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Abstract

Labour markets for research are changing and the traditional segmentation model of the research labour market where the doctorate was mainly valuable in the academic sector is loosing ground. The paper studies a sample of PhDs and their corresponding employing firms to analyse patterns of mobility, economic returns, and innovation outputs. Qualitative and quantitative indicators are combined to tackle two sets of general questions: The first relates to the incentives for doctorate holders to pursue a company career versus an academic career. The second concerns the flexibility and/or reversibility of career options for young PhDs and the relative value of a doctorate outside academia. The results question the idea that the labour market for PhDs is tightly segmented and highlights the complementarity of PhDs' individual competencies and collective capabilities in the assessment of innovation outputs. They also demonstrate that economic returns are significantly different by gender

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Introduction

The European research labour market is experiencing important quantitative and qualitative changes. In many countries, the public sector is no longer the main source of employment opportunities for researchers, yet the proportion of researchers and PhDs employed in the private sector continues to be rather low in several countries. In the context of these transformations the paper presents some evidence on the trajectories, mobility and innovation outputs of young PhDs in firms.

Qualitative and quantitative indicators are combined to tackle two sets of general questions. The first relates to the incentives for doctorate holders to pursue a company career versus an academic career. Here, an important indicator to measure incentives and opportunity costs are relative salaries, both entry salaries and progression over time, but more qualitative aspects related to stability prospects are also relevant. A second set of relevant issues concerns the flexibility and/or reversibility of career options for young PhDs and the relative value of a doctorate outside academia. These issues relate to testing the model of the segmentation versus circulation of the PhD labour market. More specifically, the paper addresses the following questions: What are the motivations and returns for PhDs to enter the private sector? How this relates to expectations and preferences during their PhD training? Are there mismatches between PhD training and R&D jobs' content in private companies? Are professional trajectories flexible for recent PhDs? What is the relationship between individual qualifications and collective capabilities when assessing innovation outputs of PhDs employment in companies? Are there significant gender differences in the employment of PhDs in firms?

Entry of PhDs into the academic sector and scientific careers in the public research sector have been now well analysed (Ehrenberg, 2002). The progress into the academic sector is conditioned by the quality of publishing activities (Diamond, 2001; Levin and Stephan, 2001) that remains the main determinant of getting a permanent job as an academic researcher. Experiences during the PhD training such as collaboration with the private sector or intensity of publication activity are also important factors to explain the entry job for doctorates (Mangematin, 2000). Cross nationally, different science training policies and modes of scientific human resources management lead to divergent incentive structures that might promote or hinder mobility between sectors (Gaughan and Robin, 2004). But also more subjective elements such as preferences and attitudes (Fox and Stephan, 2001; Freeman *et al*., 2001) and supervisor's role and research production (Stephan and Levin, 2001; Van Ours and Ridder, 2003) are also influential on employment destinations. Nevertheless, job mobility from the academic sector to the private one is a rather unexplored issue, although some research results have been recently published (Enders, 2002, 2004). Likewise, entry into private R&D careers has been little studied. Most of the literature on research trajectories has traditionally focused on the academic profession (Clark, 1987; Carmichael, 1988; Stephan and Levin, 2001).

The analysis of PhDs trajectories is relevant because PhDs employment within firms contributes to knowledge transfer from academia and thus it relates to competitiveness and innovation. Despite the role that PhDs employment in the private sector plays in fostering innovation, fewer research has been done to analyse this employment. The classical work of Kornhauser (1962) analysed, from the sociology of science

perspective, the tensions between the normative and incentive systems of the industrial and academic sectors of science. These conflicts were addressed in further developments (Cotgrove and Box 1970) evidencing, however, that scientists who join industry are able to adapt to values different from those of academic science. This work found little support for the view that the employment of scientists in industry generates substantial strains or dissatisfaction, nor they find evidence on the failure of industry to use the skills capacities of its scientists to the full.

From a more economic perspective, Dasgupta and David (1994) argued that academic and industrial science have the same requirements and nature, and that if they are different it is because they are socially organised in different ways, with different incentive and reward mechanisms. More recently, Audretsch and Stephan (1999) have investigated the different incentive structures that industrial and academic scientists confront when choosing a way to commercialise their knowledge, in the context of their path-dependent career trajectories, in the biotechnology sector.

Collaboration between industrial firms and public research centres has also been investigated and some conclusions have been drawn applying the notion of "absorptive capacity" of the firm (Cohen and Levinthal, 1990) to analyse knowledge transfer of diverse nature (Mangematin and Nesta, 1999). Firms that collaborate with public research centres and universities and those that use research outputs coming from public R&D centres as sources of information seem more likely to hire PhD graduates (Beltramo *et al.* 2001) Additionally, some very recent work has deepened previous analysis of careers by integrating the role of mobility in the circulation of knowledge and how science and technology human capital is deployed in different contexts, industry included (Bozeman and Mangematin, 2004).

The research reported here is based on findings emerging from the evaluation of a public programme (*Acción IDE* –Employment of PhDs in firms-) aimed to increase the number of doctorate holders employed in firms. The paper contributes to these debates by studying a sample of PhDs and their corresponding employing firms to analyse patterns of mobility, economic returns, and innovation outputs. The method consists in the statistical analysis of qualitative and quantitative data coming from two surveys with structured questionnaires. The article questions the idea that the labour market for PhDs is tightly segmented and highlights the complementarity of PhDs' individual competencies and collective capabilities in the assessment of innovation outputs.

