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"Are we wasting our talent?Overqualification and overskilling among PhD graduates"

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Abstract

Drawing on a very rich data set from a recent cohort of PhD graduates, we examine the correlates and consequences of qualification and skills mismatch. We show that job characteristics such as the economic sector and the main activity at work play a fundamental direct role in explaining the probability of being well matched. However, the effect of academic attributes seems to be mainly indirect, since it disappears once we control for the full set of work characteristics. We detected a significant earnings penalty for those who are both overqualified and overskilled and also showed that being mismatched reduces job satisfaction, especially for those whose skills are underutilized. Overall, the problem of mismatch among PhD graduates is closely related to demand-side constraints of the labor market. Increasing the supply of adequate jobs and broadening the skills PhD students acquire during training should be explored as possible responses.

JEL classification: I20, J24, J28, J31

Keywords: overskilling, overqualification, doctors, earnings, job satisfaction

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1. Introduction

In recent decades we have witnessed the emergence and consolidation of the so-called knowledge economy, in which economic success does not critically depend on natural resources, physical capital and low-skill labor but rather on the effective utilization of intangible assets such as knowledge, skills and innovative potential. Economic performance is viewed as being closely related to the education and skills of the labor force, underpinned by effective research and development (R&D) capacity. In this new economic paradigm, there is growing consensus that PhD holders have a strategic role to play in the success of firms and nations (European University Association, 2007). PhD recipients represent a key element for innovation and the generation of new knowledge in the economy because of their ability to solve complex problems (Stephan et al., 2005; Auriol, 2010). On the one hand, they produce the most up-to-date scientific knowledge (through basic research), and on the other, they bring their capabilities to firms, where they help to transform scientific inventions into new market products (Herrera et al., 2010). In addition, it has been shown that employing PhD holders helps firms to cooperate with universities and to create external networks with the scientific community, which very often is the only way to access forms of knowledge that are mainly tacit in nature (Garcia-Quevedo et al., 2012). It has even been argued that the production of new PhD graduates might be universities' most important contribution to economic growth and development (Stephan et al., 2004; Sumell et al., 2009).

In recognition of the importance of ensuring an adequate supply of highly educated workers, many countries have expanded and reformed their doctoral programs (Park, 2007). In quantitative terms, the number of doctoral degrees awarded in OECD countries has increased dramatically in recent decades (Auriol, 2010), even more so than the number of undergraduate degrees (NSF, 2008; OECD, 2009), and in qualitative terms, extensive reforms have changed the definition, organization and evaluation of doctoral programs (Enders & de Weert, 2004). Much interest has been focused on how to facilitate the entry of new PhD graduates into the labor market, and not just in the traditional academic sector. There is increasing recognition of the importance of promoting transition into non-academic employment (Neumann & Khim, 2011). Indeed, there is an ongoing debate in policy and academic spheres on whether doctoral programs are sufficiently well designed to equip graduates with the skills they need to rapidly adjust to the productive environment of firms (Borrell-Damian, 2009). The usual claim is that PhD graduates lack good employability skills because of the over-focus of doctoral programs and advisors on preparation for an academic carrier (Mangematin, 2000; Green & Powell, 2005, Lee et al., 2010). This is, however, debatable (Neumann & Khim, 2011). The low incidence of unemployment among PhD holders throughout the different stages of their careers, their increasing presence in non-academic employment and the positive impact of their higher

qualifications on wages would appear to indicate that doctoral graduates possess valuable employment skills (Raddon & Sung, 2009). These conflicting opinions, in fact, demonstrate that, while growing, research on the labor market situation of PhD holders is still limited. Precisely, the match between the skills held by PhD graduates and the extent to which they are used in the workplace needs to be further investigated, as much of the current data available is based on the opinions of employers (Purcell et al. 2005).

It is important to study the quality of match between skills supplied and skills exercised in the workplace for several reasons. The repercussions of job mismatch have been a concern for policy makers for many years. Recent reports analyzing a large number of countries indicate that job-skill mismatch is a widespread, persistent problem (Quintini, 2011; Berkhout et al., 2012; Pouliakas, 2013) and one that is likely to be associated with considerable individual and societal costs. One common concern is the impact the misallocation of highly educated workers can have on the development of sustainable employment growth. As stated by Pouliakas (2013: 385), "converting skills into job-rich growth is only attainable if effective use is made of the available talents". Considering the importance of PhD holders for the economy, the high cost of doctoral education and the high levels of public funding received by doctoral students [1], the potential costs of job-education mismatches are much higher for PhD recipients than for other educational groups. In addition, it seems quite reasonable to investigate how the rapidly increasing influx of doctoral graduates has impacted the labor market, especially in view of recent signs of saturation in the academic job market, especially in some European countries. Unfortunately, analysis of mismatch among PhD holders is virtually non-existent and the little information available is from the US[2]. Furthermore, the alternative of deriving conclusions from the more extensive evidence on college graduates is *a priori* problematic, as both individuals and jobs may be quite different.

The goal of this paper is to contribute to filling this important research gap by adding empirical evidence to the debate on the importance, correlates and consequences of qualification and skills mismatch among PhD holders. Drawing on very detailed data from a recent cohort of PhD graduates from the public university system in Catalonia (Spain), we analyze three important aspects. First, we examine the conditioning factors of mismatch, distinguishing between overqualification and overskilling, with a focus on the role of socio-demographic factors, academic attributes and job characteristics. Second, we analyze the wage penalty

[1] According to the Department of Education's National Centre for Education Statistics (NCES), the average cost of a doctoral degree at a public school in the US in 2008 was $48,400 a year. Private school tuition during the same year was $60,000. A typical doctoral program takes five full-time years to complete, bringing the total cost to $242,000 - $300,000. The NCES also calculated that 93% of all doctoral students attending school full-time receive some sort of financial assistance.

[2] To the best of our knowledge, there are only two papers on this topic, both based on US panel data from the Survey of Doctoral Recipients (see section 2).

associated with different types of mismatch among PhD recipients, and third, we explore the relationship between mismatch and job satisfaction.

Overall, our results show that, in our cohort, overqualification and, in particular, overskilling are associated with a significant waste of individual and public resources. Our findings suggest that job characteristics such as employment sector (academic, public, private) and the work actually performed are key, direct correlates of the likelihood of being well matched. By contrast, academic attributes seem to exert a largely indirect effect, since their conditional relationship with the risk of being mismatched tends to disappear after controlling for job characteristics. In line with recent findings on college graduates, we detected a significant wage penalty for PhD graduates who are both overqualified and overskilled. We also found a remarkable negative effect of mismatch, especially in the form of overskilling, on satisfaction with the job as a whole and with non-monetary aspects (job content and skills-job match). On the contrary, we did not find mismatch to be associated with dissatisfaction with earnings or promotion opportunities.

The rest of this paper is organized as follows. In the next section we briefly review the relevant literature. Section 3 presents the data and section 4 illustrates the conditioning factors of mismatch among PhD graduates from public universities in Catalonia. In Section 5, we explore the consequences of mismatch in terms of earnings (5.1) and job satisfaction (5.2). Finally, Section 6 concludes the paper.

2. Related Research

This paper draws on two strands of literature: analysis of labor market mismatches and the more limited but growing literature on labor market decisions and experiences of PhD recipients.

The literature on the determinants and consequences of different forms of labor market mismatch is quite extensive (for recent reviews see McGuinness, 2006; Leuven & Oosterbeek, 2011; Quintini, 2011; Sattinger, 2012). Some well-established conclusions emerge from this literature, namely that overqualified workers are more likely to endure wage penalties, lower job satisfaction, higher turnover and absenteeism, and potentially lower participation in training. For employers, costs associated with qualification and skills mismatch may take the form of higher recruitment costs, lower productivity and lower product quality[3].

[3] Some of these conclusions are currently being revised. Some researchers claim that unobserved individual heterogeneity biases the estimated earnings effects (Leuven & Oosterbeeek, 2011). Also, some recent research challenges the supposed negative impact on productivity (Pouliakas, 2013). Indeed, using linked employer-employee data, Kampelmann & Rycx (2012) suggest that employing overeducated workers is beneficial for productivity at the firm level.

Much of the existing literature is based on the concept of educational or qualification mismatch, which is defined using educational credentials as a reference point (Dolton & Vignoles, 2000; Bauer, 2002; McGuinness & Bennet, 2007; Carroll & Tani, 2013). More and more authors, however, are using measures of deficits/surpluses in skills or competences (Allen & van der Velden, 2001; Green et al., 2002; McGuinness, 2003; Allen & de Weert, 2007; Green & McIntosh, 2007; McGuinness & Wooden, 2007; Mavromaras et al., 2010; McGuinness & Sloane, 2011)[4]. An initial conclusion emerging from this literature is that, quite unexpectedly, educational and skills mismatches are only weakly correlated, indicating that perhaps they are distinct empirical phenomena that need to be studied separately[5]. A more controversial issue is the impact that educational and skills mismatches have on wages. The literature reports negative wage effects stemming from both forms of mismatch, a finding that is consistent with the growing evidence that educational and skills mismatches are distinct problems. However, there is a lack of consensus on which form has a greater negative effect, although there is increasingly robust evidence that the worst situation is to be overskilled *and* overqualified.

Several papers (Allen & van der Velden, 2001; Green & Zhu, 2010; McGuinness & Sloane, 2011; Mavromaras et al., 2013) have analyzed the impact of educational and skills mismatch on job satisfaction. The argument is that in order to fully understand the labor market impacts of job mismatch it is important to analyze job satisfaction along with earnings, because the mismatch may not be involuntary (generating a productivity constraint). Workers, for instance, may forego higher wages in favor of other, more satisfying, job attributes, such as job security or work-life balance (McGuinness & Sloane, 2011; Mavromaras et al., 2013). The results of this incipient literature show that qualification mismatch *per se* is not strongly correlated with job satisfaction and that underutilization of acquired skills has more serious consequences, particularly when accompanied by educational mismatch.

In recent years, the role and transformation of doctoral education has attracted increasing attention in specialized academic journals (mainly in the educational field), as well as in national and international policy management spheres (reports and recommendations)[6]. However, the specific literature on the labor market situation of PhD holders, while growing, is still quite limited, mainly because of a scarcity of suitable data[7]. Several recent descriptive studies analyzing the career paths of PhD holders show an across-the-board employment

[4] Other authors have combined formal qualification mismatch with different measures (some indirect) of skill mismatch (Chevalier, 2003; Chevalier & Lindley, 2009; Green & Zhu, 2010, Mavromaras et al., 2013), stressing the importance of the latter over the former in the graduate labor market.

[5] Recent reports by the OECD (Employment Outlook, 2011) and the European Union (Pouliakas, 2013) support this hypothesis.

[6] For an interesting discussion about the impact, effects and contributions of the doctorate see Special Issue: The Impact of the Doctorate in Studies in Higher Education, 36:5, 2011. See also European University Association (2010).

[7] Several countries have recently promoted surveys and projects to collect data on PhDs. Also, under an initiative launched by the OECD, the UNESCO Institute for Statistics (UIS) and EUROSTAT, several countries participated in the Careers of Doctorate Holders (CDH) project in 2006 and 2009 to compile data on the labor market, career paths and international mobility of doctorate holders (see www.oecd.org/sti/cdh).

premium and higher patterns of geographical mobility, even though the conditions of employment and fixed-term employment in particular are less beneficial (Stern, 2004; Recotillet, 2007; Raddon & Sung, 2009; Auriol, 2010; Newman & Khim, 2011; Schwabe, 2011; Agrawal & Ohyama, 2013). The employment sector for PhD recipients is slowly but clearly shifting from the academic and public spheres to the private firm, although there are still striking differences across countries. Indeed, this is one of the most active research sub-areas related to the labor market situation of PhD holders, and reflects the need to better understand how private firms can better harness the skills of this group of workers (Enders & de Weert, 2004; Newman & Khim, 2011; Canal & Muñiz, 2012). It is interesting to see how traditional supply-side arguments based on the misalignment between skills acquired during training and those needed by firms are increasingly being combined with demand side–based claims, which are critical of the lack of jobs that actually make use of the capacities of PhD graduates (Cyranosky et al., 2011; Garcia-Quevedo et al., 2012).

