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WAGE DIFFERENCES AMONG DOCTORS BY AREA OF KNOWLEDGE. ARE SCIENCE AREAS BETTER PAID THAN HUMANITIES ONES?

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Abstract

This paper analyzes wage differences among workers with doctoral studies depending on their specialized area of knowledge, humanities or science, and on the kind of job they have, university teacher or other professional activity. Traditionally, it has been considered that science-related activities implied higher wages than the humanities ones due to the fact that the market tends to value higher the productivity of such disciplines considered sciences. By using a 2006 specific database for Spanish doctors and by estimating an endogenous switching model, we have observed the existence of a positive wage difference in favour of doctors of humanities as for university teachers. This is explained by the contribution of every component into which wage difference was broken down. So, worker and job characteristics contribute more to their wages in the case of doctors of humanities. However, coefficients component contribution indicates that the characteristics of workers with doctoral studies in science are the best valued ones by job markets. The fact that this component was comparatively more reduced in the case of university teachers is what determines that finally, wage differences should favour doctors of humanities in this group.

Key Words: Returns of higher education, wage differences, doctor of science and doctor of humanities, switching model
Classification JEL: J24, J31, J44

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1. Introduction

Nowadays, doctoral studies are being undergone a rigorous analysis, not only by the academic world, but also by every country's educational authorities. As a consequence of this process, there have been continuous changes in the education policies related to this part of the educational system (Kehm 2007). In this sense, the Bologna Declaration of 1999 directed to build up a European Higher Educational Area, or the Lisbon Strategy of 2000 designed to create a European Area for Research and Innovation, have prompted decisive changes in how doctoral studies were ordinary regarded.

Traditionally, doctoral studies have allowed students to become part of university's scientific community, to have access to its knowledge, to acquire its values, to learn its implied rules, as well as the abilities required to be allowed into such community (Probst and Lepori 2008). Once the doctoral studies would be finished, the student would have proved enough abilities to become a university teacher (Noble 1994 and Clark 1995). Welfare state expansion and the development of public university education from the sixties onwards meant a change on how university ultimate target was perceived. Then, it became a place not only for education but also for research. Since then, the university has been pressured to change and transform as a consequence of the socio-economic and technological progress, which has also caused and triggered off both the progressive transformation in the PhD graduate meaning, as its market valuation. So, as Enders (2004) and Kehm (2007) pointed out, doctor demand by the job market has increased remarkably due to several reasons. Among them, we may stand out, on one hand, the fact that nowadays to be a PhD graduate has become a necessary requirement for those researchers who want to develop a university career, and on the other, public and private firm's need to recruit more individuals with research experience. This makes doctoral studies very attractive for students as part of their training background.

Within this international scope, Perotti (2007) says that Spain is a unique case as for how quickly its university has undergone changes, and so how it has completely broken with the previous model. First and second cycle university studies (graduates and undergraduates) have been constantly under analysis in our country (see Sánchez Ferrer 1996; Mora et al. 2000; Mora and Ayala 2000). However, doctoral studies have been normally excluded from research, mainly due to the lack of databases gathering accurate information related to this university cycle. So, papers such as Buela-Casals and Castro's (2008) analyse the development of doctoral studies in Spain just from a quantitative perspective, and generate Spanish universities' rankings based on the number of high quality PhD

The problem of having little information is not exclusive of our country, as it is present in other nearby countries. In order to have a deeper knowledge of this higher training cycle, the EU has encouraged surveys based on Regulation 753/2004 on science and technology which defines the framework to generate statistics about PhD graduate workers. By applying this regulation, INE (National Statistics Institute) carried out in 2008 "2006 Survey on Human Resources in science and technology", which means an exhaustive study on doctors who obtained their degree between 1990 and 2006 at any Spanish university either public or private.

