.138 [0.099]	0.206 [0.265]	0.204 [0.222]	0.063 [0.119]	0.052 [0.114]	0.034 [0.114]	0.135 [0.105]
Parents edu_2	-0.004 [0.038]	0.002 [0.038]	-0.047 [0.038]	0.041 [0.056]	0.043 [0.056]	-0.032 [0.058]	-0.048 [0.051]	-0.032 [0.050]	-0.063 [0.051]
Parents edu_3	-0.001 [0.044]	-0.000 [0.043]	-0.007 [0.045]	0.066 [0.065]	0.065 [0.064]	0.027 [0.068]	-0.061 [0.060]	-0.054 [0.058]	-0.022 [0.060]
Parents class_2	0.002 [0.032]	0.010 [0.032]	-0.082** [0.033]	0.058 [0.047]	0.059 [0.047]	-0.067 [0.050]	-0.048 [0.045]	-0.031 [0.044]	-0.082* [0.045]
Parents class_3	0.032 [0.046]	0.049 [0.046]	-0.155*** [0.047]	0.053 [0.065]	0.057 [0.065]	-0.122* [0.068]	0.012 [0.065]	0.043 [0.063]	-0.164*** [0.063]
Parents class_4	0.054 [0.054]	0.065 [0.054]	-0.116** [0.056]	0.035 [0.081]	0.041 [0.082]	-0.178** [0.084]	0.072 [0.074]	0.077 [0.071]	-0.044 [0.076]
Parents class_5	-0.057 [0.083]	-0.018 [0.084]	-0.314*** [0.080]	-0.074 [0.173]	-0.070 [0.173]	-0.115 [0.169]	-0.087 [0.099]	-0.019 [0.099]	-0.313*** [0.095]
Ph.D age	-0.047* [0.028]	-0.064** [0.029]	0.176*** [0.030]	-0.085*** [0.043]	-0.089** [0.043]	0.130*** [0.046]	-0.021 [0.039]	-0.058 [0.039]	0.223*** [0.039]
Financial support	-0.113** [0.049]	-0.126*** [0.049]	0.137*** [0.045]	-0.025 [0.064]	-0.025 [0.063]	0.021 [0.063]	-0.256*** [0.079]	-0.311*** [0.077]	0.322*** [0.067]
Recent cohort	0.041 [0.025]	0.057** [0.026]	-0.152*** [0.026]	0.047 [0.038]	0.054 [0.039]	-0.200*** [0.040]	0.044 [0.035]	0.069** [0.035]	-0.136*** [0.035]
Ph.D end	0.024 [0.041]	0.005 [0.041]	0.139*** [0.039]	0.010 [0.064]	0.006 [0.064]	0.092 [0.065]	0.047 [0.054]	0.017 [0.053]	0.129*** [0.049]
Visiting abroad	-0.090*** [0.028]	-0.105*** [0.028]	0.157*** [0.028]	-0.109*** [0.044]	-0.116*** [0.044]	0.202*** [0.045]	-0.073** [0.037]	-0.100*** [0.036]	0.161*** [0.036]
Hard Sciences	0.046 [0.061]	0.059 [0.061]	-0.131** [0.061]	0.255*** [0.089]	0.261*** [0.089]	-0.193** [0.093]	-0.148* [0.088]	-0.129 [0.085]	-0.074 [0.084]
Medicine	0.227*** [0.066]	0.226*** [0.065]	-0.041 [0.068]	0.437*** [0.096]	0.439*** [0.096]	-0.107 [0.103]	0.057 [0.094]	0.046 [0.091]	0.039 [0.092]
Agric. and Veter. Sc.	0.178** [0.075]	0.196*** [0.074]	-0.204*** [0.075]	0.329*** [0.109]	0.335*** [0.109]	-0.202* [0.113]	0.034 [0.106]	0.065 [0.102]	-0.187* [0.101]
Technical Sciences	0.067 [0.063]	0.062 [0.062]	0.064 [0.066]	0.236** [0.092]	0.235** [0.092]	0.052 [0.100]	-0.080 [0.090]	-0.089 [0.087]	0.079 [0.089]
Law	0.103 [0.078]	0.133* [0.077]	-0.290*** [0.075]	0.307*** [0.111]	0.311*** [0.111]	-0.171 [0.117]	-0.099 [0.112]	-0.021 [0.111]	-0.367*** [0.101]
Soc.-Pol. Sc. and Hum.	0.097 [0.062]	0.140** [0.064]	-0.400*** [0.061]	0.216** [0.091]	0.229** [0.094]	-0.391*** [0.092]	-0.011 [0.089]	0.068 [0.088]	-0.408*** [0.083]
Selfemployed	0.469*** [0.037]	0.461*** [0.037]		0.413*** [0.055]	0.412*** [0.055]		0.514*** [0.051]	0.489*** [0.050]	
Informal access	0.201*** [0.042]	0.198*** [0.041]		0.089 [0.064]	0.089 [0.064]		0.284*** [0.055]	0.271*** [0.053]	
Academic	-0.925*** [0.038]	-0.903*** [0.042]		-0.805*** [0.054]	-0.803*** [0.055]		-1.072*** [0.054]	-0.994*** [0.075]	
R&D	-0.933*** [0.031]	-0.914*** [0.035]		-0.868*** [0.045]	-0.866*** [0.045]		-1.039*** [0.046]	-0.975*** [0.063]	
Part time_1	0.155*** [0.044]	0.154*** [0.043]		-0.031 [0.075]	-0.031 [0.075]		0.248*** [0.055]	0.237*** [0.053]	
Part time_2	0.280*** [0.058]	0.280*** [0.057]		0.205*** [0.078]	0.206*** [0.078]		0.400*** [0.087]	0.387*** [0.083]	
North-West	0.376*** [0.061]	0.369*** [0.060]	-0.008 [0.061]	0.517*** [0.104]	0.516*** [0.104]	-0.017 [0.109]	0.302*** [0.077]	0.293*** [0.073]	-0.046 [0.074]
North-East	0.408*** [0.064]	0.407*** [0.063]	-0.069 [0.063]	0.601*** [0.109]	0.603*** [0.109]	-0.135 [0.113]	0.287*** [0.079]	0.282*** [0.075]	-0.052 [0.077]
Centre	0.379*** [0.060]	0.382*** [0.059]	-0.114** [0.056]	0.475*** [0.103]	0.478*** [0.103]	-0.154 [0.105]	0.338*** [0.075]	0.341*** [0.071]	-0.135** [0.068]
South	0.276*** [0.066]	0.316*** [0.067]	-0.398*** [0.064]	0.400*** [0.110]	0.412*** [0.112]	-0.332*** [0.109]	0.201** [0.088]	0.285*** [0.089]	-0.486*** [0.081]
Islands	0.433*** [0.080]	0.461*** [0.079]	-0.340*** [0.073]	0.513*** [0.131]	0.526*** [0.132]	-0.385*** [0.128]	0.420*** [0.103]	0.457*** [0.099]	-0.355*** [0.092]
Children			0.127**			-0.023			0.268**
Sex*children			-0.357*** [0.071]			-0.280** [0.110]			-0.421*** [0.094]