Only a few papers have analyzed the monetary payoff of holding a PhD, with some showing positive returns and others showing a negative payoff. These apparently contradictory results might be related to differences in the methods used to control for self-selection into enrollment and specific fields of study and completion of studies (Dolton & Makepeace, 1990; Engelage & Hadjar, 2008; Canal & Rodriguez, 2013; Mertens & Röbken, 2013).

Unfortunately, the analysis of job-education mismatch among PhD holders is almost non-existent. Auriol (2010), using descriptive data from the Careers of Doctorate Holders (CDH) project, reported that a non-negligible share of PhD holders seem to be employed in unrelated or low-skill occupations, though again, results vary considerably across countries. Auriol suggests that this could be a sign of a bottleneck or mismatch in the labor market. Canal and Muñiz (2012) also reported a substantial incidence of overeducation among Spanish PhD holders, especially outside academia. In more analytical terms, and to the best of our knowledge, only two papers have studied the causes and consequences of labor market mismatch among PhD recipients, and both used the US Survey of Doctoral Recipients (Bender & Heywood, 2009; 2011). In their first paper, Bender and Heywood (2009) analyzed three subjective indicators of mismatch and found that they appear to be negatively related to earnings and job satisfaction and positively related to the probability of job turnover. They also estimated the determinants of being mismatched according to each of the three indicators and highlighted the influence that socio-demographic factors, academic attributes and job characteristics have on the likelihood of mismatch, in any form. In a later paper, Bender and Heywood (2011) presented panel data estimates of the wage penalty associated with mismatch in different fields of study and at different career stages, and found worse effects for those with a degree in Hard Sciences and, to a lesser extent, Social Sciences, as well as for those at an advanced stage of their career. They also explored the existence of differential effects by reason of mismatch and the determinants of

transitions in-and-out of mismatch, and suggested there is a clear relationship between mismatch status and career development.

3. Data and Descriptive Statistics

Our paper is based on data from a recent cohort of PhD graduates from public universities in Catalonia, Spain[8].The Catalan university system has undergone substantial changes in the last twenty years with the creation of new public and private universities and the consolidation of management practices and infrastructures similar to those seen in the top European and American universities. Currently, the level of R&D activity at Catalan public universities is close to the average of OECD countries and above the Spanish level. This dynamic research environment has driven a highly significant increase in scientific production. About 15,000 academics and 8,000 administrative and supporting staff serve slightly more than 200,000 undergraduate and postgraduate students (with a 25-30% share of international students among the latter). The number of PhDs awarded by Catalan universities increased from 968 during the 1997-98 academic year to 1,781 in 2010-11 (an increase of 84%). As can be seen in Figure 1, the increase in doctoral awards in Catalonia has followed the same general tendency observed for Spain as a whole.

[FIGURE 1 ABOUT HERE]

The increase in the number of PhD holders in recent decades, however, has not caused a major supply shock in the Spanish labor market. In 2011, the doctoral graduation rate was just 1.1% of the population in the reference age cohort, considerably below the OECD mean of 1.6% and just slightly up from the rate of 0.9% reported for Spain in 2011 (OECD, 2013: 94). In 2009 there were 6.7 doctorate holders per thousand population aged 25-64 in Spain, contrasting with 14 in Germany, 13.5 in the United States, and 7.6 in Finland (OECD, 2013:96).

The data used in the empirical analysis in the present study come from a 2011 survey on the early labor market experiences of PhD holders[9]. The target population consisted of all Spanish-born individuals who completed a PhD in one of the seven Catalan public universities in 2006 or 2007. The entire population was composed of 1,824 individuals and the questionnaire was correctly completed by 1,225, which corresponds to a fairly high response rate of 67.2%. We checked for potential biases due to lack of response (using gender, age, program field and

[8] The Catalan Public Education System is composed of seven universities: University of Barcelona (UB), Autonomous University of Barcelona (UAB), Polytechnic University of Catalonia (UPC),PompeuFabra University (UPF), University of Lleida (UdL), University of Girona (UdG) and Rovira i Virgili University (URV). See García-Quevedo et al. (2010) for a comprehensive overview of the Catalan Higher Education System.

[9] In 1996 the Catalan government set up the Quality Assurance Agency for the Catalan University System (AQU) with the aim of promoting the quality and continuous enhancement of the Catalan university system. AQU collects data through regular surveys conducted among graduates who have completed their studies. See http://www.aqu.cat/insercio/index.html#.Uqs8htGA3mR for details of the survey.

university) and concluded that the sample provided an adequate representation of the population of PhD graduates. Graduates were contacted four years after completing their PhD and those who agreed were interviewed by telephone using a CAPI system. Note, therefore, that our analysis concerns the short-term mismatch situation of our sample of PhD holders. It could be argued that analyzing this early period in the professional careers of PhD graduates may be misleading as they are still adjusting to a situation that may evolve towards a better match. While theoretically this would appear to be likely, the scant evidence available suggests that the negative effects of mismatch in recent graduates tend to be quite permanent (Scherer, 2004; Baert, et al., 2013), which makes our short-term analysis particularly interesting.

The dataset employed in this study is very rich. It contains basic socio-demographic data, information on academic attributes and the doctoral program followed, as well as detailed information on current employment. We restricted the sample to those individuals who were in a full-time job at the time of the survey and were aged 40 or younger when they completed their PhD. [10] It might be argued that focusing only on a subsample of working PhD holders would introduce bias due to self-selection into employment. However, since only 32 (3%) of the graduates interviewed reported they were not working, this sample restriction is not likely to undermine the significance of our results. Moreover, the high employment rate detected indicates that the recession, which was well underway in Spain when the survey was conducted, did not contribute to worse unemployment among recent PhD holders in comparison with graduates from 2003/2004, who were interviewed in a previous wave of the AQU survey in 2008[11].

Unfortunately, the cross-sectional nature of the data does not allow us to explicitly deal with time-invariant unobserved heterogeneity. Indeed, it might be argued that mismatch among PhD holders is mostly driven by unobserved variables such as innate ability (see Leuven & Oosterbeek, 2011 for a broader and comprehensive discussion of this issue). Moreover, measurement/misclassification errors in the mismatch variables might also be a potential source of bias in the estimates. Even though we had a very rich data set, we were unable to find suitable exclusion restrictions that are necessary to identify the key parameters in an IV framework. However, the homogeneity of the sample in terms of institutional and labor market

[10] Given the aims of this paper, the age-at-completion restriction was used to prevent including observations by individuals who were at an advanced stage of their career when they enrolled in the doctoral program. Moreover, the fact that the AQU survey only targeted Spanish graduates might be a limitation of the database, but we believe it is not a limitation for our purposes, since having only Spanish-born individuals represents an implicit reduction of the degree of labor market-related heterogeneity in our sample. Finally, the size of the final sample is somewhat reduced when we consider earnings and job satisfaction because of the presence of additional missing values for these variables.

[11] See for more details about the first wave of the AQU survey of PhD graduates. Unfortunately, the results of this survey cannot be used in the empirical analysis because the questions on skills mismatch were only asked of those who were in a job that required a PhD. Nevertheless, a comparison of data suggests that the high stable rate of employment among PhD recipients does not come at a cost of lower job quality, at least in terms of overqualification. The number of overqualified doctors decreased only marginally from one cohort to the next, possibly because the Spanish recession was particularly hard on sectors with low human capital intensity that do not generally attract PhD holders.

elements, as well as the inclusion of a large list of control variables, together with PhD-type and university fixed effects, in our models, would limit the extent of unobserved heterogeneity bias in our estimates. Nevertheless, the reader should bear in mind that our results represent conditional associations that, although meaningful, cannot be directly interpreted as causal parameters.

3.1 Descriptive statistics

The main variables of interest are those concerning the job (mis)match status of PhD holders, taken from two specific questions from the AQU survey. In the first question, respondents were asked about the educational entry requirements for their current job. Four possibilities were considered: 1) a PhD degree, 2) a specific undergraduate degree (i.e. the degree held by the individual), c) any undergraduate degree, and d) no qualification requirements. In the second question, respondents were asked whether their PhD-specific skills were necessary in their current job. Given that all the respondents were PhD recipients, following Dolton & Silles (2008) and Sutherland (2012), individuals were defined as overqualified if they stated that their PhD was not necessary for securing their current job, and as overskilled if they considered that their PhD skills were not necessary for performing the job.

Table 1 shows the marginal and joint distribution of these two distinct dimensions of mismatch.

[TABLE 1 ABOUT HERE]

The data indicate that just over 72% of our sample were adequately matched in terms of skills and that just 53% were adequately matched in terms of qualifications. These figures clearly reflect a considerable level of overqualification and overskilling in our cohort[12]. It is difficult to validate these data due to a lack of comparable information, but they are quite similar to results reported for Spain in Auriol (2010: table 1), where 17.5% of Spanish PhD holders stated that they were not in jobs related to their doctoral degrees. Our findings are also similar to those in Canal & Muñiz (2012: table II), where 18% of Spanish PhD graduates reported being in jobs that were only minimally related to their doctoral studies and 51% were in jobs that required an undergraduate degree. It should be noted that the above results correspond to the whole population of PhD holders and not just to a cohort of recent doctors as in our case. Moreover, the

[12] However, the 47% rate of overqualification could actually indicate that firms in Spain/Catalonia (the main labor market for PhD holders in our sample, see table 1A) may not "legally" demand a PhD, either because of tradition or because they want to avoid paying higher wages.

relatively lower incidence of mismatch in the studies by Auriol and Canal & Muñiz could be due to the fact that the older PhD holders entered the labor market at a time when there was a more favorable balance between supply and demand. The differences could also be due to the application of different criteria to define mismatch.

Cross-tabulation of qualification and skills mismatch measures show that the probability of being well matched in terms of skills is significantly higher for PhD graduates in occupations that required a PhD, meaning that these two distinct facets of (mis)match are likely to be interrelated. Indeed, the correlation between the two mismatch indicators is 0.51, which is well above the correlation indicated in papers using similar mismatch measures for college graduates. Nevertheless, it is important to stress that only 45% of our sample can be considered adequately matched in terms of job entry requirements and skills required for the job. Furthermore, 26% are in jobs that do not seem to require either a PhD qualification or the skills acquired during doctoral studies. In other words, over a quarter of our sample are both overqualified and overskilled. Finally, a very small proportion of the survey respondents in our sample stated that while their doctoral studies were a job entry requirement, they were not actually necessary for the job.

What are the characteristics of our graduates? Does mismatch status reflect differences in observed individual, academic and labor market characteristics? Table 1A in the Appendix contains the complete list of explanatory variables (socio-demographic characteristics, academic information and job-related variables) and the mean for the whole sample as well as for the four mismatch statuses analyzed: adequately matched, overqualified, overskilled, and overskilled and overqualified. Overall, it appears that mismatch status is clearly related to the academic and professional profile of the individual. Well-matched PhD holders are more likely to be younger males with a clear academic orientation. They also tend to have a shorter job tenure and are more inclined to work in academia, research institutes or private firms doing R&D work. The profile of graduates who are both overskilled and overeducated is similar but they have a significantly longer tenure and are more likely to have started working as adjunct professors or research assistants at a university before completing their PhD. This suggests that they funded their doctoral studies through lecturing or research work and were still working at the university at the time of the survey. It is interesting to note that strongly mismatched graduates (i.e. overqualified and overskilled) were more likely to work either in the government or private sector.