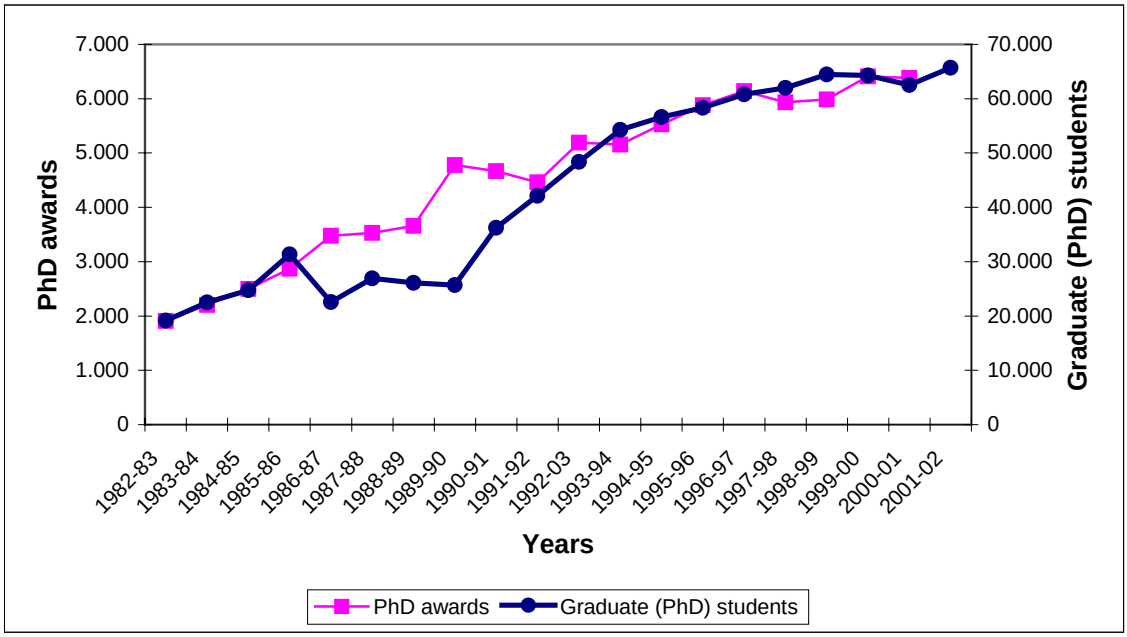
The paper is structured as follows. The next section describes some of the features of the Spanish R&D system and the PhD research labour market and related policies. Two specific headings are devoted to the description of the IDE Programme and to the data and methods used. Following that, we analyse the trajectories of a sample of PhDs employed in the private sector addressing patterns of mobility by using information about their previous employment situation, expectations and preferences during their PhD training. The following section focuses on the analyses of the role of the employment of this type of researchers in fostering innovation and collaboration between firms and Public Research Centres (PRC). Next we study the determinants of the continuity and salary differences of the PhDs in the private sector, including gender, and finally the last section discusses the main conclusions of the analysis in the light of the questions posed at the beginning.

The research labour market and R&D human resources policies

In 2001, while the Spanish GDP per capita was 85% of the EU average, the GDP allocated in R&D was 48.5% of the EU average. It was generally agreed that the main problem of the Spanish S&T system was the low level of R&D investment, but concerns also emerged regarding human resources in S&T. One additional problem, associated with the limited private R&D expenditure, was the short number of researchers employed in private firms. Over the second half of the nineties, just only 25% of researchers (FTE) were employed in firms, versus 49.8% in the EU average[1].

In Figure 1 we observe the sharp increase in the total number of annual doctorates awarded by Spanish universities along with a large increase of graduate students. This evolution was related to several factors (Cruz-Castro and Sanz-Menéndez, 2005). Over the last 20 years, more than 80,000 new PhDs have been awarded: 7,000 from engineering and technology and more than 45,000 in science and medicine.

Figure 1. Evolution of the graduate students and PhD awards in Spain. 1981-2001



Source: Spanish Statistics. INE. *Higher Education Statistics.* Various years

In Spain, as in many other countries, the PhD degree is a diploma required to access to a stable or tenured academic job, with the condition of civil servant. Some analyses have shown that professional trajectories in research are not flexible and that PhDs have to choose a trajectory when their level of information on employment and other returns prospects is very low (Mangematin, 2000). Moreover, in Spain the public and private research sectors are institutionally rather differentiated, and out of the academe, for some fields for research, people expect difficulties to obtain returns from the investment in a PhD, therefore, the costs of mobility become too high, and this contributes to enlarge the segment of "waiting positions" in the public research sector. However by the mid-nineties, it was more and more evident that the number of PhDs that the university system was generating surpassed the absorptive capacities of the public research sector[2].

The evolution of the R&D human resources policies

The "programme for the employment of PhDs in firms" (Acción para la Incorporación de Doctores en Empresas - IDE) is part of a policy sequence (Weir, 1992) that started in the early eighties associated to what was called "research training policy". Since then Government policy has shifted from a simple training or mobility policy to a policy focused also on employability issues (either in private companies or in the public research sector) as a way of promoting the use and transfer of the R&D capabilities created; without abandoning the supply side policies more emphasis has been given to demand side ones (see table 1).

Table 1. Some stages of the Spanish S&T human resources policy, based in the addition of new instruments to the focus

60s and 70s. Training strategies abroad defined by the Public Research Centres
80s. Governmental research training programme (FPI) in Spain and abroad
Late 80s. Mobility schemes between public and private sectors
Early 90s. Re-incorporation of researchers (from abroad)
Mid 90s. PhDs employability schemes in firms (Acción IDE)
2000s. Employability of PhDs in the public sector (Ramon y Cajal and Juan de la Cierva Programmes) and PhD holders and scientist and engineers in firms (Torres Quevedo Programme)

Source: Cruz-Castro and Sanz-Menéndez (2005)

The IDE programme was a demand-side policy launched in 1997 by the Ministry of Education and aimed to alleviate the problem of the low innovative capacities of Spanish firms trough the incorporation of highly qualified S&T human capital. The programme subsidised firms willing to contract junior PhD not previously working in the company for R&D and innovation jobs[3]. Any junior PhD (up to five years from graduation) was eligible provided he or she was not already employed in the applying firm and that the job offered was related to innovative activities[4]. The selection of the PhD was made at the company level.

The IDE programme was active for five years (1997-2001) and got 761 applications for funding from 450 different firms. The selection procedure consisted mainly in the evaluation of the innovation content of job. As a result, 602 PhDs were contracted, by 371 different firms. The total subsidies provided by the IDE programme over its life amounted to 16.2 million euros.

The distribution of the contracted PhDs by areas was: 69.1% had a degree in the Natural Sciences field, including Biology, Chemistry, Pharmacy and Physics; PhDs in the medical areas were 9.5%, Engineering PhDs were 11%, and agricultural sciences 4.1%. One out of three were Chemistry PhDs.