continue to the next page

Table A.1: continued from the previous page

	All*			Before the crisis			After the crisis		
	<i>Probit</i> (1) overqual	<i>Probit with sample sel.</i> (2) overqual	(3) employm	<i>Probit</i> (4) overqual	<i>Probit with sample sel.</i> (5) overqual	(6) employm	<i>Probit</i> (7) overqual	<i>Probit with sample sel.</i> (8) overqual	(9) employm
Married			0.309*** [0.050]			0.355*** [0.078]			0.216*** [0.068]
Sex*married			-0.289*** [0.064]			-0.288*** [0.101]			-0.282*** [0.085]
Constant	-0.994*** [0.155]	-0.923*** [0.156]	1.292*** [0.147]	-1.575*** [0.308]	-1.566*** [0.308]	1.799*** [0.291]	-0.553*** [0.192]	-0.383** [0.189]	0.962*** [0.177]
Province dummies:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,543	20,661	20,661	8,557	9,423	9,423	9,981	11,238	11,238
Wald test of $\rho = 0$ (p-value)			6.14 (0.013)			0.45 (0.504)			7.09 (0.008)
Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.									

Legend: *‘All’ includes only the Ph.D graduates occupied after the attainment of the doctoral title.

Table A.2: Determinants of over-skilling. All, before and after the crisis.