The information contained in such survey is considered vitally important within the transformation framework the Spanish university is undergoing now, not only in relation to the target and structure of the different doctoral programmes, but also in relation to their success measured by the professional careers developed by the doctors. This paper is focused on the latter, as it will study how the job market values the work developed by the doctors. In particular, traditionally it has been believed that wages for science activities were higher than as for humanities' ones as the market would tend to value more the return of science-related subjects.

On the other hand, PhDs' labour lives have been traditionally linked to university, so their professional careers were mainly focused on combining teaching with research. However, as it was previously stated, the number of doctors who decide to develop a professional career in either private or public companies is increasing day by day. In this new professional environment, unrelated to the academic world, professional targets are different as well as the hiring criteria. For this reason it is interesting to analyse whether wage differences as for the knowledge area selected (sciences or humanities) are also related to the chosen professional environment (university vs other activities).
As to verify such wage behaviour, this paper analyses how nowadays, the job market assesses training investment made by doctors, depending on the knowledge field (divided into two great groups: sciences and humanities) and the type of job they carry out (university teacher and other professional activities). Such difference might determine individuals when directing their academia training, if such choice is made in terms of a cost-benefit analysis in human capital investment. Therefore, it would also affect any decision the Universities should make in relation to their third cycle training programmes.

This paper's structure will be as follows. In Section 2, there is a concise approach of the changes undergone by research training education. Section 3 analyses the main characteristics of workers with a PhD title. Then, in Section 4, the econometric method is described, whereas Section 5 presents the results of such estimations. Finally, in Section 6 the main conclusions of this investigation are summarized.

2. How the PhD model has evolved

Many papers have been devoted to the changes undergone by the university in the recent years (see Abbot 2001; Naidoo 2003; Naidoo and Jaimeson 2005). According to them, on one hand, the university has basically changed from being a training place for a selected group of people, to face overcrowding problems in some cases. And on the other hand, it has turned from being a knowledge generating institution into becoming an institution meant to pass on the necessary knowledge to train people to deal with their daily working difficulties (Gibbons et al. 1994; Häyrinen-Alestalo and Peltola 2006).

As Jamieson y Naidoo (2007) point out, it would be surprising to expect doctoral studies to cut themselves off such changes. The excessive offer of people with higher education has prompted their value "to be devaluated" in the job market and this has caused the need to incorporate another "requirement" with master and doctoral studies. The difference between them would be that the former implies that the student has a great command of some existent knowledge, whereas the latter proves the student is able to innovate in the knowledge area.

In the case of doctoral studies, Enders (2004) and Kehm (2005) consider that worldwide demand increased 30% in the nineties. This increase in the number of students taking such training level has caused a growing interest among the different governments to know the return of the funds devoted to university research within an international framework where there is a great competitiveness to have the most qualified labour force available (Brooks and Heiland 2007; Pearson et al. 2007). National and supranational institutions (f.e.: European Commission), have ventured a definition of a PhD according to society's need to obtain a return and a quicker application of the knowledge achieved at the university, and for such reason they have boosted a more practical university research also more related to the non-university world. As Kehm pointed out (2007), the remarkable growth in the number of PhD students and in the variety of research fields both in Europe and in America has placed the professional university career as a less accessible labour option for students who in turn decide to look for a job outside the university. Nowadays, within this context, the traditional doctoral studies directed to university teaching prove unsatisfactory to cover new doctors' labour needs (Crosier et al. 2007).

We may distinguished two underlying tendencies when identifying the targets of the different reforms and when analysing the means and models used for their putting into practice. On one hand, doctoral studies and research training are not only promoted for an unselfish knowledge search. The creation of new knowledge has become such a basic strategic resource for developed economies which is not left any more in the hands of teachers and departments, but it becomes a target when formulating national or even supranational policies. On the other hand, the remarkable growing number of doctors will be a challenge in itself among themselves when looking for employment in the labour market outside the academic institutions. This employment would be in turn necessary so that qualified labour force should boost economic growth and innovation. However, for such jobs, research training directed to academic teaching is not considered enough, so it would be necessary to carry out some changes in doctoral studies (Kehm 2007).