The gender distribution was quite balanced and presented a similar distribution of the PhDs awarded a couple of years before: 54.2% of contracted PhDs were male and 45.8% female. Almost 90% of them were under 35 years old at the moment they were contracted; the data is consistent with the average age of completion of the PhD in Spain that was 30-31 years old.

The pharmaceutical industry was strongly represented among the employing firms (30%); services to enterprises represented 15% and R&D services 12.6% of firms[5]. These sectors are the main engine of private demand of PhDs in Spain, specially for those working in R&D activities.

Methods and data

The following analysis uses data from three different sources referred to the same universes. First, data coming from the Ministerial Register of the IDE Programme which contains some basic characteristics of the applying firms and PhD holders (450 and 761 respectively) among other variables. Secondly, data coming from two postal surveys. with structured questionnaires targeted to the complete universes of firms and PhDs beneficiaries of the subsidies (371 and 602 respectively) that were used for the evaluation of the programme (Sanz Menéndez, Cruz Castro and Aja, 2004).

The valid response rates were 74.9% for PhDs and 73.0% for firms[6]. We also defined a sub data set including responses matching the cases of PhD holders and firms that referred to 287 employees for which we have also the corresponding answers of the contracting company; one advantage of this methodology compared to traditional PhD holders surveys is that it tells us about characteristics of employing firms.

Questionnaires combined descriptive quantitative questions with more subjective self-perception scales, of the Likert type, referred to both to the past trajectory[7] of PhDs holders and their current working conditions. Likewise, the employers' survey also addressed some variables describing possible changes and evolution in company features and specially assessment of the PhDs impact on their innovative activities[8].

Employment trajectories, preferences and mobility

The majority of our sample of PhDs graduated when they were around 30 years old. When speaking about the transition to work for this type of population, it is important to take into account their status during the doctoral training. One approach is to get information about the source of funding of the doctoral training. In this respect, almost all analysed PhDs (93.2%) had a grant, fellowship or training contract during their doctorate.

Although the majority of them had a preference for the public research sector during their doctorate (54.9%), preferences were quite balanced. In the areas of research represented in our sample, still 45.1% of PhD students had preferred a job in the private sector after their doctorate, while doing their PhDs. However, the expectations about future employment prospects were negative in the 69.8% of the cases, especially among those who preferred a job in the pubic research sector among which more than 80% thought that there were few possibilities in this sector for their research area, as compared to a proportion of 56% of pessimists among those who preferred the private sector (see table 2).

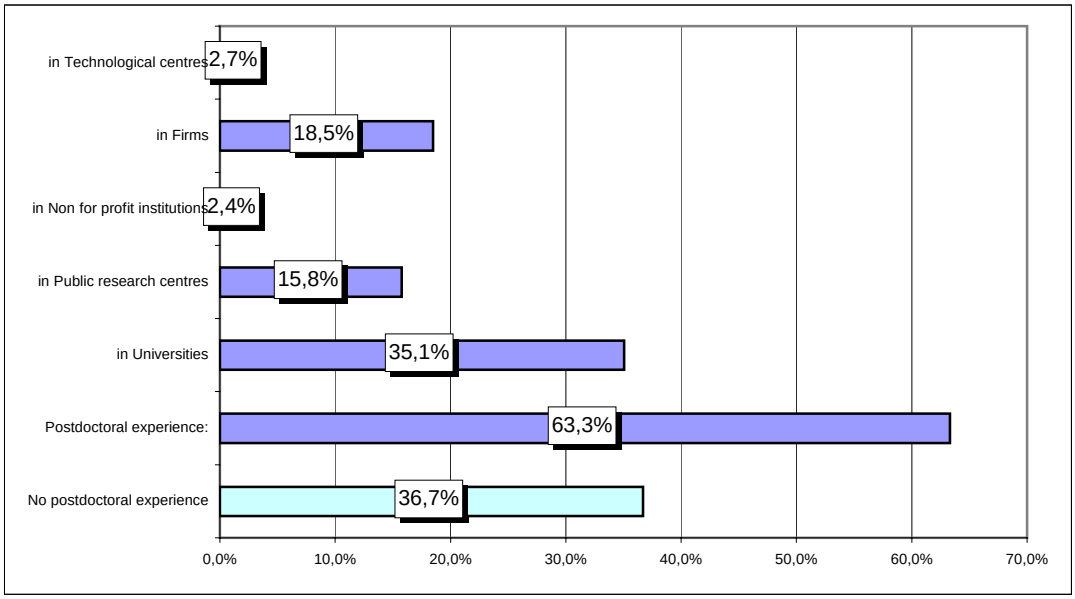
Table 2. Preferences and expectations for future working at the time of doing the PhD

	Expectations about future employment prospect		
Preferred sector of employment	Positive	Negative	Total
Public Sector	10.4%	44.5%	54.9%
Private sector	19.8%	25.3%	45.1%
Total	30.2%	69.8%	100.0%

Source: PhDs holders survey (N= 373). Valid cases = 364.

For the majority of PhDs contracted it was their first experience in the private sector and many of them had moved from the academic sector. In fact for 36.7% of our sample, this was their first employment experience, while the rest (63.3%) already had postdoctoral employment experience (figure 2).

Figure 2. Postdoctoral experience of PhD holders before getting the IDE contract

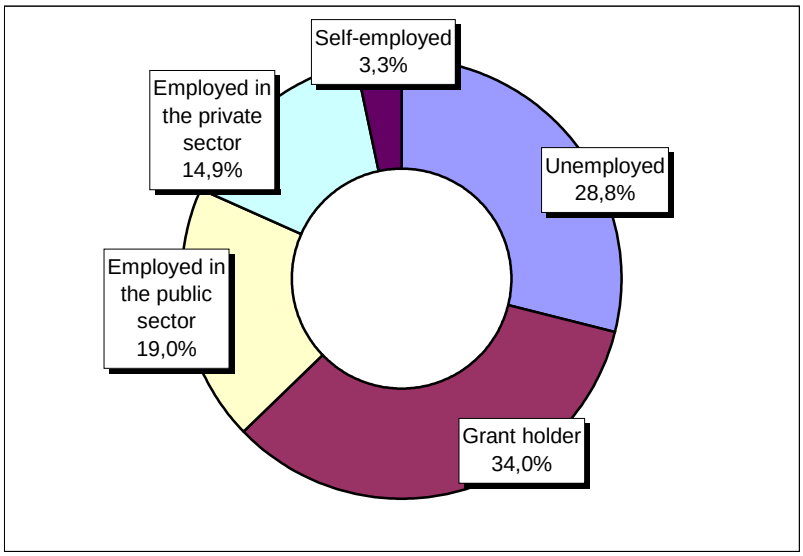


Source: PhDs holders survey. N=373. Valid cases=364. Multiple answer allowed for those with postdoctoral experience.