Table 1A contains descriptive information about potential wage and job satisfaction penalties associated with mismatch status. With respect to raw differences in gross annual earnings, 33.4% of our sample earned between €30,000 and €40,000 (the modal category); this percentage was slightly higher among PhD graduates in occupations that adequately matched their qualifications. Interestingly, graduates earning more than €50,000 (the top-coding category) were significantly more likely to be mismatched, particularly in terms of skills. This is possibly related to the fact that a higher proportion of these graduates worked in the better-paid private sector. The survey

also provided information about perceived satisfaction with the job as a whole and with four specific facets: promotion opportunities, earnings, job content and skills-job match. On average, job satisfaction was rather high (5.7 on a 1-7 Likert scale) and the respondents were especially satisfied with promotion opportunities, but less happy with job content and pay. As expected, those who were overqualified and even more so those who were overskilled were significantly less satisfied with the match between their skills and the work they were doing.

4. The correlates of qualification and skills mismatch

The descriptive statistics revealed a significant incidence of overskilling and overqualification among this recent cohort of PhD graduates from public universities in Catalonia. Moreover, the incidence of mismatch appears to be related to individual, academic and job market characteristics. In this section we examine the conditioning variables of mismatch in a multivariate framework to contribute to a better understanding of the channel through which the different variables analyzed affect the likelihood of being mismatched. We estimated two Seemingly Unrelated Bivariate Probit equations with identical regressors that model the probability of being overskilled and of being overqualified. This allowed us to check for significant differences in the conditional association between the explanatory variables and each of the two types of mismatch[13]. Table 2 shows the average changes in the predicted probabilities for four different specifications of the two equations. The baseline specification (a) contains socio-demographic variables, academic credentials, and a set of indicators for pre-and post-doctoral mobility. Model (b) adds the type and region of work, model (c) job attributes, and model (d) information on the main activities performed at work[14]. This stepwise inclusion of controls was designed to observe whether and how academic and job-related attributes separately affect the likelihood of being overqualified and/or overskilled. Additionally, each model contains fixed PhD-type and university effects to cover factors shared by graduates with similar PhDs across the seven universities. As expected, the estimated correlation between the residuals of the two equations was positive and significant in all cases, pointing to the presence of common unobserved determinants of overskilling and overqualification.

[TABLE 2 ABOUT HERE]

[13] An alternative specification to obtain different estimates for the probability of being overskilled/overqualified could be the Multinomial Logit Model (as in Chevalier 2003 and Chevalier & Lindley 2009). We tried to use this alternative econometric model and the results obtained were qualitatively similar. However, we retained the current specification because, unlike the Multinomial Logit, it is not subject to the Independence of Irrelevant Assumption, which is clearly not supported by our data. Notice that the lack of identifying variables (i.e. there is no reason to include one variable in one equation but not in the other) precludes estimating the conditional effect of overqualification on overskilling using a recursive model.

[14] The various categories are not mutually exclusive in the sense that individuals may perform more than one activity. Moreover, this information is reported only for individuals who work outside the university.

Two immediate points emerge from the results of our analysis. First, the estimates are qualitatively similar for qualification and skills mismatch, with two notable exceptions: socio-demographic variables are related to the probability of being overskilled but not overqualified and academic variables seem to have a larger impact on overqualification than on overskilling. Second, our stepwise inclusion of different groups of regressors did not generate striking changes in the estimated coefficients as we moved from one model to the next, meaning that the general picture of the conditioning factors of mismatch among PhD holders in our series remained largely unchanged.

The first variables included in our models were gender and age. Female graduates are more likely (5 percentage points [p.p] higher) to be overskilled than male graduates with similar characteristics, but we did not observe any gender differences in terms of the probability of being overqualified. This finding could be a cause for concern as it might mean that while the formal process of accessing the labor market is similar for men and women, there may be subsequent (discriminatory) filtering of women into jobs or tasks requiring fewer skills. A similar tendency was observed for age, with older graduates more likely to be overskilled (although at a decreasing rate, given the significant and negative quadratic term). On the contrary, age was not observed to have any significant effect on overqualification.

We had a large number of variables capturing academic experience. These were divided into three groups: source of PhD funding, academic attributes that characterize PhD studies, and research mobility. Ideally, these variables would capture the quality of training received and, therefore, signal the best doctoral graduates, who, in a normal, well-functioning labor market, should be better matched[15]. However, if PhD programs are, at least to some extent, designed to attract and channel students into the academic profession, these variables could also be capturing a sorting process into specific labor markets. The first aspect to emerge on looking at the coefficient estimates is that variables capturing academic experience have a modest impact on the probability of being overskilled but a more sizable effect on the probability of being overqualified.

Funding one's PhD through any of the three main mechanisms analyzed (scholarship, working at a university-research center as an instructor/research assistant, or working in a related job) does not seem to be associated with dramatic differences in mismatch status. It should be noted, however, that scholarships are associated with a lower incidence of both overqualification and overskilling, but this beneficial effect tends to be lost once job characteristics are controlled for. This means, at least to some extent, that individual profiles simply affect occupational choices, which, in turn, determine the chances of being mismatched

[15] We cannot rule out the presence of self-selection of the best students into specific situations. Nevertheless, it should also be recalled that all the models contain dummies for the program and university, which should capture part of the training quality dimension.

or not. For the small group of students working in jobs unrelated to their PhDs during their doctoral studies (about 4% of the sample), we observed a higher risk of being affected by either of the two forms of mismatch. These students might represent the least able students (those unable to secure a more favorable way of funding their PhD), but it is also possible that their desire to obtain a PhD was driven more by a "consumption" motivation than by academic/professional goals.

Only two of the academic attributes capturing individual performance during PhD studies have a significant effect on the probability of being mismatched. First, working in a research group while pursuing one's PhD favors access to jobs where the PhD qualification is a job requirement, but has no effect on the likelihood of the acquired skills being fully utilized. This observation clearly points to the value of using research infrastructures as a stepping stone towards an academic career requiring a PhD. Second, and contrary to our expectations, participating in external conferences increases the probability of being overqualified by about 11 percentage points.

Pre-doctoral research mobility and, most notably, post-doctoral mobility in national or international institutions decrease the probability of being mismatched, although the size of the effect diminishes after controlling for job-related variables. On average, post-doctoral mobility reduces the probability of being overskilled and overqualified by about 25 p.p. with respect to the reference category (no post-doctoral mobility). It is interesting to see that both forms of mismatch are lower for students who spent time as visiting scholars at other institutions. Therefore, these variables are not just capturing the importance of this type of experience for securing a job in the academic-research world, but are also a proxy for the learning and personal maturity that can be gained through research mobility. One could argue that these results might represent a malfunction of the training process, but it seems reasonable to think that skills acquired through mobility experiences are rather difficult to reproduce in the student's own institution during the regular training period. Moreover, research mobility, particularly following completion of a PhD, might also have a positive impact on job quality resulting from increased networking opportunities and access to information during research stays at different institutions.

Moving to the results obtained in the models where job-related variables are included as additional covariates, we must stress that the employment sector is of fundamental importance for explaining the likelihood of being overqualified and, in particular, of being overskilled. Being employed in the private sector and even more so in the public sector (i.e. government, public administration and other public non-academic institutions) substantially increases the chances of being mismatched and, even though this penalty is reduced when the main activities at work are included in the model, it remains sizeable and significant. On the contrary, those who work in research institutes are not more likely to be overskilled and are just slightly more

likely to be overqualified when job attributes and main activities are maintained constant. These results are remarkable, especially considering that working outside an academic-research environment has a very large impact on the probability of being overskilled. It would therefore appear that the problem of mismatch among PhD holders is not just related to a lack of recognition of the PhD credential outside the university (i.e. overqualification), but also points to a more fundamental problem related to a clear underutilization of skills by many employers.

The estimates of work location suggest that working outside Spain is associated with a lower probability of being mismatched. This could reflect either positive sorting of PhD holders who migrate after completing their PhD or a higher supply of suitable jobs in destinations to which Spanish PhD graduates are likely to migrate, namely Northern Europe and the US. The estimated marginal effects for the additional job-related controls highlight a sizeable positive effect of job tenure on the probability of overqualification. This effect might be explained by the cohort nature of our data and also perhaps by the fact that some graduates in our sample may have started their current job before completing their PhD. However, seniority seems to be unrelated to the likelihood of overskilling. In our sample, those with a permanent contract are slightly more likely to be adequately matched in terms of qualifications than others. In agreement with evidence reported for college graduates, we found that working in a medium-large firm (250-500 workers) has a beneficial effect on the probability of being adequately matched.

Finally, model (d) controlled for the main activities at work for those employed in non-university settings. Therefore, the effect of these variables in this model has to be interpreted as the impact of job task variation once the "average" effect of the main sector of activity has been controlled for. In other words, we are capturing within-sector changes associated with the main activities performed in the workplace. As expected, working in R&D reduces the likelihood of being mismatched in a consistent way for both indicators (-30 and -24 p.p. for overskilling and overqualification respectively). This means that working outside a university *per se* is not synonymous with mismatch. Rather, the higher risk of being mismatched depends on whether or not the graduate's PhD skills are utilized in the (non-academic) job. In other words, working outside academia, but in a research-related job, would compensate for the higher average likelihood of mismatch among private and public sector workers. This is also confirmed by the positive effect that performing technical support tasks has on both forms of mismatch, as well as the increased likelihood of those working in management and health care being mismatched. However, this last point should not be interpreted in terms of having "too many skills" but rather in terms of having skills that are not useful for a particular job.

Overall, our results clearly indicate that job characteristics are key factors in explaining mismatch status among PhD holders. Working in a non-academic or non-research setting increases the likelihood of mismatch. On the contrary, the academic characteristics of both PhD

programs and students have a less influential role and may be more closely related to easier access to academic and research-oriented jobs, which in turn would affect the likelihood of job mismatch.

5. Are mismatched doctors penalized?

5.1 Mismatch and earnings

In this section we examine the potential labor market penalty associated with job mismatch in our cohort of new doctors. Our starting point is an analysis of earning differences by mismatch status. Following standard practice, we estimated an extended earnings equation[16] that includes several academic attributes and job characteristics as control variables, following an "assignment" view of the labor market in which both individual human capital and academic and job characteristics determine earnings.

Table 3 shows the estimates from the augmented earnings regression[17]. Our primary interest is whether job mismatch approximately four years after completing one's PhD is associated with a wage penalty. Following Mavromaras et al. (2013), we included the four job match statuses in our model: adequately matched, overskilled, overqualified, and overskilled and overqualified. Our results indicate that being overskilled or overqualified is not statistically associated with earnings, suggesting that PhD recipients in these two categories do not earn less than their adequately matched counterparts. On the contrary, compared to well-matched graduates, those who are both overqualified and overskilled face a wage penalty of about 12%. These findings are consistent with the panel data evidence reported in Mavromaras et al. (2013), which indicates that only the combination of overskilling and overeducation has a significant detrimental effect on earnings among Australian graduates. Our estimates are also in line with the results reported by Chevalier (2003), Chevalier & Lindley (2009) and Green & Zhu (2010). Even though we used a different measure of mismatch, our results are also comparable with findings presented by Bender and Heywood (2009; 2011) for the US, which highlight a negative wage penalty associated with mismatch that seems to persist even after controlling for individual fixed effects. Also using panel data, Frenette (2004) did not detect a substantial wage penalty among overqualified Canadian PhD holders. This might be taken as further evidence

[16] In order to better adapt to the interval-coding of annual gross earnings we opted for an interval regression method (*intreg* command in STATA). Nevertheless, the estimates obtained by OLS using the typical mid-point approximation are virtually the same, although somewhat less precise.