Facing the forthcoming changes in the doctoral studies, it is fundamental to analyse whether the current investment on this type of education has the expected return for the doctors, or rather, it is necessary to change the contents of the doctoral studies in order to increase worker's productivity in such a way that first, they should make this teaching alternative much more attractive to university students by implying high wages, and second, they should encourage firms to hire them.

Due to the lack of specific databases for such market labour segment, up until now, it was not possible to carry out any deep analysis. However, "2006 Survey on Human Resources in science and technology" allow us to know doctors' current labour situation so that we can get a close real picture of the success of Spanish current doctoral studies. In this sense and out from the information included in such sample, the following section presents a series of data that will allow defining the main labour-related characteristics of working doctors.

3. Which is the actual professional situation of doctors in Spain?

As it has been stated in the introduction, "2006 Survey on Human Resources in science and technology", represents an exhaustive study of doctors who obtained their title between 1990 and 2006 at any public or private Spanish university. The statistic unit of the survey is PhD graduate under his 70's, and the total amount of selected individuals is 17,000, being the final total sample population 12,625[1]. As for the time framework, the survey takes as basic reference year 2006, although some other periods are included according to the theme areas into which the survey was divided.

Most of the interviewees are Spanish, and 54.8% men. As it has been mentioned before, most of PhD' directories in Spanish universities are quite recent. This means an average age of 41 years-old while the common one is 38 years-old.

Those interviewees are divided into areas of knowledge and it reveals that three of those areas gathered most of the remarks: natural sciences (29.2%), medical sciences (22.6%) and social sciences (20.8%). They three sum up almost 73% of the total interviewees. Far behind we see humanities (14%), engineering and technology (9.6%), and agriculture science (4%). So, science areas are predominant over the humanities ones.

In relation to the year the titles were obtained, the fact that doctor databases are recent determines the results, as 54% of the individuals got the title after 2000. Despite this bias, there is a growing tendency in the number of new doctors since 1990. This data follows the international behaviour that changes its tendency in 2003 though. This fact could be caused by students' decreasing interest in joining the research field of some science areas (maybe due to the greatest job opportunities granted to graduates by labour markets at that time), In the particular case of Spain, the greater decreases between 2003 and 2006 corresponded to social sciences and humanities (47% and 44% respectively).

Once the PhD title is obtained, the incorporation to labour market does not seem to be very complicated as by December, 31st 2006, the activity rate was very high, placed at 96.5%, quite above the rate standing for the whole of the Spanish labour market. Unemployed were 2% and inactive 1.4%.

As far as the firm sector the interviewees work for, 45% belonged to higher education institutions and 36% to the Public Administration, so we can confirm that almost 81% of those interviewees belonged to the public sector, 14.8% to the private one and the rest work for institutions with no profit in mind. These

[1] The problem lies on the fact that there is no national directory including all the individuals who have a PhD. So, INE had to recall the information from every university through the Consejo Superior de Universidades. To gather such information individually implied several problems as some of those universities do not have the lists, while others present heterogeneous lists in relation to their seniority, being most of them quite recent.

data are consistent with the tendency of European labour market which calls for research trained individuals (both for public and private companies) as more than half of PhD do not work for teaching institutions.

So, despite the increasing professional tendency towards jobs outside the university, the main activity is university teacher. At a distance, it is followed by doctors and other health-related professionals (except nurses) with 18.3%, and by high-school teachers with 7.6%. Therefore, PhD's most frequent choice seems to be teaching-related institutions.