	All*			Before the crisis			After the crisis		
	<i>Probit</i>	<i>Probit with sample sel.</i>		<i>Probit</i>	<i>Probit with sample sel.</i>		<i>Probit</i>	<i>Probit with sample sel.</i>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	oversk	oversk	employm	oversk	oversk	employm	oversk	oversk	employm
Sex	0.034 [0.024]	-0.015 [0.024]	-0.005 [0.036]	0.040 [0.035]	-0.012 [0.035]	-0.025 [0.059]	0.030 [0.034]	0.039 [0.035]	0.030 [0.045]
Citizenship	0.297*** [0.095]	0.292*** [0.091]	0.120 [0.099]	0.470** [0.182]	0.446** [0.178]	0.048 [0.229]	0.205* [0.113]	0.202* [0.113]	0.127 [0.106]
Parents edu_2	-0.038 [0.035]	-0.046 [0.033]	-0.051 [0.038]	-0.019 [0.050]	-0.026 [0.048]	-0.030 [0.058]	-0.045 [0.050]	-0.042 [0.050]	-0.064 [0.051]
Parents edu_3	-0.010 [0.041]	-0.012 [0.039]	-0.004 [0.044]	-0.004 [0.058]	-0.001 [0.055]	0.032 [0.068]	0.005 [0.058]	0.006 [0.058]	-0.021 [0.060]
Parents class_2	0.013 [0.030]	-0.002 [0.029]	-0.085*** [0.033]	0.034 [0.043]	0.022 [0.041]	-0.069 [0.051]	0.013 [0.043]	0.016 [0.043]	-0.079* [0.045]
Parents class_3	0.083* [0.043]	0.045 [0.041]	-0.156*** [0.046]	0.055 [0.059]	0.028 [0.057]	-0.124* [0.068]	0.131** [0.062]	0.137** [0.062]	-0.160** [0.063]
Parents class_4	-0.040 [0.051]	-0.059 [0.049]	-0.122** [0.055]	-0.034 [0.075]	-0.064 [0.071]	-0.182** [0.083]	-0.006 [0.072]	-0.004 [0.072]	-0.042 [0.075]
Parents class_5	-0.037 [0.086]	-0.108 [0.082]	-0.308*** [0.080]	0.139 [0.183]	0.114 [0.173]	-0.135 [0.164]	-0.025 [0.101]	-0.011 [0.101]	-0.314*** [0.095]
Ph.D age	-0.019 [0.026]	0.013 [0.025]	0.164*** [0.030]	-0.064* [0.037]	-0.036 [0.036]	0.112** [0.047]	0.046 [0.036]	0.038 [0.037]	0.224*** [0.039]
Financial support	-0.171*** [0.049]	-0.117** [0.048]	0.115** [0.046]	-0.128** [0.059]	-0.111* [0.057]	0.004 [0.064]	-0.163* [0.087]	-0.179** [0.088]	0.323*** [0.067]
Recent cohort	0.016 [0.024]	-0.015 [0.023]	-0.153*** [0.026]	0.074** [0.034]	0.037 [0.034]	-0.202*** [0.040]	-0.047 [0.033]	-0.041 [0.034]	-0.140*** [0.035]
Ph.D end	-0.050 [0.039]	-0.008 [0.038]	0.133*** [0.039]	-0.088 [0.061]	-0.056 [0.059]	0.086 [0.065]	-0.046 [0.052]	-0.052 [0.052]	0.127** [0.049]
Visiting abroad	-0.179*** [0.025]	-0.133*** [0.025]	0.148*** [0.028]	-0.136*** [0.037]	-0.091** [0.038]	0.190*** [0.045]	-0.183*** [0.034]	-0.190*** [0.034]	0.161*** [0.036]
Hard Sciences	0.103* [0.053]	0.068 [0.050]	-0.108* [0.060]	0.161** [0.071]	0.117* [0.069]	-0.157* [0.091]	0.078 [0.080]	0.080 [0.080]	-0.063 [0.082]