[17] Notice that the set of RHS variables in the earnings equation is almost the same as that in the mismatch equations, with some exceptions. First, we retained only those academic attributes that are directly related to human capital accumulation; the results are virtually the same including all the mismatch equations' covariates. Second, we included age at job entry rather than current age to better proxy for previous labor market experience. We also adopted a linear specification for both age at job entry and current job tenure because, given the cohort nature of the AQU data, there is insufficient variability to capture quadratic effects. The results were invariant to the inclusion of quadratic terms, which were statistically insignificant at any conventional significance levels.

that, unless accompanied by a certain degree of skills mismatch, overqualification does not have a detrimental effect on job match among PhD graduates.

[TABLE 3 ABOUT HERE]

The estimates of the control variables in our model are quite standard and are just briefly discussed. The results show a significant *ceteris paribus* gender difference in annual earnings in favor of male doctors. As expected, earnings rise with age at job entry, probably reflecting previous experience. However, a longer time between finishing college and starting one's PhD studies has a negative effect. Graduates who obtain their PhD while working in a job related to their studies earn more, which might also be a reflection of greater work experience. Moreover, when other academic attributes and job characteristics are kept constant, graduates who take more than 6 years to finish their PhD studies endure a wage penalty.

There exists a sizable positive earnings differential in favor of PhD holders working in the private sector compared to the university[18], but no significant differences were detected among those working in research institutes or in the public sector. The public sector dummy coefficient is significantly higher and statistically different from zero when main activities at work are excluded from the model, suggesting that PhD recipients who work in the public sector earn more than those who work in a university only if they perform certain activities that are better remunerated, such as management and health care work.

PhD graduates working in the province of Barcelona earn more than in other Spanish provinces, but less than those who moved away from Spain. As expected, we also found a positive earnings effect for longer current job tenure, a permanent contract and employment in a medium-large firm. Moreover, PhD recipients who perform management and health-related tasks (outside the university setting) are better paid than others. The estimates from the PhD-type fixed effects reveal that those with a PhD in Biology earn more than those who studied humanities, sociology, political science or communication, but less than those who studied economics, business, chemistry, medicine, or computer and information engineering. Controlling for crossed PhD-type and university fixed effects would logically increase the likelihood of capturing unobserved differences related to the academic quality and prestige of the doctorate program, which might, in turn, be related to earnings potential. We tested this specification for robustness, but the results (available upon request) indicated virtually no differences. Following the Akaike and Schwarz criteria, we retained the more parsimonious specification with separate fixed effects, which requires the estimation of fewer parameters (the same applied to the following analysis of job satisfaction). The similarity of the results between

[18] We also explored the heterogeneous effect of mismatch by employment sector and area of study, but found no significant differences for the conditional correlates of mismatch and earnings compared in any of these two dimensions. It is of course likely that we were unable to detect significant differences due to the small sample size and subsequent lack of statistical power. Moreover, such calculations would be technically complex due to the endogenous nature of the choice of sector among PhD holders. See Di Paolo (2012) for a more complete discussion of this subject.

the two specifications might also be taken as suggestive evidence of the (relative) homogeneity of specific PhD programs across Catalan universities, indicating that potential bias due to unobserved heterogeneity related to university quality should not be the main driver of the results.

5.2 Mismatch and job satisfaction

In this section we analyze the conditional association between job mismatch and job satisfaction. It has been argued that a better understanding of the relationship between these two factors may help to determine whether or not mismatch is voluntary (McGuinness & Sloane 2011; Mavromaras et al. 2013). Those who accept a lower-paying job that does not match their qualifications or skills might do so because they are attracted by other job characteristics and consequently, might be as or even more satisfied than their well-matched counterparts. However, the combination of lower earnings and lower job satisfaction would suggest involuntary mismatch, probably due to labor market frictions and job queues, which is likely to be the case with recent PhD holders (especially in countries like Spain).

We consider perceived overall job satisfaction as an aggregate indicator of all relevant aspects of the job. Moreover, as already mentioned, the AQU survey asked about perceived satisfaction with four distinct facets of the job, namely promotion opportunities, earnings, job content and job-skills match. We considered that conducting a separate analysis of satisfaction with these four domains would provide a better insight into the channel through which mismatch affects the level of utility derived from the job. Given the ordinal nature of the variables in question, we applied the standard Ordered Probit approach[19].

Table 4 shows the marginal effect of each mismatch indicator on the probability of being very satisfied (the highest category) with the job as a whole and with each job domain[20]. It appears that mismatched PhD holders are not statistically less satisfied with earnings than their well-matched peers, and that those classified as both overskilled and overqualified are just slightly less satisfied with their career prospects. However, a certain degree of mismatch is significantly associated with a lower probability of being very satisfied with job content and job-skills match, two domains that reflect more intrinsic and non-monetary aspects of the job.

[19] The results using simple OLS are quite similar in terms of trade-off ratios between coefficients. It should be noted that the existence of common latent traits that simultaneously affect job satisfaction and the self-reported measures of mismatch may cause some bias in the estimates. For example, intrinsically optimistic PhD holders might be less likely to declare that they are mismatched and more likely to declare that they are satisfied with their job. Moreover, economic and professional expectations created during the PhD may also exert some unobserved influence. Our results must thus be simply considered as conditional associations that may not represent true causal effects.

[20] The complete models (see table 2A in the Appendix) contain, as is common, a large list of individual, academic and job controls that might covariate with job satisfaction and mismatch, as well as a set of earning categories dummies. The models also include indicators for missing information about annual earnings, as well as PhD-type and university fixed effects. The estimated coefficients of the entire list of control variables are quite standard and are not described here for brevity.

Specifically, graduates in the overqualified category are less satisfied with these job content and jobs-skills match, although educational requirements *per se* appear to have a lower impact on job satisfaction than skills utilization. Indeed, skills underutilization makes PhD holders significantly less likely to be very satisfied with job content and job-skills match. Notice that the loss of satisfaction associated with being both overqualified and overskilled is very similar to that associated with being overskilled only, indicating that underutilization of skills is significantly more damaging to job satisfaction than disregard of the attained qualification.

[TABLE 4 ABOUT HERE]

A more general view of the relationship between job mismatch and job satisfaction among PhD holders can be obtained from the estimates of the overall satisfaction equation. Overall job satisfaction represents an aggregate of job domain satisfaction and very probably includes additional domains to the four we considered (van Praag & Ferrer-i-Carbonell, 2007). Similarly to the case of earnings, being overqualified appears to be just slightly negatively associated with lower job satisfaction. More importantly, job satisfaction is significantly lower when overqualification and overskilling are combined and is lower still among PhD graduates who are overskilled but not overqualified, (although this estimate is less precise because of the few observations in this category). There are at least two explanations for these results. First, it might be that overqualified doctors enjoy other features of their job (unobserved in our data) that would compensate for underutilization of skills; this would be consistent with the hypothesis of compensating differentials. Second, it is possible that (unfulfilled) expectations might have a role. In other words, the fact that a PhD was required to get the job might have falsely raised the graduate's expectations regarding the need for his/her skills. Whatever the case, in agreement with data from international studies of highly educated workers, our findings on earnings and job satisfaction indicate that overskilling among PhD holders is quite unlikely to be voluntary and is a cause for concern as it is associated with lower job satisfaction and, when combined with overqualification, lower earnings.

6. Conclusions

This paper analyzes job mismatch among PhD holders in Catalonia, Spain. We draw on a very rich data set containing information on a recent cohort of PhD graduates from the public university system. Following the most recent literature on job mismatch among highly educated workers, in this empirical analysis we distinguish between two forms of mismatch: qualification mismatch and skills mismatch. Overall, our analysis reveals a worrisome situation in which a non-negligible proportion of recent PhD graduates face involuntary mismatch associated with a significant penalty in terms of job satisfaction and, in the most severe case, earnings.

In the first step of our analysis, we model the likelihood of overqualification and overskilling as two separate but interrelated processes. Initially, and contrasting with typical findings for college graduates, our results show that these two phenomena are quite closely correlated. This would indicate that employers' recruitment and promotion strategies are quite closely aligned with actual job content, reflecting a clear understanding of what can be accomplished by a PhD graduate. The job market for PhD graduates from Catalan universities is segmented into, on the one hand, jobs at universities and research institutes where graduates' credentials and skills are recognized and largely used, and, on the other hand, jobs in the public and private sectors where this is not so much the case. The main conditional correlates of job mismatch are sector of employment and the activities performed within the sector. It is important to stress that the problem of mismatch is more closely related to the skills requirements of the job rather than to employment in a private firm or the public sector. In other words, job mismatch, especially in terms of overskilling, seems to be more sensitive to the demand side than the supply side of the labor market. The negligible impact of academic characteristics on the probability of being overskilled (when individual and job characteristics were held constant) reinforces the idea that where you work is more important than what you learn during your doctoral training.

In the second step we investigated the impact of job mismatch on earnings and job satisfaction. Our findings coincide with those observed for college graduates in recent papers, since PhD holders face a severe wage penalty only when they are both overqualified and overeducated. The analysis of overall job satisfaction and its different domains indicate that mismatched graduates, and in particular overskilled graduates, are less satisfied with their job as a whole, with the content of their job, and with the match between their job and their skills. No significant effect, however, was observed on satisfaction with earnings and promotion prospects. In brief, overqualified and overskilled PhD holders are less satisfied with their jobs; the dissatisfaction observed seems to be mostly related to non-monetary aspects (reflecting intrinsic job quality) and unobserved facets, such as organization structure, work flexibility and other fringe benefits. According to our results, it could be argued that only PhD holders who are both overqualified and overskilled face a wage penalty and represent cases of high and mostly involuntary underemployment, which is probably due to the existence of frictions and queues in the academic/research-oriented labor market. On the contrary, those who are either overqualified or overskilled are, at least partly compensated by higher earnings, but this does not offset the lack of possibly more relevant non-monetary aspects of the job that are highly valuable for newly graduated PhD holders. The fact that overskilling has a more negative effect on job satisfaction than overqualification and that this effect was significant only for job content and job-skills match suggests that what really matters to new graduates is the extent to which they can exploit their "scientific" knowledge (i.e. their research potential) in the workplace.

Once again, the employment sector plays an important role in determining earnings. A job in the private sector commands a sizeable wage premium, casting doubts on the claim that PhD holders do not have skills required to be productive outside the academic world. It seems, however, that a certain number of graduates working in private companies (and to some extent in government and other public sector jobs) undertake tasks and responsibilities that are more closely related to management than to R&D. Despite their higher earnings, these graduates feel that their skills are being misused, which is reflected in the job satisfaction analysis. This apparent contradiction could be explained by the fact that PhD's "high taste for science" is not fulfilled in their jobs (Stern 2004, Roach & Sauermann 2010, Agarwal & Ohyama 2013).

We consider that our results can be interpreted within the broader discussion of the availability of adequate jobs for the increasing number of PhD holders entering the labor market. The growing influx of graduates may have not been adequately absorbed by a labor market that, on the one hand, is creating fewer academic and research jobs and, on the other, has long been incapable of effectively channeling new graduates into suitable jobs in industry, private business, government and the public sector in general. This does not mean, however, that new PhD graduates lack the skills to be successful in positions with a clear research and innovation content outside the academic world. In addition, there are signs that these graduates, when placed in middle- and top-management positions, can be a key asset. Unfortunately, there seems to be a misalignment between the skills acquired during the completion of a PhD and those required in management positions.