As far as labour relation is concerned, most of all the interviewees (94%) work full time and with permanent contract (72%). However, temporality rates do not differ from the ones observed for the labour market as a whole, and this has become particularly worrying especially as we see that hardly 12% of such temporal workers belong to the private sector. This means that, the problem of temporality among PhD is located in the public sector, mainly caused by higher education where half of the temporal workers are located. The situation of university teachers is particularly worrying as they themselves suppose 42% out of all temporal workers with a temporality rate of 33.4%.

As far as wage levels, contrary to what it is regular in labour market surveys, information is divided into intervals.

Table 1. Earnings according to the area of knowledge (percentage of workers for each interval).

Interval	Natural sciences	Engineering and technology	Medical sciences	Agricultural sciences	Social sciences	Humanities
Less than 10000	2.78	1.69	1.18	1.86	2.73	6.11
From 10001 to 20000	13.96	9.81	7.68	14.23	11.79	16.53
From 20001 to 30000	30.90	23.43	13.34	29.90	24.28	30.21
From 30001 to 35000	18.13	17.51	11.26	22.47	16.63	16.65
From 35001 to 40000	13.62	17.01	12.91	12.99	16.28	11.20
From 40001 to 45000	9.90	10.91	11.51	9.48	11.79	9.62
From 45001 to 50000	5.31	7.53	13.31	4.74	6.83	5.87
More than 50000	5.39	12.10	28.80	4.33	9.68	3.81

As we can see in Table 1, there are clear differences in relation to the earnings the labour market establishes for research training where those working at medical science areas are the ones who benefit the most. Humanities, agriculture sciences and nature sciences are located just on the opposite side, whereas engineering and technology and social sciences are just in the middle.

Based on this information, the following section develops an econometric model directed to determine whether the wage differences previously mentioned are significant and to what an extend they can be explained by an Economic Theory. Besides, this model will also take into account whether the differences vary depending on the professional activity of the individual and whether they are conditioned by individuals' training choices.

4. The econometric model

The analysis of how the type of PhD has an effect on the paid wages can be carried out by estimating just one wage equation for the whole sample and using a dummy variable that identifies doctor's area of knowledge. Nevertheless, this method has an objection as it imposes the same coefficient structure for all the individuals of the sample. Besides, there are two sample selection problems as neither the selection of the area of knowledge (sciences or humanities), nor the selection of the professional career (university or non-university), are randomly processes. For such reason, the correct estimation of knowledge sciences area and doctors' profession effect on wages should be carried out within a context where the two selection problems mentioned above were corrected.

In order to solve both problems, the econometric specification developed here consists of an endogenous switching model including Heckman's method (1979) to correct the double sample self-selection previously mentioned. The method here presented is similar to others used in previous investigations (Ugidos 1997; Albert and Moreno 1998; Davia and Hernanz 2004) devoted to the analysis of wage differences among groups of workers in Spain, even though the current case presents two fundamental differences. In the first place, this paper's target has no precedents for the Spanish case, as for the first time a paper deals with the problems derived by the different returns of investment on third cycle training while other papers were focused on analysing the cases of some other groups of employees. Besides, on such papers, the job market self-selection problem is corrected while our paper considers it unnecessary as it understands that every individual with a PhD mean to join the job market. Employment and inactivity low rates (both together are less than 3.5%), and their origins support this idea.

The second difference refers to wage equations. As it was mentioned in the section above, wage information is presented in intervals which limits the use of econometric devices. This research uses interval regression method, a method originally develop by Steward (1983), which allows estimating a type of model where the individual's dependent variable is located within an interval.

The econometric model consists on the estimation of two wage equations (one for doctors of science and other for doctors of humanities) for two different groups of workers: those working as university teachers (public or private), and those working for a firm (public or private). Then, wage difference decomposition using the Oaxaca-Blinder (1973) method will allow us to identify which part of the difference is due to the variations in the distribution of worker and job characteristics, and which part is caused by the performance linked to his training in science or humanities.