When asked about the type and place of their postdoctoral experience previous to that contract, 73.0% of those who had been employed after their doctoral graduation reported a fellowship or contract in a public university or in a public research centre. This employment was in 61.8% of the cases in the same university or research centre in which they had prepared their PhD. This is indicative of the low mobility of Spanish PhD after graduation as compared with research labour markets in other countries. However, there was an important group who reported postdoctoral experience in the private sector (29.2% of the group with post doctoral employment experience or 18.5% of all cases).

Figure 3 shows that just before joining the firms participating in the programme, more than half of the PhDs were employed in the public research sector, the majority of them with a fellowship and only a minority with an employment contract. Around 20% were employed in other firms and 28.8% were unemployed.

Figure 3. Employment situation of the PhDs at the time of being contracted by the firm



Source: PhDs holders survey (N = 373). Valid cases =368.

Unemployment was higher among women (32.7%) than men (25.5%). Therefore, the overall picture for PhD holders a couple of years after their graduation was characterised by a lack of stable employment conditions in most of the cases.

Motivations to work in the private sector and innovation outputs

Incentives to work in a particular firm or sector are usually connected with salary, employment conditions, prestige, social recognition, autonomy and several other factors. In our study, we found that motivations to work in the private sector were not much related to economic factor. The motivations to work in the private sector were several, but it is striking the low importance of salary considerations reported in the questionnaires. As observed in table 3, the most important factor was the attractiveness of the possibility of having professional experience in the private sector, which was mentioned by 29.6% as the first factor in the decision, and by 49.9% as the first or second factor in the decision. Also the possibility of stable employment in the firm was taken into account by more than 41.8% who mentioned this factor as the first or the second in importance. This was followed by the absence of stable employment prospects in the public sector. The salary was mentioned as the most important factor by just 3.6% and as the second most important factor by 14.2%. The search for short-term employment improvements does not seem to be a decisive factor even for those moving from the public sector. It is the prospects for stable employment what appears to be most relevant.

Table 3. Most important factors taken into account by PhDs to joint the firms

Factors taken into account to join the firm	First factor	Second factor	First and second factors cumulative
The salary	3.6%	14.2%	17.2%
The firm	19.5%	13.7%	32.2%
Opportunity to have work experience in private sector	29.6%	21.8%	49.9%
Possibility to continue in the firm	15.9%	27.4%	41.8%
Lack of opportunities of stable employment in the public sector	20.5%	18.7%	38.1%
To exit from unemployment	11.0%	4.2%	14.7%
	100.0%	100.0%	
Total valid cases =	365	358	

Source: PhDs holders survey (N= 373).

The preferred sector of employment during the doctorate seems to influence the factors that the PhD took into account to work in the private sector. For instance, it is highly significant that those who preferred a job in the public sector mentioned the absence of stable job prospects in that sector as the most important factor in 33.3% of the cases compared with just 4.3% of those who were inclined to private sector employment during their PhD. As we can see in table 4 significant differences between the two groups are evident for almost all decision factors.

Table 4. First motivation to join the firm and initial employment preferences

	Initial employment preferences of the PhD		
Factors taken into account to join the firm	Public sector	Private sector	Total
The salary	4.6%	2.5%	3.6%
The firm	11.3%	29.0%	19.3%
Opportunity to have work experience in private sector	26.7%	34.0%	30.0%
Possibility to continue in the firm	13.8%	18.5%	16.0%
Lack of opportunities of stable employment in public sector	33.3%	4.3%	20.2%
To exit from unemployment	10.3%	11.7%	10.9%
Total	100.0%	100.0%	100.0%
Total valid cases =	195	162	357

Source: PhDs holders survey (N=373).

Little is known about the way in which supply and demand matches in the private research labour market. In order to get some indicators about these processes, we analysed the way of contact between the PhD and the firm, and its relation with the size of the firm and its knowledge absorptive capacity (measured by the existence of other PhDs in the firm, and of an R&D department). Whereas size did not show any significant relation, we found a strong relationship between the previous existence of an R&D department and the way the employment contact was made. Table 5 shows that in firms with such department, it was the firm that searched for the PhD in 68.3% of the cases. In 52.6% of the cases in which no R&D department existed, they were the PhDs themselves who made the contact.

Table 5. Initiative of the contact according to the existence or not of a R&D Department and other PhDs in the firm

	Who had the initiative in the contact?					
	Intermediation organizations	The PhD	The firm	Both the firm and the PhD	Total	Valid cases=
R&D department in the firm	10.3%	20.0%	68.3%	1.4%	100.0%	145
R&D Department in process of constitution	11.4%	36.4%	52.3%	0.0%	100.0%	44
Non R&D Department	10.5%	52.6%	36.8%	0.0%	100.0%	57
Total	10.6%	30.5%	58.1%	0.8%	100.0%	246
	Who had the initiative in the contact?					
	Intermediation organizations	The PhD	The firm	Both the firm and the PhD	Total	Valid cases=
Firm has other PhDs already	6.2%	30.0%	63.1%	0.8%	100.0%	130
Firm has NOT other PhDs already	15.5%	31.0%	52.6%	0.9%	100.0%	116
Total	10.6%	30.5%	58.1%	08%	100.0%	
Valid cases=	26	75	143	2		246