Medicine	0.275*** [0.059]	0.242*** [0.056]	-0.007 [0.068]	0.405*** [0.082]	0.354*** [0.081]	-0.051 [0.106]	0.234*** [0.087]	0.232*** [0.087]	0.043 [0.092]
Agric. and Veter. Sc.	0.183*** [0.068]	0.124* [0.066]	-0.174** [0.075]	0.305*** [0.093]	0.243*** [0.091]	-0.156 [0.113]	0.092 [0.102]	0.099 [0.102]	-0.186* [0.101]
Technical Sciences	0.177*** [0.055]	0.169*** [0.052]	0.088 [0.065]	0.236*** [0.075]	0.223*** [0.072]	0.089 [0.100]	0.155* [0.082]	0.152* [0.082]	0.089 [0.088]
Law	0.289*** [0.069]	0.212*** [0.067]	-0.271*** [0.074]	0.211** [0.093]	0.172* [0.089]	-0.141 [0.115]	0.415*** [0.103]	0.430*** [0.104]	-0.364*** [0.100]
Soc.-Pol. Sc. and Hum.	0.108** [0.054]	0.017 [0.053]	-0.381*** [0.060]	0.126* [0.073]	0.052 [0.071]	-0.361*** [0.091]	0.113 [0.082]	0.130 [0.083]	-0.397*** [0.082]
Selfemployed	0.202*** [0.044]	0.173*** [0.041]		0.162** [0.064]	0.139** [0.060]		0.227*** [0.060]	0.226*** [0.060]	
Informal access	0.138*** [0.044]	0.126*** [0.040]		0.108* [0.064]	0.107* [0.059]		0.152*** [0.059]	0.151*** [0.058]	
Academic	-1.121*** [0.027]	-1.060*** [0.028]		-1.030*** [0.040]	-0.981*** [0.039]		-1.254*** [0.040]	-1.250*** [0.041]	
R&D	-1.205*** [0.025]	-1.131*** [0.028]		-1.135*** [0.037]	-1.063*** [0.041]		-1.343*** [0.036]	-1.339*** [0.037]	
Part time_1	0.270*** [0.047]	0.235*** [0.043]		0.145* [0.079]	0.116 [0.072]		0.372*** [0.060]	0.372*** [0.060]	
Part time_2	0.348*** [0.070]	0.293*** [0.066]		0.191** [0.093]	0.146* [0.087]		0.570*** [0.102]	0.570*** [0.102]	
North-West	0.565*** [0.050]	0.540*** [0.048]	0.011 [0.060]	0.622*** [0.084]	0.599*** [0.081]	-0.007 [0.107]	0.523*** [0.065]	0.522*** [0.065]	-0.045 [0.074]
North-East	0.614*** [0.054]	0.573*** [0.052]	-0.051 [0.063]	0.700*** [0.092]	0.658*** [0.089]	-0.149 [0.114]	0.528*** [0.068]	0.528*** [0.068]	-0.057 [0.077]
Centre	0.534*** [0.048]	0.491*** [0.047]	-0.098* [0.055]	0.590*** [0.082]	0.551*** [0.079]	-0.151 [0.102]	0.473*** [0.063]	0.476*** [0.063]	-0.131* [0.068]
South	0.380*** [0.056]	0.283*** [0.054]	-0.383*** [0.063]	0.454*** [0.089]	0.382*** [0.086]	-0.341*** [0.108]	0.276*** [0.077]	0.296*** [0.079]	-0.482*** [0.082]
Islands	0.436*** [0.071]	0.354*** [0.068]	-0.330*** [0.073]	0.521*** [0.113]	0.437*** [0.110]	-0.403*** [0.128]	0.331*** [0.095]	0.343*** [0.095]	-0.345*** [0.091]
Children			0.116** [0.058]			-0.023 [0.090]			0.299*** [0.078]
Sex*children			-0.338*** [0.070]			-0.287*** [0.107]			-0.442*** [0.094]
Married			0.283*** [0.050]			0.336*** [0.078]			0.198*** [0.069]
Sex*married			-0.276*** [0.062]			-0.277*** [0.099]			-0.269*** [0.086]