Following Lachaud's specification (1995), as an extension of Maddala and Nelson model (1975), the econometric model for each one of these groups is presented as follows:

$$LnW_c = X_c\beta_c + u_c \quad (1)$$

$$LnW_l = X_l\beta_l + u_l \quad (2)$$

$$I_1^* = H_1\delta_1 + \varepsilon_1 \quad (3)$$

$$I_2^* = H_2\delta_2 + \varepsilon_2 \quad (4)$$

$$I_1 = \begin{cases} 1\ if\ \ I_1^* > 0 \\ 0\ otherwise \end{cases}$$

$$I_2 = \begin{cases} 1\ if\ \ I_2^* > 0 \\ 0\ otherwise \end{cases}$$

Equations (1) and (2) are wage equations to be estimated, where LnW_c and LnW_l stand for doctor of science and doctor of humanities wages logarithm respectively, X_i is a characteristics vector, β_i is a parameters' vector and u_i the random errors which are distributed in a normal and independent way with mean 0 and variance $\sigma_u^2(0,\sigma)$. As wage information is given at intervals, we will use the interval estimation method where the dependent variable for an individual *i* is placed within a given interval. Following Stewart (1983), if an individual *i* wages is placed in interval k_i

$$A_{k-1} \leq LnW_i \leq A_k$$

where A_{k-1} and A_k are interval's upper and lower limits respectively, the probability function of the observed sample is

$$L = \sum_{k=1}^{K}\sum_{i\in k}\log\left[F\left(\frac{A_k - X_i\beta_i}{\sigma}\right) - F\left(\frac{A_{k-1} - X_i\beta_i}{\sigma}\right)\right]$$

where *K* are the observed wage intervals and *F* is the accumulative distribution function. The maximization of *L* allows obtaining consistent estimations for β and σ.

Equation (3) is the knowledge area selection equation (sciences vs humanities), while equation (4) refers to the selection of a professional career (university teacher vs other activities). H_i are exogenous variable vectors that might contain some variables related to vector X_i. In particular, H_1 and H_2 stand for the variables that determine the likelihood of becoming a doctor of science versus of humanities, and of becoming a university teacher or of choosing some other profession respectively. I_1^* and I_2^* are the decision rule indexes for the area of knowledge and for the professional career respectively. We do not observe such variables but whether the individual has become a doctor of science or of humanities ($I_1 = 1$ or $I_1 = 0$) or rather if the individual works as university teacher or has some other professional activity ($I_2 = 1$ or $I_2 = 0$).

When developing the method, first, the equation probit (3) is estimated, which makes it possible to obtain the inverse Mills-ratio (λ_0), which will be included in equations (5) and (6). This coefficient represents the likelihood of being included in the sample as a doctor of sciences or of humanities. Particularly, this probit dependent variable takes value 1 if the individual is a doctor of science and value 0 if he is a doctor of humanities. In this equation, variables related to sex, age and the university the individual took his courses have a special explicative relevance. So to speak, the strategy is based on the following facts: traditionally there have been "male" and "womanly" like careers, and so the selection of an area of knowledge is more likely to happen depending on the sex. Also, faculties at certain universities have more national or international academic prestige so they will attract more easily students for the doctoral studies. Finally, women's massive incorporation into the university has been observed during the recent years as well as the development of some fields of knowledge (specially related to new technologies) that have displaced other areas. These three have influenced the selection of an area of knowledge.

Then, in the second place, and following a sequential decision making (first of all, the research field and then the professional career were selected) there is an estimation of the second probit included in equation (4), one for the group of people to become doctors of science and the second for the ones to become doctors of humanities. The dependent variable takes value 1 if the individual works as university teacher and 0 otherwise. In this case, relevant variables are those related to the type of training and to research commitment. The strategy is based on the fact that selecting a university professional life where worker's selection process is based on his research ability and experience, must be related to his research quality, his training career at the university as well as his bent to develop a research work. Besides, when selecting a professional activity we expect more job opportunities for certain areas of knowledge than for others either as at the university or at firms. In the case of equation (4), inverse Mills-ratio (λ_1 for doctors of science and λ_2 for doctors of humanities) gathers the chance of working at the university or in other professional activity being its values entered in equations (5) and (6), respectively.