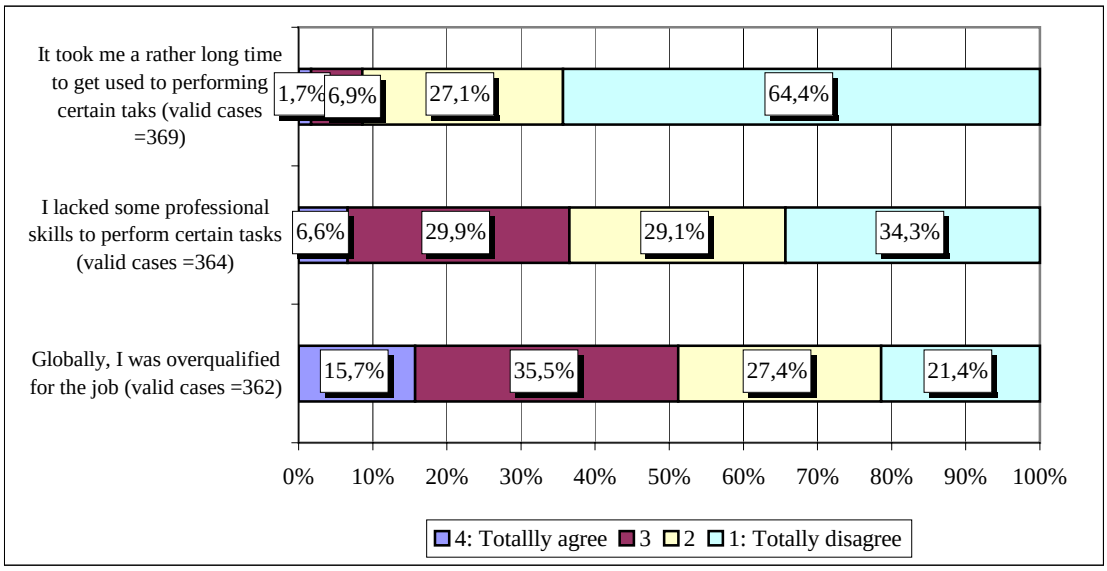
Source: Survey to employer firms (N= 260).

The firms initiating the contact were also characterised by having other PhDs among their personnel. Firms with other PhDs among their personnel contacted the contracted researcher in 63.1% of the cases, whereas 52.6% of the firms without PhD personnel initiated the contact. The data indicates the positive role of the intermediation organisations, more relevant when there was no R&D department or other PhDs in the firm.

The idea of relevance of doctoral training outside the academic sector is an important issue and pressures have grown to make this training more relevant to a variety of other careers (Enders, 2002). We explored the matching of the content of the job with the doctoral qualifications and we found that once contracted by the firms, PhDs got R&D jobs in 85% of the cases, without significant differences related to the previous employment experiences of individuals. More detailed information about job tasks evidences that applied research and development were a significant part of the job content in 75% and 73.5% of the cases respectively. Basic research however was among the principal activities of PhDs only in 25% of them, with some but small differences by gender (29% for males and 20.6% for females). In the majority of the cases the job and the research area of the PhD were strongly (43%) or somehow related (42%) Only in 14% of the cases the job content and the research field of the PhD were not related.

Much has been discussed about the possible mismatch between the qualifications and skills of PhD holders and the needs of the productive structures of firms arguing that often, academic training is too formalised and with little orientation to applications. Our evidence does not show such a mismatch. As show in figure 4, the lack of professional skills was not at all a problem for the majority of surveyed PhDs (63.4%). Moreover, half of them felt subjectively overqualified for the job in various degrees, while the other half did not, and these were precisely those whose activities were strongly related with their PhD training. Thus, the question of whether firms make full use of PhDs qualifications remains open.

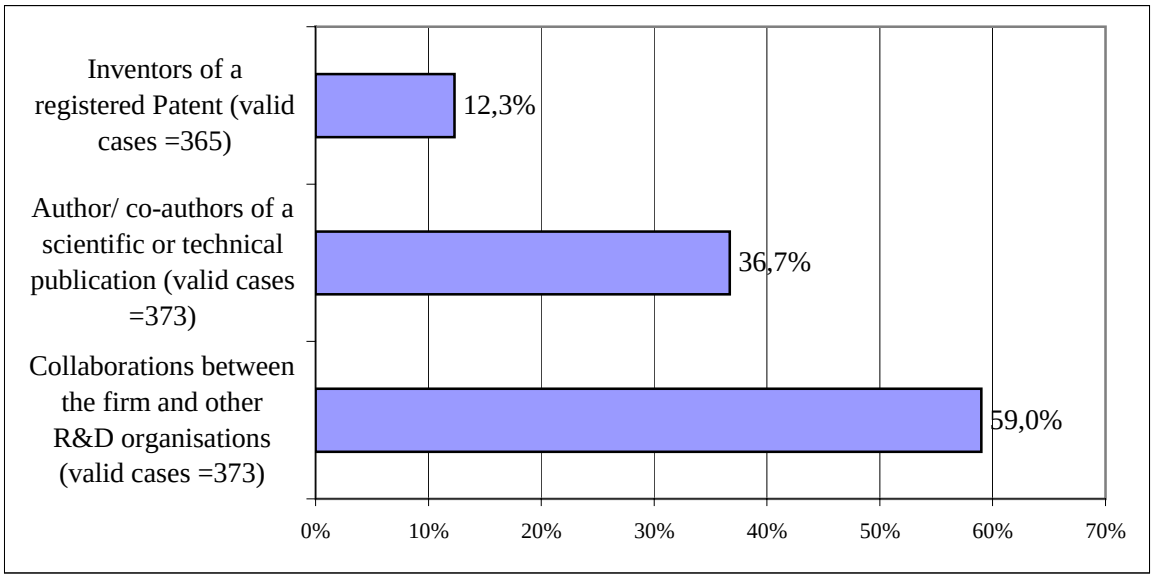
Figure 4. PhD skills and jobs: Agreement/Disagreement with statements



Source: PhDs holders survey (N=373).

Finally, we explored some of the outputs associated with the employment of the PhD in the firms. For that purpose, we focused on participation of employed PhDs in patents, publications and collaborations. The distribution along these outputs can be observed in figure 5. Nevertheless, these innovation results were more likely to occur in firms with previous research capabilities, including among these the existence of an R&D department and previous collaborations of the firms with public research organisations.