The results presented in this paper call for a new set of policies aimed at reforming supply and demand conditions. From the demand perspective, it is clear that Spanish firms must continue to transform their structures and incorporate more R&D activities to increase their competitiveness. However, in addition to fostering such changes, more attention should be given to promoting collaboration between the business world and universities and doctoral programs, through initiatives such as joint research projects, research spin-offs and co-training of graduates. From the supply perspective, there is a need for policies aimed at developing what has been called a "new skills agenda", with broader generic personal and professional skills that are transferable to a range of career paths, within and beyond research. PhD holders may have too many skills that are not useful outside academic spheres (Lee et al., 2010). Future PhD programs should attempt to incorporate the acquisition of more horizontal and transferable skills, such as managerial, organizational, leadership and teamwork skills. These skills would not only improve the employability of PhD graduates outside the traditional academic sector, but also foster the productive potential of graduates employed by industry, private firms and the government.

To conclude, the results presented in this paper may very well apply to other countries (particularly in southern Europe) that have experienced a similar increase in the supply of

highly educated workers. Ensuring an influx of highly qualified workers into the labor market is a necessary condition for helping firms to move towards high value added product strategies, but by no means is it the only condition. In order to fully exploit the productive and innovative potential of recent PhD graduates to feed the productive structure and economy as a whole, it is also necessary to develop mechanisms to induce changes in firms and government and other public agencies and create the conditions needed to fully harness the skills and capabilities of PhD recipients. In our opinion, European-level policies aimed at creating synergies between firms and doctoral programs would be an effective step towards achieving this goal.

References

Agarwal, R. & Ohyama, A. (2013). Industry or Academia, Basic or Applied Career Choices and Earnings Trajectories of Scientists. *Management Science*, 59(4), 950-970.

Allen, J. & De Weert, E. (2007). What Do Educational Mismatches Tell Us About Skill Mismatches? A Cross-country Analysis. *European Journal of Education*, 42 (1), 59–73.

Allen, J. & van der Velden, R. (2001). Educational Mismatches versus Skill Mismatches: Effects on Wages, Job Satisfaction, and On-the-Job Search, *Oxford Economic Papers*, 53 (3), 434-452.

Auriol, L. (2010). Careers of Doctorate Holders: Employment and Mobility Patterns," OECD Science, Technology and Industry Working Papers 2010/4, OECD Publishing.

Baert, S., Cockx, B. & Verhaest, D. (2013). Overeducation at the start of the career: Stepping stone or trap? *Labour Economics,* 25 (3), 123-140.

Bauer, T. K., (2002). Educational mismatch and wages: a panel analysis. *Economics of Education Review*, 21(3), 221-229.

Bender, K.A. & Heywood, J.S. (2009). Educational Mismatch among Ph.D.s: Determinants and Consequences. In R.B. Freeman, & D.L. Goroff, (Eds.), *Science and Engineering Careers in the United States: An Analysis of Markets and Employment* (pp. 229 - 255), National Bureau of Economic Research, Inc.

Bender, K.A. & Heywood, J.S. (2011). Educational mismatch and the careers of scientists. *Education Economics*, 19(3), 253-274.

Berkhout, E., Sattinger, M., Theeuwes, J. & Volkerink, M. (2012). *Into the gap: exploring skills and mismatches*. SEO-report nr. 2011-56. SEO Economic Research, Amsterdam.

Borrell-Damian, L., (2009). Collaborative Doctoral Education University-Industry Partnerships for Enhancing Knowledge Exchange. *DOC-CAREERS Project*, European University Association.

Canal, J. F. & Muñiz, M. A. (2012). Professional doctorates and careers: the Spanish case. *European Journal of Education*, 47 (1), 153–171.

Canal, J. F. & Rodriguez, C. (2013). Wage differences among PhDs by area of knowledge: are science areas better paid than humanities and social ones? The Spanish case. *Journal of Education and Work*, 26 (2), 187–218.

Carroll, D. & Tani, M., (2013). Over-education of recent higher education graduates: New Australian panel evidence. *Economics of Education Review*, 32(C), 207-218.

Chevalier, A. (2003). Measuring Over-education. *Economica*, 70(279), 509-531.

Chevalier, A. & Lindley, J. (2009). Overeducation and the skills of UK graduates. *Journal Of The Royal Statistical Society Series A*, 172(2), 307-337.

Cyranoski, D., Gilbert, N., Ledford, H. , Nayar, A. & Yahia, M. (2011). Education: the PhD factory, *Nature*, 472, 276-279.

Di Paolo, A. (2012). (Endogenous) occupational choices and job satisfaction among recent PhD recipients: evidence from Catalonia, Working Papers XREAP2012-21.

Dolton, P. J. & Makepeace, G. H. (1990). Graduate earnings after six years: Who are the winners? *Studies in Higher Education*, 15(1), 31–55.

Dolton, P. J. & Silles, M. A. (2008). The effects of over-education on earnings in the graduate labour market. *Economics of Education Review*, 27(2), 125-139.

Dolton, P. & Vignoles, A. (2000). The Incidence and Effects of Overeducation in the UK Graduate Labour Market. *Economics of Education Review*, 19, 179-198.

Enders, J. & Weert, E., (2004). Science, training and career: changing modes of knowledge production and labour markets. *Higher Education Policy*, 17, 135–152.

Engelage, S., & Hadjar, A. (2008). Promotion und Karriere—Lohnt es sich zu promovieren? Eine analyse der Schweizerischen absolventenstudie. *Schweizerische Zeitschrift für Soziologie*, 34(1), 71–93.

European University Association (2007). *Doctoral programmes in Europe's universities: achievements and challenges: report prepared for European universities and ministers of higher education*, EUA.
European University Association (2010). *EUA policy document on quality and quality assurance in the European Higher Education Area*, EUA.

Frenette, M. (2004). The overqualified Canadian graduate: the role of the academic program in the incidence, persistence, and economic returns to overqualification. *Economics of Education Review*, 23(1), 29-45.

García-Quevedo, J., Mas-Verdu, F. & Polo, J.L. (2012). Which firms want PhDs? An analysis of the determinants of the demand. *Higher Education*, 63, 607-620.

García-Quevedo, J., Betts, A., Doménech, M., Duch, N., Fina, X., Pifarré, H. & Polo, J.L. (2010). The Autonomous Region of Catalonia, Spain: Self-Evaluation Report. *OECD Reviews of Higher Education in Regional and City Development*, IMHE.

Green, F., McIntosh, S. & Vignoles, A. (2002). The Utilization of Education and Skills: Evidence from Britain. *The Manchester School*, 70(6), 792-811.

Green, F. & McIntosh, S. (2007). Is there a genuine under-utilization of skills among the over-qualified? *Applied Economics*, 39, 427–439.

Green, F. & Zhu, Y. (2010). Overqualification, job dissatisfaction, and increasing dispersion in the returns to graduate education. *Oxford Economic Papers*, 62(4), 740-763.

Green, H. & Powell, S. (2005). *Doctoral Education in Contemporary Higher Education*. Open University Press, Maidenhead.

Herrera, L., Muñoz-Doyague, M. F. & Nieto, M. (2010). Mobility of public researchers, scientific knowledge transfer, and the firm's innovation process. *Journal of Business Research*, 63(5), 510-518.

Lee, H.-F. & Miozzo, M. & Laredo, P. (2010). Career patterns and competences of PhDs in science and engineering in the knowledge economy: The case of graduates from a UK research-based university. *Research Policy*, 39(7), 869-881.

Kampelmann, S. & Rycx, F. (2012). The impact of educational mismatch on firm productivity: Evidence from linked panel data, *Economics of Education Review*, 31(6), 918-931.

Leuven, E. & Oosterbeek, H., (2011). Overeducation and Mismatch in the Labor Market. In Hanushek, E.A., S.Machin, S. & Woessmann, L. (Eds.), *Handbook of the Economics of Education* (pp. 283-326), Elsevier.

Mangematin, V. (2000). PhD job market: professional trajectories and incentives during the PhD. *Research Policy*, 29(6), 741-756.

Mavromaras, K. G. & McGuinness, S. & O'Leary, N. C. & Sloane, P. J. & Fok, Y. K. (2010). The Problem of Overskilling in Australia and Britain. The Manchester School, 78(3): 219–241.
Mavromaras, K. G. & McGuinness, S. & O'Leary, N. C. & Sloane, P. J. & Wei, Z. (2013). Job Mismatches and Labour Market Outcomes: Panel Evidence on Australian University Graduates. *Economic Record*, 89(286), 382-395.

McGuinness, S. (2003). Graduate Overeducation as a Sheepskin effect: Evidence from Northern Ireland. *Applied Economics*, 35, 597–608.

McGuinness, S. (2006). Overeducation in the Labour Market. *Journal of Economic Surveys*, 20(3), 387-418.

McGuinness, S. & Bennett, J. (2007). Overeducation in the graduate labour market: A quantile regression approach. *Economics of Education Review*, 26(5), 521-531.

McGuinness, S. & Wooden, M. (2007). Overskilling, Job Insecurity and Career Mobility, *IZA discussion paper,* No. 2938.

McGuinness, S. & Sloane, P. J. (2011). Labour market mismatch among UK graduates: An analysis using REFLEX data. *Economics of Education Review*, 30 (1), 130-145.

Mertens, A. & Röbken, H. (2013). Does a doctoral degree pay off? An empirical analysis of rates of return of German doctorate holders. *Higher Education*, 66 (2), 217-231.

National Science Foundation (2008). *Science and engineering indicators 2008 (vol. 2).* Arlington, VA: Author.

Neumann, R. & Khim, K. (2011). From PhD to initial employment: the doctorate in a knowledge economy. *Studies in Higher Education*, 36 (5), 601-614.

OECD (2009). *Science, Technology and Industry Scoreboard 2009*. OECD, Paris.

OECD (2011). *Employment Outlook 2011*. OECD, Paris.

OECD (2013). *Science, Technology and Industry Scoreboard 2013*. OECD, Paris.

Park, C. (2007). *Redefining the doctorate.* York: Higher Education Academy.

Pouliakas, K. (2012) *The skill mismatch challenge in Europe.* Employment and Social Developments in Europe 2012. European Commission. Luxembourg: Publications Office of the European Union.

Purcell, K., Durbin, S., Warren, S., Elias, P., Behle, H. & Davies, R. (2005). The employment of social science PhDs in academic and non-academic jobs: Research skills and postgraduate training Report prepared for the ESRC Training and Development Board (available at http://www2.warwick.ac.uk/fac/soc/ier/publications/2005/final_draft_socsci_phds_06_june_2005.pdf).

Quintini, G. (2011). Over-qualified or under-skilled: A review of the existing literature, *OECD Social, Employment and Migration papers*, DELSA/ELSA/WD/SEM.

Raddon, A. & Sung, J. (2009). *The career choices and impact of PhD graduates in the UK: A synthesis review*. Report prepared for the Economic and Social Research Council 'Science and Society' Team and the Research Councils UK Research Careers and Diversity Unit. University of Leicester.

Recotillet, I., (2007). PhD Graduates with Post-Doctoral Qualification in the Private Sector: Does it Pay Off? *LABOUR*, 21(3), 473-502.

Roach, M. & Sauermann, H. (2010). A taste for science? Ph.D. scientists' academic orientation and self-selection into research career in industry. *Research Policy*, 39(3), 422–434.

Sattinger, M. (2012). *Assignment models and quantitative mismatches*. Working Paper, Department of Economics, University at Albany, SUNY.

Scherer, S. (2004). Stepping-stones or traps? the consequences of labour market entry positions on future careers in West Germany, Great Britain and Italy. *Work, Employment and Society*, 18 (2), 369-394.

Schwabe, M. (2011). The career paths of doctoral graduates in Austria. *European Journal of Education*, 46 (1), 153-168.

Stephan, P., A. Sumell, G. Black, & J. Adams. (2004). Doctoral education and economic development: The flow of new PhDs to industry. *Economic Development Quarterly,* 18 (2), 151–67.