In the third place, the interval estimation method is applied on the following wages equations which include bias corrections:

$$LnW_c = X_c\beta_c + \alpha_c\lambda_0 + \gamma_c\lambda_1 + \mu_c \qquad (5)$$

$$LnW_l = X_l\beta_l + \alpha_l\lambda_0 + \gamma_l\lambda_2 + \mu_l \qquad (6)$$

Out from the results of equations (5) and (6), the estimated wages differences among science and humanities workers could be divided into three components:

A: Wages differences due to differences of the characteristics of workers and jobs.
B: Differences due to the pay structure.
C: Wages differences related to the selectivity bias.

There are two main ways to calculate such components following the wages structure to be present in our market but for the science-humanities division should exist. To select one or the other as the predominant lacks any economic foundation and so, such selection should not be carried out at random (see Albert and Moreno). For such reason, decomposition results are presented from science structure (equation (7)) and humanities' (equation (8)). So, we might check out if the results are determined by the coefficient structure selected.

$$Ln\overline{W}_c - Ln\overline{W}_l = \underbrace{\beta_c(\overline{X}_c - \overline{X}_l)}_{A} + \underbrace{\overline{X}_l(\beta_c - \beta_l)}_{B} + \underbrace{\lambda_0(\alpha_c - \alpha_l) + \lambda_1\gamma_c - \lambda_2\gamma_l}_{C} \quad (7)$$

$$Ln\overline{W}_c - Ln\overline{W}_l = \underbrace{\beta_l(\overline{X}_c - \overline{X}_l)}_{A} + \underbrace{\overline{X}_c(\beta_c - \beta_l)}_{B} + \underbrace{\lambda_0(\alpha_c - \alpha_l) + \lambda_1\gamma_c - \lambda_2\gamma_l}_{C} \quad (8)$$

As it has been previously stated, component *A* refers to that part of wages differences explained by productivity diversity derived from the differences in worker and job characteristics. Component *B* presents differences in the returns to the same characteristics given the wage structure of depending on worker's PhD area of knowledge. In some wages differences research by sex (De La Rica et al. 2006), or by the type of contract (Davia and Hernanz), this fact is related to discrimination even though it should be understood as that part that cannot be explained by wages equations as several reasons could be causing such differences (see Canal and Rodríguez, 2008). In this analysis, *B* should stand for an extra wages related on one hand to worker unobserved characteristics that employers linked to worker's training, and on the other to the presence of some different job demand conditions for each area of knowledge. Finally, equations' component *C* states the estimated effect for selection bias.

5. The result of the estimations

This section offers the results of the estimations carried out and based on the econometric model previously developed.

5.1. Descriptive statistics

Table 2 presents the descriptive statistics of variables contained in different estimations and which are defined in Table 1 of the Appendix. The two first data columns correspond to a simple sample division among doctors of science and of humanities. The following fields are included in the science division: natural sciences, engineering and technology, medical sciences, agriculture sciences and within social sciences, economy and business administration. Within the humanities group we include all the doctors of humanities plus the remaining doctors of social science. The four last columns distinguish the sub samples of doctors working as university teachers and in other professional activities and dividing again both groups by the area of knowledge.

As it can be seen in Table 2, there are some important differences when analysing the characteristics of doctors according to their area of knowledge. For example, regarding sex, it is observed that the greatest part of male university teachers is found in the science area (62%), and the smallest in the humanities area (49%). Other groups present a more balanced sex distribution.