Figure 5. R&D and innovation outputs as a result (associated) of the employment of the PhD in the firm (% of cases)



Source: PhDs holders survey (N=373).

As reflected in table 6 the previous existence of an R&D department within the firm was positively related with the publications of the PhD as a result of his/her employment in the company. 42.7% of PhDs employed in firms with an R&D department authored some publications, whereas the figure was 25% for those working in firms without such a department.

Table 6. S&T papers and patents as PhDs outputs according to the existence of a R&D department in the employer firm at the time of hiring

Firms according	Publication of S&T papers as result of the work activity				Patents as result of the work activity			
	Yes	No	Total	N	Yes	No	Total	N
R&D department in the firm	42.7%	57.3%	100.0%	185	18.9%	81.1%	100.0%	190
R&D Department in process of constitution	39.5%	60.5%	100.0%	43	9.1%	90.9%	100.0%	44
Non R&D Department	25.0%	75.0%	100.0%	36	2.7%	97.3%	100.0%	37
Total	39.8%	60.2%	100.0%		15.1%	84.9%	100.0%	
Valid cases =	105	159		264	41	230		271

Source: Cases of PhD holders that matched to employer firms (N=287).

Likewise, the relationship between the previous existence of an R&D department and the existence of patents in which the PhD was included as a co-author is also positive and significant. Almost 19% of PhDs contracted in firms with R&D department participated in at least one patent, whereas the figure was 9.1% for those in firms where this department was under construction, and just 2.7% for those working in firms without such departments.

Moreover, publications and patents are also strongly associated with the previous collaboration of the firms with universities and public research centres. Actually, PhDs employed in firms without such previous collaborations were not included as co-authors of any patent, and 43.9% of PhDs working in firms with such previous collaborations were included as authors of scientific publications as compared with 17.5% of those employed in firms without previous collaboration records with the public sector (see table 7).

Table 7. Results of the PhD activity and firm collaboration with Public Research Organizations (PRO) in the previous five years

	Publications	Patents	Collaborations
Firm has collaborated with PRO (% has:)	43.9%	17.9%	69.3%
Firm has not collaborated with PRO (% has:)	17.5%	0.0%	43.%
% of cases with output	39.7%	15.1%	65.3%
% of cases without output	60.3%	84.9%	34.7%
Total valid cases =	252	258	259

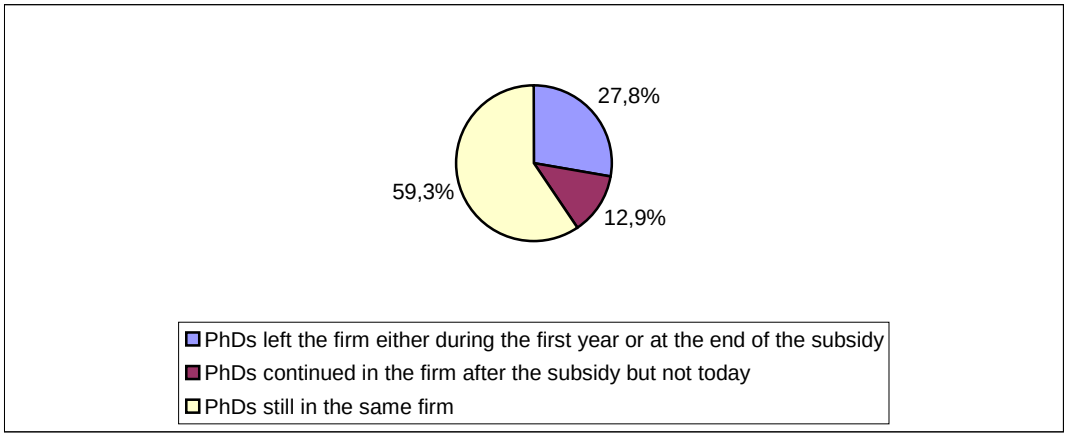
Source: Cases of PhD holders that matched to employer firms (N= 287).

Collaboration might, however, be also the outcome of the employment of the PhD, because that employment may favour the creation of new networks or strengthen existing ones. A means of deploying S&T human capital occurs when the researchers exploit their network positions and build relationships between their academic social networks and the firms (Murray, 2004). We have seen that the majority of the PhDs in our study had a research background in the public research sector. The previous academic experience of the PhD mediates the networks that she/he can bring to a firm. As observed in figure 5, the establishment of collaborations between the firm and other R&D organisations is by far the most mentioned result of the employment of the doctorates in the firms. All that means that highly qualified human resources are a significant carrier of the technology transfer and future stable collaborations.

PhD trajectories in the firms: continuity, salaries and gender

One of the central indicators of the success of the IDE programme in terms of employment outcomes was the proportion of those PhDs who stayed in the firms after the two years of the subsidy period, and in this respect, 72.2% of the PhDs contracted under the programme continued after that period, and 59.3% continued to be employed in the same firm at the time of the survey, that is an average of 4 years after their IDE contract.