Stephan, P.E., Sumell, A.J., Adams, J.D. & Black, G. (2005). Firm Placements of New PhDs. In Fornahl, D., Zellner, C., Audretsch, D.B. (Eds.), *The Role of Labour Mobility and Informal Networks for Knowledge Trans*fer, International Studies in Entrepreneurship, 6 (XII): 123-146.

Stern, S. (2004). Do scientists pay to be scientists? *Management Science*, 50(6), 835–853.

Sumell, A.J., Stephan, P.E. & Adams, J.D. (2009). Capturing Knowledge: The Location Decision of New Ph.D.s Working in Industry, NBER Chapters, in Freeman, F.B. &Goroff, D. (Eds.), *Science and Engineering Careers in the United States: An Analysis of Markets and Employment* (pp. 257-287), National Bureau of Economic Research, Inc.

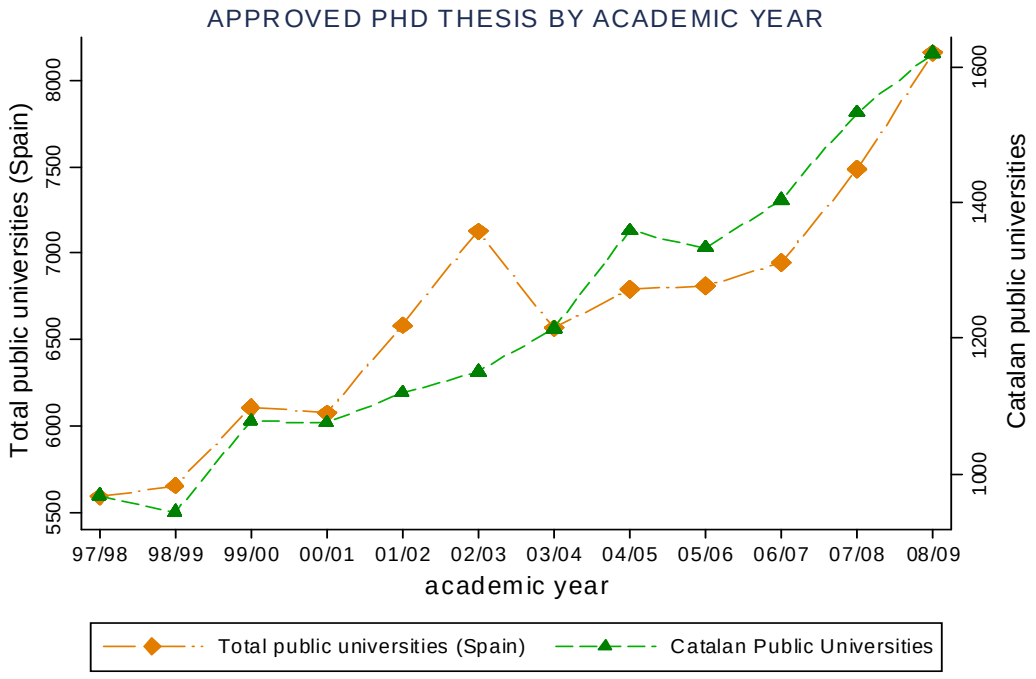
van Praag, B. M. S. & Ferrer-i-Carbonell, A. (2007). *Happiness Quantified: A Satisfaction Calculus Approach*. Oxford, Oxford University Press.

TABLES & FIGURES

Table 1: Cross-tabulation of qualification and skills mismatch

		PhD qualification required		
		No	***Yes***	***Total***
PhD skills necessary	***No***	260 *(25.95%)*	16 *(1.6%)*	276 *(27.54%)*
	Yes	275 *(27.45%)*	451 *(45%)*	726 *(72.46%)*
	Total	535 *(53.4%)*	467 *(46.6%)*	1,002 *(100%)*

Fig. 1. PhD theses approved in Spain and Catalonia between 1997-98 and 2008-09



Source: Spanish National Statistical Institute (INE).

Table 2: Probabilities of overskilling/overqualification — average marginal effects from Bivariate Probit models

	ΔPr[Overskilling]				ΔPr[Overqualification]			
	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)
Socio-demographic variables								
Female	0.051	0.039	0.039	0.050	0.033	0.026	0.016	0.035
	0.02 [b]	*0.02* [c]	*0.02* [c]	*0.02* [a]	*0.04*	*0.03*	*0.03*	*0.03*
Age/10	0.336	0.552	0.444	0.513	0.010	0.166	-0.037	-0.035
	0.31	*0.26* [b]	*0.25* [c]	*0.25* [b]	*0.36*	*0.31*	*0.36*	*0.42*
$(Age/10)^2$	-0.045	-0.066	-0.052	-0.058	0.003	-0.015	-0.012	-0.012
	0.04	*0.03* [b]	*0.03* [c]	*0.03* [b]	*0.05*	*0.04*	*0.05*	*0.05*
Academic variables								
Time between completion of undergraduate degree and PhD/10	0.035	0.025	0.023	-0.001	0.071	0.057	0.087	0.083
	0.06	*0.04*	*0.04*	*0.04*	*0.07*	*0.06*	*0.04* [b]	*0.04* [b]
PhD funding: research fellowship								
PhD funding: teaching or research during PhD	-0.021	0.060	0.041	0.009	0.090	0.128	0.036	0.028
	0.05	*0.03* [c]	*0.03*	*0.03*	*0.06*	*0.05* [b]	*0.04*	*0.04*
PhD funding: work related to PhD	0.082	-0.030	-0.023	-0.045	0.136	0.058	0.043	0.030
	0.04 [b]	*0.03*	*0.03*	*0.03*	*0.05* [a]	*0.04*	*0.04*	*0.04*
PhD funding: work not related to PhD or other situations	0.148	0.034	0.038	-0.029	0.231	0.178	0.157	0.165
	0.07 [b]	*0.06*	*0.07*	*0.05*	*0.05* [a]	*0.04* [a]	*0.04* [a]	*0.03* [a]
PhD duration > 6 years	0.008	0.002	-0.003	-0.022	0.044	0.032	0.020	0.022
	0.04	*0.03*	*0.03*	*0.03*	*0.04*	*0.04*	*0.03*	*0.03*
Extraordinary PhD prize	-0.098	-0.041	-0.039	-0.029	-0.066	-0.029	0.004	0.010
	0.03 [a]	*0.04*	*0.04*	*0.04*	*0.03* [b]	*0.03*	*0.02*	*0.02*
PhD thesis in English	-0.056	-0.024	-0.028	-0.025	-0.043	-0.022	0.003	0.010
	0.04	*0.04*	*0.03*	*0.03*	*0.04*	*0.03*	*0.03*	*0.03*
PhD thesis within a research group	-0.064	-0.016	-0.008	0.011	-0.151	-0.116	-0.070	-0.060
	0.04	*0.03*	*0.03*	*0.03*	*0.03* [a]	*0.03* [a]	*0.03* [b]	*0.03* [b]
Participation in internal seminars	-0.026	-0.031	-0.038	-0.045	0.001	0.004	0.007	-0.001
	0.03	*0.03*	*0.03*	*0.03*	*0.03*	*0.03*	*0.02*	*0.02*
Participation in external conferences	0.004	-0.002	-0.001	0.008	0.113	0.110	0.094	0.096
	0.04	*0.03*	*0.03*	*0.03*	*0.04* [b]	*0.04* [a]	*0.03* [a]	*0.02* [a]
Pre- and& post-doctoral mobility								
No pre-doctoral mobility	*Reference Category*							
Pre-doctoral mobility in national institutions	-0.070	-0.060	-0.034	-0.046	-0.026	0.002	0.005	0.003
	0.04	*0.03* [c]	*0.03*	*0.03*	*0.06*	*0.05*	*0.04*	*0.04*
Pre-doctoral mobility in foreign institutions	-0.043	-0.014	-0.014	-0.010	-0.087	-0.051	-0.038	-0.036
	0.03	*0.02*	*0.02*	*0.02*	*0.03* [a]	*0.03* [c]	*0.02* [c]	*0.02*
No post-doctoral mobility	*Reference Category*							
Post-doctoral mobility in national institutions	-0.238	-0.123	-0.133	-0.115	-0.220	-0.134	-0.061	-0.062
	0.05 [a]	*0.05* [b]	*0.05* [a]	*0.04* [a]	*0.06* [a]	*0.05* [a]	*0.05*	*0.04*
Post-doctoral mobility in foreign institutions	-0.257	-0.112	-0.112	-0.076	-0.271	-0.133	-0.069	-0.064
	0.03 [a]	*0.03* [a]	*0.03* [a]	*0.03* [a]	*0.03* [a]	*0.03* [a]	*0.03* [b]	*0.03* [b]

Note: All the estimations include fixed effects for PhD type and university (not shown). Standard errors (in italics) are clustered at the PhD program level; [a] significant at 0.01%, [b] significant at 0.05%, [c] significant at 0.1%.The average marginal effect for indicator variables are average discrete changes in the predicted probabilities.

Table 2 (*continued*): Probability of overskilling/overqualification — average marginal effects from Bivariate Probit models

	ΔPr[Overskilling]				ΔPr[Overqualification]			
	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)
Type of work								
University				*Reference Category*				
Research institute		0.041	0.011	0.034		-0.013	0.063	0.076
		0.03	*0.04*	*0.03*		*0.04*	*0.03* [b]	*0.03* [a]
Public sector		0.515	0.488	0.303		0.359	0.414	0.284
		0.04 [a]	*0.04* [a]	*0.06* [a]		*0.03* [a]	*0.02* [a]	*0.04* [a]
Private sector		0.389	0.344	0.216		0.220	0.255	0.138
		0.04 [a]	*0.04* [a]	*0.05* [a]		*0.03* [a]	*0.03* [a]	*0.04* [a]
Working region								
Barcelona province				*Reference Category*				
Elsewhere in Spain		-0.011	-0.022	-0.027		-0.030	-0.010	-0.017
		0.03	*0.03*	*0.02*		*0.03*	*0.02*	*0.03*
Outside Spain		-0.135	-0.135	-0.101		-0.210	-0.124	-0.085
		0.05 [a]	*0.05* [a]	*0.05* [c]		*0.03* [a]	*0.03* [a]	*0.04* [b]
Job attributes								
Current job tenure (in years/10)			-0.013	-0.016			0.568	0.541
			0.03	*0.03*			*0.05* [a]	*0.05* [a]
Permanent contract			0.018	-0.003			-0.038	-0.042
			0.03	*0.02*			*0.02*	*0.02* [b]
# Workers < 50				*Reference Category*				
50 < # Workers < 250			0.047	0.054			-0.043	-0.056
			0.04	*0.03* [c]			*0.03*	*0.03* [c]
250 < # Workers < 500			-0.118	-0.124			-0.129	-0.137
			0.04 [a]	*0.03* [a]			*0.05* [a]	*0.04* [a]
# Workers > 500			-0.026	-0.011			-0.040	-0.035
			0.04	*0.03*			*0.03*	*0.03*
Main activities (outside university; non-exclusive)								
Management				0.047				0.017
				0.02 [b]				*0.02*
R&D				-0.299				-0.239
				0.04 [a]				*0.03* [a]
Technical support				0.061				0.115
				0.02 [b]				*0.03* [a]
Teaching				0.010				0.036
				0.02				*0.03*
Health care				0.067				0.082
				0.04 [c]				*0.10*

Note: all the estimations include fixed effects for PhD type and university (not shown). Standard errors (in italics) are clustered at the PhD program level; [a] significant at 0.01%, [b] significant at 0.05%, [c] significant at 0.1%.The average marginal effect for indicator variables are average discrete changes in the predicted probabilities.