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Table A.2: continued from the previous page

	All*			Before the crisis			After the crisis		
	<i>Probit</i> (1)	<i>Probit with sample sel.</i> (2) (3)		<i>Probit</i> (4)	<i>Probit with sample sel.</i> (5) (6)		<i>Probit</i> (7)	<i>Probit with sample sel.</i> (8) (9)	
	oversk	oversk	employm	oversk	oversk	employm	oversk	oversk	employm
Constant	0.162 [0.138]	0.019 [0.132]	1.319*** [0.147]	-0.095 [0.237]	-0.146 [0.230]	1.797*** [0.294]	0.229 [0.190]	0.268 [0.194]	0.961*** [0.177]
Province dummies:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,560	20,661	20,661	8,557	9,423	9,423	10,003	11,238	11,238
Wald test of $\rho = 0$ (p-value)			30.00 (0.000)			13.05 (0.000)			1.29 (0.256)
Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.									

Legend: *‘All’ includes only the Ph.D graduates occupied after the attainment of the doctoral title.

Table A.3: Determinants of high mismatch. All, before and after the crisis.

	All*			Before the crisis			After the crisis		
	<i>Probit</i>	<i>Probit with sample sel.</i>		<i>Probit</i>	<i>Probit with sample sel.</i>		<i>Probit</i>	<i>Probit with sample sel.</i>	
	(1) high mism.	(2) high mism.	(3) employm	(4) high mism.	(5) high mism.	(6) employm	(7) high mism.	(8) high mism.	(9) employm
Sex	0.037 [0.027]	0.061** [0.030]	0.007 [0.036]	0.026 [0.041]	0.030 [0.045]	-0.023 [0.060]	0.042 [0.037]	0.080** [0.037]	0.030 [0.045]
Citizenship	0.124 [0.114]	0.111 [0.113]	0.137 [0.099]	0.337 [0.265]	0.336 [0.265]	0.061 [0.223]	0.067 [0.125]	0.046 [0.119]	0.131 [0.105]
Parents edu_2	-0.025 [0.039]	-0.019 [0.039]	-0.048 [0.038]	-0.004 [0.059]	-0.004 [0.059]	-0.032 [0.058]	-0.047 [0.052]	-0.031 [0.051]	-0.061 [0.051]
Parents edu_3	-0.022 [0.045]	-0.021 [0.045]	-0.007 [0.045]	0.019 [0.067]	0.019 [0.067]	0.027 [0.068]	-0.061 [0.061]	-0.053 [0.059]	-0.021 [0.060]
Parents class_2	0.011 [0.033]	0.019 [0.033]	-0.082** [0.033]	0.053 [0.049]	0.054 [0.049]	-0.067 [0.050]	-0.026 [0.046]	-0.010 [0.045]	-0.081* [0.045]
Parents class_3	0.031 [0.048]	0.047 [0.048]	-0.155*** [0.047]	0.037 [0.068]	0.039 [0.069]	-0.122* [0.068]	0.019 [0.066]	0.051 [0.065]	-0.162** [0.063]
Parents class_4	0.045 [0.056]	0.056 [0.056]	-0.115** [0.056]	-0.023 [0.085]	-0.020 [0.086]	-0.178** [0.084]	0.092 [0.075]	0.096 [0.073]	-0.040 [0.076]
Parents class_5	-0.021 [0.087]	0.014 [0.088]	-0.314*** [0.080]	-0.028 [0.183]	-0.026 [0.183]	-0.116 [0.170]	-0.059 [0.102]	0.009 [0.101]	-0.311*** [0.095]
Ph.D age	-0.043 [0.029]	-0.059* [0.031]	0.177*** [0.030]	-0.092** [0.045]	-0.094** [0.045]	0.130*** [0.046]	-0.011 [0.040]	-0.049 [0.040]	0.224*** [0.039]
financial support	-0.107** [0.051]	-0.120** [0.050]	0.136*** [0.045]	-0.030 [0.067]	-0.030 [0.067]	0.019 [0.063]	-0.247*** [0.079]	-0.303*** [0.077]	0.325*** [0.067]
Recent cohort	0.043* [0.026]	0.058** [0.027]	-0.152*** [0.026]	0.053 [0.039]	0.056 [0.041]	-0.201*** [0.040]	0.048 [0.036]	0.074** [0.035]	-0.136*** [0.035]
Ph.D end	0.023 [0.042]	0.006 [0.042]	0.139*** [0.039]	0.028 [0.065]	0.026 [0.066]	0.092 [0.065]	0.040 [0.055]	0.009 [0.053]	0.129*** [0.049]
Visiting abroad	-0.078*** [0.029]	-0.092*** [0.029]	0.157*** [0.028]	-0.083* [0.045]	-0.086* [0.047]	0.201*** [0.045]	-0.083** [0.038]	-0.110*** [0.037]	0.161*** [0.036]
Hard Sciences	0.013 [0.064]	0.025 [0.063]	-0.131** [0.061]	0.182* [0.094]	0.185* [0.095]	-0.191** [0.093]	-0.135 [0.090]	-0.117 [0.086]	-0.072 [0.083]