Figure 6. Trajectories of the PhDs according to their present situation

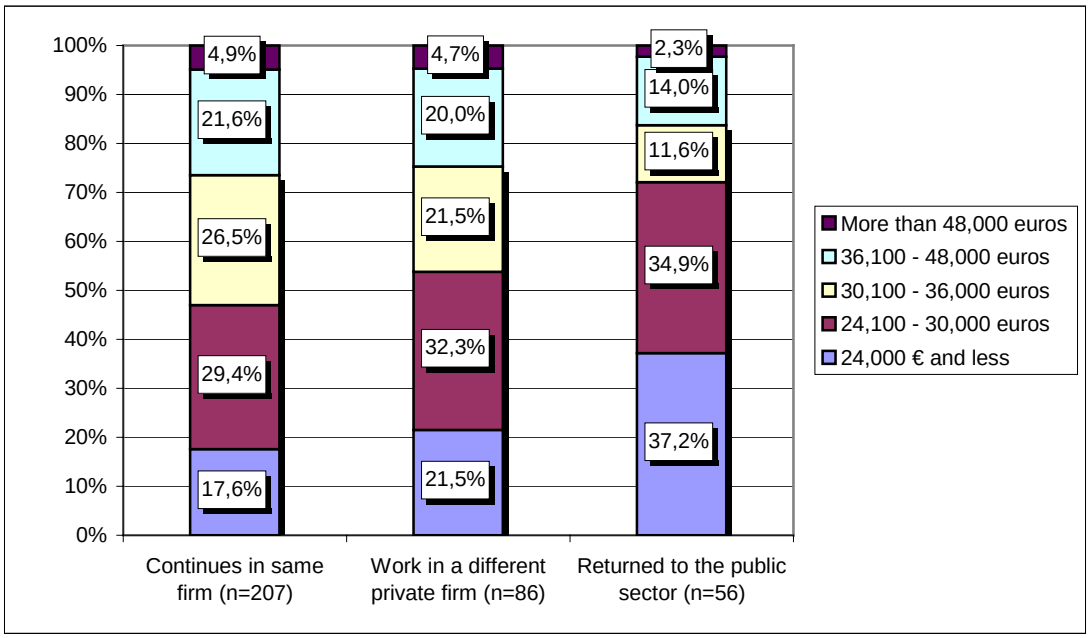


Source: Survey to PhD holders. N=373. Valid cases= 349.

One striking result is that there is not any individual attribute significantly correlated with the ratio of continuation in the company. The variables related to continuity are mostly related to the firm and the nature of the job. It seems that the capabilities of firms to accommodate this highly qualified personnel are linked to some structural characteristics. In this sense, the existence of an R&D department increased the proportion of continuity of PhDs in firms. Likewise, ratios of continuity were higher in firms that already had others PhD among their personnel.

Comparing the distribution of the annual income of the three groups of PhDs holders in figure 7, we get the clear impression that the economic returns are significantly higher for those that have continued in the same company. The situation in terms of wage levels is significantly worse for those who returned to the public sector.

Figure 7. Current salaries distribution of PhDs and professional trajectories (euros). 2003



Source: Survey to PhD holders (N=373). Valid cases= 349.

In the research related to the impact of particularistic attributes on careers, gender has been widely studied, and whereas we did not find big gender imbalances on the issues reviewed so far, we did find significant imbalances as regards annual salaries. During the first year of contract, one out of every two females (49.1%) earned less than 21,000 Euro, while 30.8% of males were under that level. At the other end of the salary range, 12.6% of men earned more than 30,000 Euros whereas just 3.0% of women are above that level (table 8).

Table 8. Entry salaries for PhDs employed in firms

Wage level (in euros)	Males	Females	Total
Between 18,000 and 21,000 €	30.8%	49.1%	39.2%
Between 21,100 and 24,000€	20.7%	18.3%	19.6%
Between 24,100 and 30,000	35.8%	29.6%	33.0%
More than 30,000 €	12.6%	3.0%	8.2%
	100.0%	100.0%	100.0%
Valid cases =	198	169	367

Source: Survey to PhD holders (N=373).

These differences can hardly be explained by the differences on previous employment experience[9]. Another hypothesis could be a positive relationship between entry salary and firm size, and differences by gender in relation to firm size. However, none of these relations were significant in our data. Salary differences by gender remain at later stages of the employment trajectory (table 9), even for those who continue in the same firm (table 10).

Table 9. Net salaries gains for PhDs (in euros)

	Males	Females	Total
Net loss of wages or unemployed	5,7%	10,4%	7,8%
Actual salary same than entry salary	14,9%	28,0%	20,9%
Gains lower than 10.000 euros	36,1%	42,1%	38,8%
Gains between 10,000 and 19,000 euros	37,6%	15,9%	27,7%
Gains of 20,000 euros or more	5,7%	3,7%	4,7%
	100,0%	100,0%	100,0%
Valid cases=	194	164	358

Source: Survey to PhD holders (N=373).

Table 9 presents the net salary progression of the PhD holders after an average period of 4 years. The diversity of increases by gender is significant, because while 20.6% of males have the same or a lower current salary than the entry salary, the figure for females is 38.4%. In the opposite side of the distribution, among those who have increased their salaries on more than 10,000 euros, we found 43.3% of males and only 19.6% of females.

As regards salary progression, there are significant differences by gender even for those who continue in the firm currently. At the time of the survey, only 8.4% of males had a gross annual salary under 24,000 Euro, while 31.8% of females were under this level. At the other end of the range, 34.2% of men earned more than 36,000 Euros, whereas only 14.6% of women were above that salary level (table 10).

Table 10. Current salaries for PhDs that continue in the same firm in 2003

Wage level (in euros)	Males	Females	Total
Less than 21,000€	1.7%	9.8%	5.0%
Between 21,100 and 24,000€	6.7%	22.0%	12.9%
Between 24,100 and 30,000€	29.2%	29.3%	29.2%
Between 30,100 and 36,000€	28.3%	24.4%	26.7%
Between 36,100 and 48,000€	27.5%	12.2%	21.3%
More than 48,100 €	6.7%	2.4%	5.0%
	100.0%	100.0%	100.0%
Valid cases N=	120	82	202

Source: Survey to PhD holders (N=207).

Entry salary conditions appeared as relevant for further progression. The correlation between entry salary and current salary was 0.489 and statistically significant at 0.01 for all PhDs in the sample whether they had moved to a different firm or not, suggesting some support for the "entry job hypothesis" whereby employment conditions in the first transition to work after graduation are influential in further stages of the career in the private sector.

The logit analysis presented in table 11 analyses the influence of different variables on the salaries of the PhDs at the time of the survey (2003). Independent variables could be divided into two categories: on the one hand, individual characteristics and those related to the individual employment trajectory, and on the other hand, firms' variables[10]. The analysis confirms the relevance of the gender and the entry salary variables in the explanation of current salaries[11]. Other variables related to the employment trajectory of the individual were also predictive of the salary to adopt a value higher than 30,000 Euro, such as the event of having had an employment contract already elsewhere before joining the firm (contract). As for the variables related to the firms, the significant ones

were those related to its innovative profile: the location of the firm in an innovative region[12], its participation in public R&D programmes in the last five years, and its collaboration practices with public research sector organisations were all predictive of the PhD getting a higher salary.