Besides, the average age is higher in the case of doctors of humanities regardless their profession. Most of doctors (76-77% depending on cases) got the PhD title at the same university where they took their studies and for them humanities doctoral thesis took longer to be finished. A related fact is that the amount of doctors taking post doctoral studies is quite low (17% for all professions), while the rate is higher among university teachers than in other cases. Regarding science output, the number of published papers is higher as for doctors of science while the number of published books is higher in the case of doctors of humanities.

There are remarkable differences regarding the suitability of doctoral studies to the job achieved depending on the activity developed. 80% of university teachers find this suitability quite acceptable while the highest percentages among those who are not teachers correspond to doctors of science with 45%. These figures reveal that doctoral studies are still focused on the university world mainly, so when being outside this world, workers find it difficult to put their knowledge into practice either because workers do not find a job related to their area of knowledge or because their training level is not required. In this sense, the variable that tries to measure the existence of over education (the minimum level of studies required for a job) detects the lack of suitability between their studies and job requirements especially in case of doctors who are not university teachers. Around 60% of university teachers consider PhD title as the minimum necessary qualification. However, this percentage should not be considered quite high since this is the minimum requirement to develop a professional career within the university. As for those devoted to other activities, the percentages are slightly lower between 18% for doctors of sciences and 7% for doctors of humanities.

Finally, in relation to earnings, Table 2 shows eight wage intervals proposed by the survey and the percentage of workers for each of them. When dividing the sample between sciences and humanities, we see that, as a whole, wages level is higher for doctors of sciences, and such differences remains even when dividing the sample between university teachers and other type of doctors.

5.2. The results of the estimations

According to the presented econometric model, process first step is the estimation of the knowledge area selection probit (sciences versus humanities-equation (3)). Table 2 in the Appendix contains the results of the estimation from which we obtain inverse Mills-ratio (λ_0) to be used for correcting the selection bias of an area of knowledge. This probit includes all the variables incorporated to wages equations plus a group of fictitious variables standing for the university where the individual took his doctoral studies. These may affect the selection of an area of knowledge due to institution's prestige or specialization on certain subjects.

In the second place, equation (4) is estimated for doctors of sciences and of humanities, that is, the professional activity selection probit out of which we obtain the inverse Mills-ratio (λ_1 and λ_2), and whose results are presented in Table 3 of the Appendix. Once again, in this case, the estimation includes the variables incorporated to wages equations plus a group of variables standing for the proper characteristics of a doctor's return as a researcher. Such characteristics might be decisive if he ends up working at a university or in other type of activities.

Once selection bias controlling variables have been obtained, they would be incorporated to equations (5) and (6) to estimate the wages of doctors of sciences and of humanities taking into account this time, whether they carry out teaching activities at the university.