Medicine	0.202*** [0.068]	0.202*** [0.067]	-0.040 [0.068]	0.350*** [0.101]	0.351*** [0.101]	-0.105 [0.103]	0.085 [0.096]	0.071 [0.092]	0.040 [0.092]
Agric. and Veter. Sc.	0.123 [0.077]	0.140* [0.077]	-0.206*** [0.075]	0.190* [0.114]	0.193* [0.115]	-0.200* [0.114]	0.058 [0.107]	0.087 [0.103]	-0.186* [0.101]
Technical Sciences	0.052 [0.066]	0.048 [0.065]	0.064 [0.066]	0.174* [0.097]	0.173* [0.097]	0.053 [0.100]	-0.046 [0.092]	-0.056 [0.088]	0.083 [0.089]
Law	0.095 [0.081]	0.122 [0.081]	-0.289*** [0.075]	0.247** [0.118]	0.250** [0.119]	-0.170 [0.117]	-0.044 [0.113]	0.032 [0.111]	-0.364*** [0.101]
Soc.-Pol. Sc. and Hum.	0.053 [0.064]	0.095 [0.068]	-0.399*** [0.061]	0.107 [0.096]	0.113 [0.099]	-0.389*** [0.092]	0.010 [0.090]	0.090 [0.089]	-0.405*** [0.083]
Selfemployed	0.457*** [0.038]	0.449*** [0.038]		0.368*** [0.056]	0.368*** [0.056]		0.523*** [0.052]	0.496*** [0.051]	
Informal access	0.201*** [0.042]	0.199*** [0.042]		0.101 [0.066]	0.101 [0.066]		0.274*** [0.056]	0.262*** [0.053]	
Academic	-1.037*** [0.042]	-1.015*** [0.048]		-0.984*** [0.061]	-0.983*** [0.061]		-1.095*** [0.057]	-1.011*** [0.082]	
R&D	-1.060*** [0.034]	-1.041*** [0.041]		-1.005*** [0.049]	-1.005*** [0.049]		-1.131*** [0.050]	-1.058*** [0.071]	
Part time_1	0.161*** [0.044]	0.160*** [0.043]		-0.038 [0.076]	-0.038 [0.076]		0.249*** [0.056]	0.238*** [0.053]	
Part time_2	0.276*** [0.058]	0.276*** [0.057]		0.205*** [0.078]	0.206*** [0.078]		0.394*** [0.087]	0.381*** [0.082]	
North-West	0.356*** [0.063]	0.349*** [0.063]	-0.007 [0.061]	0.533*** [0.109]	0.532*** [0.109]	-0.015 [0.108]	0.277*** [0.080]	0.268*** [0.076]	-0.045 [0.074]
North-East	0.390*** [0.067]	0.390*** [0.066]	-0.069 [0.063]	0.581*** [0.114]	0.583*** [0.114]	-0.134 [0.113]	0.297*** [0.082]	0.292*** [0.078]	-0.050 [0.077]
Centre	0.319*** [0.061]	0.323*** [0.060]	-0.113** [0.056]	0.402*** [0.106]	0.403*** [0.106]	-0.154 [0.105]	0.318*** [0.076]	0.322*** [0.073]	-0.135** [0.068]
South	0.227*** [0.068]	0.265*** [0.071]	-0.397*** [0.064]	0.365*** [0.115]	0.371*** [0.118]	-0.331*** [0.109]	0.164* [0.089]	0.251*** [0.091]	-0.486*** [0.082]
Islands	0.370*** [0.082]	0.397*** [0.082]	-0.339*** [0.073]	0.463*** [0.138]	0.469*** [0.140]	-0.385*** [0.128]	0.367*** [0.105]	0.407*** [0.101]	-0.356*** [0.092]
Children			0.125** [0.060]			-0.025 [0.094]			0.277*** [0.078]
Sex*children			-0.351*** [0.071]			-0.276** [0.111]			-0.430*** [0.093]
Married			0.310*** [0.050]			0.356*** [0.079]			0.205*** [0.067]
Sex*married			-0.294*** [0.064]			-0.293*** [0.100]			-0.273*** [0.085]

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Table A.3: continued from the previous page

	All*			Before the crisis			After the crisis		
	<i>Probit</i> (1) high mism.	<i>Probit with sample sel.</i> (2) (3) high mism. employm		<i>Probit</i> (4) high mism.	<i>Probit with sample sel.</i> (5) (6) high mism. employm		<i>Probit</i> (7) high mism.	<i>Probit with sample sel.</i> (8) (9) high mism. employm	
Constant	-1.016*** [0.161]	-0.949*** [0.163]	1.293*** [0.147]	-1.641*** [0.321]	-1.637*** [0.321]	1.800*** [0.292]	-0.628*** [0.196]	-0.452** [0.194]	0.960*** [0.177]
Province dummies:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	18,543	20,661	20,661	8,557	9,423	9,423	9,981	11,238	11,238
Wald test of $\rho = 0$ (p-value)			3.07 (0.080)			0.07 (0.792)			6.63 (0.010)
Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1.									

Legend: *‘All’ includes only the Ph.D graduates occupied after the attainment of the doctoral title.

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