Table 11. Logit model: analysis of the variables that influence current salaries. 2003

	B	Standard error.	Wald	Prob.	Exp(B)	Significance
Year of the start of the IDE contract	-.479	.164	8.553	.003	.619	**
Other R&D staff	.000	.000	.772	.380	1.000	
Region	1.222	.377	10.500	.001	3.395	***
R&D programme	1.099	.475	5.353	.021	3.002	**
Gender: Male	1.140	.368	9.575	.002	3.126	**
Age	-.106	.066	2.604	.107	.900	
Contract	.849	.380	4.994	.025	2.337	**
Entry salary	.252	.052	23.861	.000	1.287	***
Collaborations	.804	.397	4.111	.043	2.235	**
Patents	.002	.489	.000	.997	1.002	
Mobility after IDE			2.613	.455		
Same firm	1.618	1.137	2.024	.155	5.041	
Different firm	1.771	1.214	2.127	.145	5.875	
Public sector	1.269	1.205	1.110	.292	3.558	
Constant	950.785	327.659	8.420	.004	.	**
R^2 Cnox and Snell = 36.2%						
R^2 Nagelkerke = 48.7%						

Conclusions

Labour markets for research are changing and the traditional segmentation model of the research labour market where the doctorate was mainly valuable in the academic sector is loosing ground. This change has been coupled with a shift in the role of a PhD qualification in the private sector research, especially in some industries in which new knowledge demands of companies have allowed for the transfer of highly qualified S&T human capital.

The analysis has shown that preferences during the doctorate are not as biased towards academia as one might expect from the traditional way of understanding what the investment in PhD education was meant for, and that preferences are somehow mediated by expectations about future employment opportunities. Incentives to work in the private sector are not much related to economic factors. Faced with conditions of employment in the public sector research characterised by bottlenecks and uncertain career prospects, individuals regard the possibility of stable employment and the prospects of a professional career in the private sector as advantageous in terms of returns to their educational investment. In the context of stagnation of stable employment opportunities in the academic sector, trajectories are not inflexible even after the completion of a PhD. However, the rates of continuation of the PhDs in the private sector after some years supports the idea of the little mobility of PhD trajectories once a sector of employment (academic or private) has been chosen and some stability has been achieved.

Entry jobs within the firms were R&D jobs for almost all surveyed PhDs. Additionally, we did not find evidence of mismatches between PhD training and job content independently of previous employment experience or firm size, suggesting the transversal and transferable nature of doctoral qualifications. Our findings for Spanish PhD graduates in the doctoral areas represented in the study, do not support the hypothesis that out of academe, it seems difficult to obtain value from the investment in a PhD[13]. However, not all firms showed to be equally equipped to turn this highly qualified human capital into innovation outputs and to retain PhDs over time.

Interestingly, innovation outputs (patents and publications) as a result of the employment of this type of S&T human capital were more likely to be found in firms with some previous knowledge absorptive capacity (i.e. the existence of an R&D department and the number of researchers already employed in the firms, and very especially, previous collaboration with universities and public research centres) and were not related to any particularistic attribute of the contracted PhD. The establishment of collaborations between the firm and other R&D organisation was by far the most likely outcome of the deployment of the PhD social capital.

It seems to be no gender differences in the access of individuals to private sector research jobs. Male and female PhDs have similar previous trajectories, and differences with respect to expectations and preferences are small. However, once contracted by the firms, female PhDs had lower entry salaries, and their salary progression was also lower, even for those who stay in the firm after two years. In general, in terms of continuity, PhDs seemed to be better off in firms with a more innovative profile.

Notes

[1] This figure is for 2001.

[2] According to the Spanish Population Census of 2001, there were 178,535 doctorate holders over a total population of 40.5 million people, which represents 0.52% of the population of 16 and more years old, and 0.89% of the employed population. Employed PhDs concentrate in very few activity sectors, basically: Education (38.3%), Health Services (22%), Services to firms (11.2%) and Public Administration, including government laboratories (9.6%). It is very significant that only 5% of employed doctorate holders work in manufacturing industries.

[3] A public annual subsidy of 18,000 Euros was given to the firm contracting the PhD. This amount was meant to cover the minimum gross salary. Participating firms had to co-finance the contract by paying social security costs and others. The programme set up the minimum gross salary but above this minimum, the actual salary level was up to the employer. Firms could apply for a second year extension in which case the subsidy was 9,000 Euros.

[4] Although the Call established the requisite of an innovation-related job and was not restricted to R&D jobs, actually, contracted PhDs got R&D jobs in 85% of the cases.

[5] The survey was not meant to be representative of the employment of PhDs in the private sector in Spain. It covered those industrial sectors that participated in the Programme. The resulting distribution of PhD jobs by doctoral areas and industrial sectors was the compounded effect of the demand of PhDs in those sectors and the relative availability of those PhDs by areas in the labour market. However, the distribution of the PhD in research jobs in the private sector is quite well represented; that gives us the indication that probably the PhD as degree is a requirement for research in some professions and not in some industries.

[6] The valid number of observations was 373 and 260 respectively. The sample error was ± 3.1% and 3.3% respectively, for a confidence level of 95% and maximum variance (p=q).

[7] We are aware of the limits of retrospective questions, specially about past preferences about the future. See for instance Zaller and Feldman (1992).

[8] The surveys were conducted in mid 2003. See Sanz-Menéndez, Cruz-Castro and Aja (2004) for a full methodological report and the complete questionnaires used.

[9] Actually, women had more previous experiences in the private sector than men. Nor they can be explained by the existing (but small) differences in the job content discussed above.

[10] Other models were tested (including variables such as sector and firm size), however the selected one was the one with more explanatory power and significance.

[11] The dependent variable was codified dichotomical to take two values: under 30,000 Euro and above 30,000 Euro.

[12] This was a dichotomy variable taking value 1 if corresponding to Madrid, Catalonia and the Basque Country and 0 in the rest of regions.

[13] This hypothesis was also rejected by Mangematin (2000) in his analysis of Engineering Science PhD Graduates. However, there is evidence that for social sciences PhDs (Mangematin and Vandran 1998) the returns from an investment in a PhD degree are low as compared to investment in a Masters degree. Also Hansen (1991) found mismatches between the training of economics PhD graduates and requirements of employers.

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