Table 3: Mismatch and annual gross earnings (in logs) — Interval Regression

Dependent Variable: Ln(annual earnings)	**Coefficient**	***S.E.***
Constant	9.663	*0.144*[a]
Mismatch variables		
Adequately matched (PhD and skills required)	*Reference Category*	
Overskilled but not Overqualified	-0.037	*0.089*
Overqualified but NOT Overskilled	-0.035	*0.028*
Overqualified and Overskilled	-0.121	*0.043*[a]
Socio-demographic variables		
Female	-0.113	*0.021*[a]
(Age at the job entry)/10	0.124	*0.043*[c]
Academic variables		
Time between completion of undergraduate degree and PhD/10	-0.089	*0.047*[a]
PhD funding: research fellowship	*Reference Category*	
PhD funding: teaching or research	0.003	*0.033*
PhD funding: work related to PhD	0.049	*0.037*
PhD funding: work unrelated to PhD or other situations	-0.061	*0.065*
PhD duration > 6 years	-0.072	*0.036*[b]
Type of work		
University	*Reference Category*	
Research institute	0.022	*0.032*
Public sector	0.065	*0.047*
Private sector	0.14	*0.043*[a]
Working region		
Barcelona province	*Reference Category*	
Elsewhere in Spain	-0.037	*0.028*
Outside Spain	0.184	*0.032*[a]
Job attributes		
Current job tenure (in years/10)	0.172	*0.040*[a]
Permanent contract	0.172	*0.028*[a]
# Workers < 50	*Reference Category*	
50 < # Workers < 250	0.055	*0.046*
250 < # Workers < 500	0.159	*0.051*[a]
# Workers > 500	0.149	*0.039*[a]

Note: robust standard errors in italics; [a] significant at 0.01%, [b] significant at 0.05%, [c] significant at 0.1%.

Table 3 (*continued*): Mismatch and annual gross earnings (in logs) — Interval Regression

Dependent Variable: Ln(annual earnings)	**Coefficient**	***S.E.***
Main activities (outside university; non-exclusive)		
Management	0.112	*0.022*[a]
R&D	0.018	*0.035*
Technical support	-0.011	*0.028*
Teaching	-0.022	*0.027*
Health care	0.25	*0.057*[a]
PhD type		
Geography and Demographics	-0.183	*0.089*[b]
History. Philosophy and Arts	-0.14	*0.054*[b]
Language. Linguistics and Literature	-0.221	*0.051*[a]
Economics and related fields	0.131	*0.062*[b]
Law and related Fields	0.071	*0.098*
Sociology, Political Sciences and Communication	-0.191	*0.079*[b]
Pedagogy and Education	-0.06	*0.065*
Psychology	0.09	*0.069*
Chemistry	0.072	*0.031*[b]
Biology	*Reference Category*	
Environmental Studies	0.03	*0.043*
Mathematics	0.045	*0.051*
Physics	0.016	*0.075*
Medicine	0.09	*0.041*[b]
Pharmacy	0.033	*0.067*
Veterinary	0.066	*0.094*
Architecture	-0.127	*0.139*
Civil, Nautical and Aeronautical Engineering	0.1	*0.078*
Production Engineering	0.083	*0.050*[c]
Computers and Information Engineering	0.159	*0.041*[a]
Agricultural Engineering	0.007	*0.119*
University		
University of Barcelona (UB)	*Reference Category*	
Autonomous University of Barcelona (UAB)	0.001	*0.023*
Polytechnic University of Catalonia (UPC)	0.045	*0.043*
Pompeu Fabra University (UPF)	0.159	*0.050*[a]
University of Lleida (UdL)	-0.004	*0.053*
University of Girona (UdG)	-0.03	*0.058*
Rovira i Virgili University (URV)	-0.008	*0.059*
Pseudo R^2	0.315	
N	937	

Note: robust standard errors in italics; [a] *significant at 0.01%,* [b] *significant at 0.05%,* [c] *significant at 0.1%.*

Table 4: Mismatch and job satisfaction — average marginal effects (probability of being very satisfied) from Ordered Probits

	Coefficient	S.E.
Promotion opportunities		
Adequately matched (PhD and skills required)	*Reference Category*	
Overskilled but NOT Overqualified	-0.061	*0.039*
Overqualified but NOT Overskilled	-0.012	*0.021*
Overqualified and Overskilled	-0.039	*0.025[c]*
Earnings		
Adequately matched (PhD and skills required)	*Reference Category*	
Overskilled but NOT Overqualified	-0.028	*0.028*
Overqualified but NOT Overskilled	0.007	*0.015*
Overqualified and Overskilled	-0.016	*0.018*
Job content		
Adequately matched (PhD and skills required)	*Reference Category*	
Overskilled but NOT Overqualified	-0.269	*0.094[a]*
Overqualified but NOT Overskilled	-0.072	*0.038[c]*
Overqualified and Overskilled	-0.228	*0.042[a]*
Job-skills match		
Adequately matched (PhD and skills required)	*Reference Category*	
Overskilled but NOT Overqualified	-0.259	*0.041[a]*
Overqualified but NOT Overskilled	-0.103	*0.032[a]*
Overqualified and Overskilled	-0.283	*0.028[a]*
Overall job satisfaction		
Adequately matched (PhD and skills required)	*Reference Category*	
Overskilled but NOT Overqualified	-0.160	*0.047[a]*
Overqualified but NOT Overskilled	-0.046	*0.029[c]*
Overqualified and Overskilled	-0.105	*0.031[a]*

Note: Each model includes controls for gender, age and age squared, time between completion of undergraduate degree and PhD, PhD funding, PhD duration >6 years, PhD type and university fixed effects, type of job, job location, current job tenure, permanent contract, firm size, main activities and annual earnings categories. Complete estimates are reported in Table 2A in the Appendix. Robust standard errors in italics; [a] significant at 0.01%, [b] significant at 0.05%, [c] significant at 0.1%.

APPENDIX

Table 1A: Descriptive statistics by mismatch status

	Total	Adequately Matched	Overskilled	Overqualified	Overskilled& Overqualified
Sociodemographic variables					
Female	0.485	0.439	0.569	0.516	0.558
Age	36.92	34.71	38.23	38.81	38.33
Age at job entry	30.7	31.83	30.26	29.64	30.05
Academic variables					
Time between completion of undergraduate degree and PhD	3.789	2.803	4.659	4.624	4.719
PhD funding: research fellowship	0.616	0.823	0.493	0.441	0.485
PhD funding: teaching or research	0.132	0.091	0.076	0.161	0.062
PhD funding: work related to the PhD	0.199	0.071	0.330	0.310	0.346
PhD funding: work unrelated/other situations	0.054	0.016	0.101	0.088	0.108
PhD duration > 6 years	0.225	0.095	0.283	0.333	0.285
Extraordinary PhD prize	0.148	0.208	0.072	0.099	0.073
PhD thesis in English	0.277	0.370	0.159	0.202	0.158
PhD thesis within a research group	0.731	0.891	0.627	0.593	0.615
Participation in internal seminars	0.720	0.787	0.659	0.664	0.658
Participation in external conferences	0.894	0.947	0.819	0.849	0.812
Pre- and post-doctoral mobility					
No pre-doctoral mobility	0.397	0.248	0.565	0.523	0.576
Pre-doctoral mobility in national institutions	0.053	0.051	0.047	0.056	0.050
Pre-doctoral mobility in foreign institutions	0.550	0.701	0.388	0.421	0.374
No post-doctoral mobility	0.605	0.399	0.874	0.773	0.882
Post-doctoral mobility in national institutions	0.056	0.080	0.022	0.037	0.023
Post-doctoral mobility in foreign institutions	0.340	0.521	0.104	0.190	0.095
Employment sector					
University	0.361	0.463	0.054	0.279	0.042
Research institute	0.209	0.348	0.043	0.095	0.042
Public sector	0.175	0.022	0.442	0.307	0.465
Private sector	0.255	0.166	0.460	0.320	0.450
Working region					
Barcelona province	0.664	0.570	0.734	0.737	0.725
Elsewhere in Spain	0.222	0.220	0.241	0.231	0.256
Outside Spain	0.114	0.211	0.025	0.032	0.019
Job attributes					
Current job tenure (in years)	6.248	2.905	7.984	9.171	8.308
Permanent contract	0.441	0.271	0.743	0.576	0.742
# Workers < 50	0.129	0.086	0.217	0.161	0.215
50 < # Workers < 250	0.108	0.109	0.149	0.103	0.142
250 < # Workers < 500	0.044	0.060	0.025	0.030	0.023
# Workers > 500	0.720	0.745	0.609	0.707	0.619
Main activity (outside university; non-exclusive)					
Management	0.307	0.226	0.406	0.374	0.408
R&D	0.711	0.960	0.236	0.505	0.215
Technical support	0.183	0.109	0.297	0.247	0.308
Teaching	0.458	0.386	0.399	0.521	0.400
Health care	0.085	0.004	0.207	0.153	0.215

Table 1A (*continued*): Descriptive statistics by mismatch status

	Total	Adequately Matched	Overskilled	Overqualified	Overskilled& Overqualified
PhD type					
Geography and Demographics	0.011	0.018	0.007	0.006	0.008
History. Philosophy and Arts	0.054	0.040	0.080	0.067	0.085
Language. Linguistics and Literature	0.042	0.013	0.051	0.065	0.050
Economics and related fields	0.032	0.020	0.029	0.043	0.031
Law and related fields	0.017	0.009	0.025	0.022	0.023
Sociology, Political Sciences and Communication	0.023	0.022	0.011	0.024	0.012
Pedagogy and Education	0.032	0.009	0.043	0.050	0.042
Psychology	0.020	0.004	0.033	0.034	0.035
Chemistry	0.120	0.177	0.091	0.067	0.081
Biology	0.175	0.244	0.145	0.112	0.135
Environmental Studies	0.053	0.071	0.051	0.037	0.050
Mathematics	0.044	0.062	0.033	0.030	0.035
Physics	0.018	0.018	0.018	0.017	0.015
Medicine	0.112	0.051	0.199	0.166	0.212
Pharmacy	0.031	0.027	0.040	0.036	0.042
Veterinary	0.021	0.013	0.036	0.028	0.038
Architecture	0.015	0.002	0.011	0.026	0.012
Civil, Nautical and Aeronautical Engineering	0.020	0.022	0.011	0.019	0.012
Production Engineering	0.060	0.069	0.040	0.054	0.042
Computers and Information Engineering	0.087	0.086	0.040	0.086	0.035
Agricultural Engineering	0.015	0.022	0.007	0.009	0.008
University					
University of Barcelona (UB)	0.399	0.406	0.464	0.389	0.458
Autonomous University of Barcelona (UAB)	0.293	0.299	0.297	0.288	0.296
Polytechnic University of Catalonia (UPC)	0.148	0.133	0.091	0.164	0.096
Pompeu Fabra University (UPF)	0.036	0.035	0.025	0.036	0.023
University of Lleida (UdL)	0.041	0.042	0.036	0.039	0.035
University of Girona (UdG)	0.034	0.038	0.040	0.032	0.042
Rovira i Virgili University (URV)	0.049	0.047	0.047	0.052	0.050
Gross annual earnings					
Annual earnings ≤ €18,000	0.034	0.018	0.047	0.049	0.050
Annual earnings €18,001-24,000	0.132	0.137	0.134	0.127	0.135
Annual earnings €24,001-30,000	0.244	0.288	0.214	0.207	0.215
Annual earnings €30,001-40,000	0.334	0.390	0.275	0.286	0.269
Annual earnings €40,001-50,000	0.095	0.086	0.080	0.105	0.085
Annual earnings > €50,000	0.097	0.053	0.156	0.133	0.158
Missing information	0.065	0.027	0.094	0.093	0.088
Job satisfaction variables					
Promotion opportunities	6.020	6.119	5.667	5.960	5.690
Earnings	4.792	4.777	4.719	4.807	4.718
Job content	4.789	4.822	4.715	4.761	4.710
Job-skills match	5.200	5.907	3.678	4.651	3.651
Overall job satisfaction	5.674	5.768	5.401	5.617	5.425
Number of observations	1002	451	276	535	260

Table 2A: Mismatch, overall job satisfaction and job domains satisfaction — Ordered Probit Model

	Promotion Opportunities		**Earnings**		**Job Content**		**Job-Skills Match**		**Overall Job Satisfaction**	
Adequately matched (PhD and skills required)					*Reference Category*					
Overskilled but NOT Overqualified	-0.336	*0.253*	-0.219	*0.243*	-0.85	*0.378*[b]	-1.135	*0.301*[a]	-0.777	*0.336*[b]
Overqualified but NOT Overskilled	-0.059	*0.102*	0.048	*0.1*	-0.201	*0.107*[c]	-0.332	*0.103*[a]	-0.173	*0.11*
Overqualified and Overskilled	-0.201	*0.13*	-0.116	*0.134*	-0.691	*0.139*[a]	-1.394	*0.141*[a]	-0.437	*0.136*[a]
Female	-0.006	*0.076*	0.127	*0.075*[c]	0.148	*0.080*[c]	0.119	*0.076*	0.14	*0.076*[c]
Age/10	-0.056	*0.972*	1.144	*0.844*	0.959	*0.92*	0.496	*0.855*	0.299	*0.983*
$(Age/10)^2$	-0.023	*0.119*	-0.145	*0.104*	-0.148	*0.114*	-0.079	*0.103*	-0.068	*0.122*
Time between completion of undergraduate and PhD	0.003	*0.156*	-0.222	*0.165*	0.228	*0.182*	-0.014	*0.164*	0.246	*0.178*
PhD funding: research fellowship										
PhD funding: teaching or research	0.157	*0.124*	-0.001	*0.122*	0.377	*0.125*[a]	-0.074	*0.124*	0.247	*0.124*[b]
PhD funding: work related to the PhD	0.128	*0.114*	-0.189	*0.118*	0.251	*0.124*[b]	-0.079	*0.124*	0.081	*0.124*
PhD funding: work unrelated to the PhD or others	0.02	*0.177*	-0.149	*0.19*	0.227	*0.195*	-0.101	*0.195*	0.179	*0.192*
PhD duration > 6 years	0.095	*0.121*	-0.086	*0.122*	-0.092	*0.133*	0.021	*0.126*	0.009	*0.133*
University					*Reference Category*					
Research institute	-0.133	*0.129*	0.065	*0.133*	0.141	*0.135*	0.202	*0.127*	0.021	*0.128*
Public sector	-0.214	*0.159*	-0.131	*0.156*	0.05	*0.172*	-0.276	*0.171*	-0.095	*0.167*
Private sector	0.075	*0.162*	0.025	*0.154*	-0.037	*0.162*	-0.358	*0.163*[b]	-0.072	*0.16*
Current job tenure in years/10	-0.186	*0.091*[b]	0.029	*0.098*	0.098	*0.105*	0.195	*0.098*[b]	0.081	*0.109*
Permanent contract	0.078	*0.1*	0.043	*0.099*	-0.088	*0.108*	-0.109	*0.102*	-0.132	*0.101*
# Workers < 50					*Reference Category*					
50 < # Workers < 250	-0.229	*0.151*	-0.088	*0.146*	-0.301	*0.152*[b]	-0.312	*0.157*[b]	-0.32	*0.144*[b]
250 < # Workers < 500	-0.259	*0.199*	0.045	*0.212*	-0.316	*0.2*	-0.329	*0.216*	-0.211	*0.205*
# Workers > 500	-0.332	*0.139*[b]	-0.026	*0.137*	-0.104	*0.142*	-0.216	*0.141*	-0.214	*0.128*[c]
Working in Barcelona province					*Reference Category*					
Working in rest of Spain	0.013	*0.102*	-0.086	*0.104*	-0.162	*0.111*	0.059	*0.104*	-0.177	*0.108*
Working outside Spain	0.462	*0.139*[a]	0.642	*0.129*[a]	0.163	*0.13*	0.059	*0.128*	0.387	*0.122*[a]
Management	0.199	*0.083*[b]	0.098	*0.084*	0.337	*0.089*[a]	0.098	*0.086*	0.302	*0.089*[a]
R&D	-0.032	*0.105*	-0.313	*0.110*[a]	0.002	*0.125*	0.114	*0.115*	-0.066	*0.115*
Technical support	-0.064	*0.1*	-0.14	*0.098*	-0.068	*0.103*	-0.113	*0.103*	-0.195	*0.102*[c]
Teaching	0.16	*0.092*[c]	0.013	*0.09*	0.091	*0.093*	0.074	*0.088*	0.156	*0.093*[c]
Health care	0.458	*0.203*[b]	-0.278	*0.201*	0.459	*0.217*[b]	0.507	*0.197*[b]	0.321	*0.203*

Table 2A (*continued*): Mismatch, job satisfaction and job domains satisfaction — Ordered Probit Model

	Promotion Opportunities		Earnings		Job Content		Job-Skills Match		Overall Job Satisfaction	
Annual earnings ≤ €18,000					*Reference Category*					
Annual earnings €18,001-24,000	0.039	*0.254*	0.174	*0.24*	-0.084	*0.253*	-0.069	*0.235*	-0.188	*0.257*
Annual earnings €24,001-30,000	0.201	*0.245*	0.276	*0.229*	0.023	*0.234*	-0.031	*0.226*	-0.001	*0.245*
Annual earnings €30,001-40,000	0.321	*0.244*	0.646	*0.230*[a]	-0.056	*0.233*	-0.083	*0.221*	-0.012	*0.242*
Annual earnings €40,001-50,000	0.812	*0.261*[a]	1.25	*0.246*[a]	0.123	*0.262*	0.017	*0.245*	0.338	*0.262*
Annual earnings >€50,000	0.609	*0.267*[b]	1.302	*0.257*[a]	0.254	*0.263*	0.146	*0.254*	0.224	*0.268*
Missing annual earnings	0.424	*0.275*	0.66	*0.261*[b]	-0.128	*0.283*	-0.17	*0.253*	-0.121	*0.287*
Geography and Demographics	0.235	*0.264*	0.277	*0.388*	0.074	*0.342*	0.272	*0.382*	0.344	*0.259*
History. Philosophy and Arts	0.187	*0.184*	0.304	*0.186*	0.242	*0.206*	-0.213	*0.203*	0.25	*0.201*
Language. Linguistics and Literature	0.269	*0.219*	0.179	*0.201*	0.554	*0.253*[b]	0.207	*0.2*	0.403	*0.240*[c]
Economics and related fields	0.38	*0.224*[c]	-0.024	*0.181*	0.053	*0.194*	0.089	*0.201*	0.156	*0.199*
Law and related fields	0.964	*0.258*[a]	0.238	*0.291*	0.293	*0.3*	0.407	*0.271*	0.283	*0.294*
Sociology, Political Sciences and Communication	0.581	*0.254*[b]	0.198	*0.261*	0.28	*0.298*	0.161	*0.257*	0.188	*0.279*
Pedagogy and Education	0.882	*0.236*[a]	0.179	*0.23*	0.535	*0.297*[c]	0.246	*0.256*	0.207	*0.283*
Psychology	1.064	*0.246*[a]	0.313	*0.262*	0.758	*0.258*[a]	-0.074	*0.284*	0.623	*0.313*[b]
Chemistry	0.005	*0.135*	-0.108	*0.126*	-0.097	*0.133*	0.071	*0.12*	-0.06	*0.134*
Biology					*Reference Category*					
Environmental Studies	0.062	*0.177*	-0.01	*0.183*	-0.079	*0.192*	0.197	*0.179*	0.042	*0.189*
Mathematics	-0.106	*0.199*	0.251	*0.206*	-0.225	*0.188*	-0.135	*0.189*	-0.331	*0.166*[b]
Physics	0.452	*0.33*	-0.385	*0.302*	0.524	*0.349*	0.294	*0.282*	0.182	*0.321*
Medicine	0.161	*0.162*	-0.126	*0.173*	0.032	*0.18*	-0.035	*0.162*	-0.036	*0.17*
Pharmacy	0.351	*0.224*	-0.066	*0.233*	0.291	*0.218*	-0.121	*0.234*	0.072	*0.219*
Veterinary	0.187	*0.339*	0.055	*0.247*	-0.063	*0.249*	-0.15	*0.3*	0.291	*0.266*
Architecture	0.707	*0.367*[c]	-0.125	*0.374*	0.349	*0.475*	0.743	*0.358*[b]	0.207	*0.433*
Civil, Nautical and Aeronautical Engineering	0.075	*0.281*	-0.099	*0.29*	-0.029	*0.258*	0.453	*0.272*[c]	0.028	*0.255*
Production Engineering	0.064	*0.202*	0.028	*0.203*	-0.066	*0.203*	0.213	*0.215*	-0.186	*0.201*
Computers and Information Engineering	0.008	*0.165*	-0.259	*0.172*	0.059	*0.17*	0.441	*0.183*[b]	0.026	*0.168*
Agricultural Engineering	-0.397	*0.418*	-0.433	*0.389*	0.845	*0.471*[c]	0.164	*0.42*	-0.415	*0.469*
University of Barcelona (UB)					*Reference Category*					
Autonomous University of Barcelona (UAB)	0.144	*0.088*	-0.037	*0.091*	0.056	*0.094*	-0.001	*0.09*	0.076	*0.094*
Polytechnic University of Catalonia (UPC)	0.134	*0.162*	-0.08	*0.169*	0.217	*0.174*	-0.31	*0.175*[c]	0.198	*0.164*
Pompeu Fabra University (UPF)	0.041	*0.176*	0.244	*0.202*	-0.086	*0.228*	-0.073	*0.185*	0.033	*0.222*
University of Lleida(UdL)	0.37	*0.193*[c]	0.306	*0.214*	0.36	*0.184*[c]	-0.045	*0.2*	0.794	*0.220*[a]
University of Girona(UdG)	0.886	*0.284*[a]	0.494	*0.259*[c]	0.112	*0.31*	-0.266	*0.319*	0.819	*0.316*[a]

Rovira iVirgili University (URV)	0.535	*0.228*[b]	0.017	*0.218*	0.538	*0.220*[b]	-0.354	*0.219*	0.63	*0.222*[a]
Cut-off point 1	-1.898	*1.975*	0.367	*1.713*	-1.674	*1.906*	-1.892	*1.788*	-2.719	*1.985*
Cut-off point 2	-1.456	*1.974*	0.946	*1.713*	-0.749	*1.885*	-1.506	*1.783*	-2.289	*1.976*
Cut-off point 3	-1.019	*1.973*	1.495	*1.713*	-0.389	*1.871*	-1.091	*1.78*	-1.598	*1.974*
Cut-off point 4	-0.541	*1.972*	2.109	*1.712*	0.159	*1.873*	-0.558	*1.78*	-0.943	*1.979*
Cut-off point 5	0.221	*1.971*	2.959	*1.711*[c]	0.987	*1.873*	0.166	*1.78*	-0.172	*1.98*
Cut-off point 6	1.072	*1.969*	4.012	*1.711*[b]	2.128	*1.875*	1.195	*1.78*	1.237	*1.982*
Pseudo R2	0.181		0.210		0.179		0.372		0.160	

Note: robust standard errors in italics; [c] *significant at 0.1%,* [b] *significant at 0.05%,* [a] *significant at 0.01%.*

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