Table 2. Descriptive statistics

						University teacher				Other professional activities			
		Sciences		Humanities		Sciences		Humanities		Sciences		Humanities	
		Mean	St dev.	Mean	St dev.	Mean	St dev.	Mean	St dev.	Mean	St dev.	Mean	St dev.
Personal characteristics													
Male		0.56	0.50	0.52	0.50	0.62	0.49	0.49	0.50	0.53	0.50	0.59	0.56
Age		39.75	7.38	42.77	8.57	39.69	6.76	41.80	7.81	39.89	7.57	43.80	39.75
Marital Status													
	Married	0.70	0.46	0.66	0.47	0.72	0.45	0.66	0.47	0.69	0.46	0.66	0.70
	Other	0.04	0.20	0.07	0.26	0.05	0.21	0.08	0.26	0.04	0.20	0.07	0.04
	Single	0.26	0.44	0.27	0.44	0.24	0.43	0.26	0.44	0.27	0.44	0.27	0.26
People under his responsibility		1.29	1.31	1.14	1.24	1.28	1.22	1.13	1.20	1.30	1.36	1.16	1.29
Training and research													
Studies and PhD at same university		0.77	0.42	0.77	0.42	0.76	0.43	0.77	0.42	0.77	0.42	0.76	0.77
PhD length		5.47	2.94	6.48	3.37	5.38	2.59	6.23	3.15	5.54	3.13	6.81	5.47
Post-doc studies		0.17	0.37	0.17	0.37	0.18	0.38	0.24	0.42	0.16	0.37	0.06	0.17
International scope		0.30	0.46	0.26	0.44	0.36	0.48	0.32	0.47	0.26	0.44	0.15	0.30
Researching on December 2006		0.67	0.47	0.74	0.44	0.94	0.25	0.93	0.26	0.53	0.50	0.50	0.67
Published books		1.33	2.78	2.80	3.95	1.79	2.99	3.50	4.24	1.08	2.65	1.78	1.33
Published papers		5.72	7.34	5.65	9.21	7.65	8.12	6.57	6.27	4.60	6.65	4.01	5.72
Job characteristics													
Public sector		0.78	0.41	0.87	0.33	0.99	0.09	0.98	0.13	0.66	0.47	0.70	0.78
Worked hours		41.10	8.77	37.17	10.20	40.72	8.33	37.74	10.75	41.32	9.02	36.29	41.10
Full time		0.95	0.21	0.91	0.29	0.96	0.20	0.91	0.28	0.95	0.22	0.89	0.95
Permanent contract		0.71	0.45	0.75	0.43	0.75	0.43	0.71	0.45	0.69	0.46	0.81	0.71

Table 2 (cont'd)

						University teacher				Other professional activity			
		Sciences		Humanities		Sciences		Humanities		Sciences		Humanities	
		Mean	St dev.	Mean	St dev.	Mean	St dev.	Mean	St dev.	Mean	St dev.	Mean	St dev.
Relation between job and doctoral studies													
	High	0.59	0.49	0.64	0.48	0.81	0.39	0.84	0.37	0.45	0.50	0.34	0.59
	Normal	0.22	0.42	0.21	0.41	0.15	0.36	0.13	0.34	0.27	0.44	0.33	0.22
	Low	0.19	0.39	0.15	0.36	0.04	0.20	0.03	0.17	0.28	0.45	0.33	0.19
Minimum training level													
	Post-doc	0.09	0.29	0.05	0.21	0.11	0.31	0.06	0.24	0.08	0.28	0.02	0.09
	Doctor	0.33	0.47	0.41	0.49	0.60	0.49	0.63	0.48	0.18	0.38	0.07	0.33
	Graduate	0.52	0.50	0.47	0.50	0.25	0.44	0.29	0.45	0.67	0.47	0.75	0.52
	Undergraduate	0.03	0.18	0.04	0.21	0.03	0.18	0.02	0.12	0.03	0.17	0.09	0.03
	Professional training	0.02	0.15	0.03	0.17	0.001	0.02	0.001	0.04	0.04	0.18	0.07	0.26
Earnings													
	Less than 10000	0.02	0.14	0.05	0.21	0.01	0.11	0.04	0.19	0.02	0.15	0.06	0.24
	From 10001 to 20000	0.11	0.31	0.15	0.36	0.09	0.28	0.14	0.35	0.12	0.33	0.16	0.36
	From 20001 to 30000	0.23	0.42	0.28	0.45	0.24	0.43	0.26	0.44	0.23	0.42	0.30	0.46
	From 30001 to 35000	0.16	0.37	0.16	0.37	0.20	0.40	0.16	0.37	0,14	0.34	0.16	0.37
	From 35001 to 40000	0.14	0.35	0.13	0.34	0.18	0.38	0.14	0.35	0.12	0.33	0.12	0.32
	From 40001 to 45000	0.11	0.31	0.10	0.30	0.14	0.34	0.12	0.32	0.09	0.29	0.08	0.28
	From 45001 to 50000	0.08	0.28	0.06	0.24	0.08	0.27	0.07	0.25	0.09	0.28	0.05	0.22
	More than 50000	0.14	0.35	0.06	0.25	0.06	0.24	0.06	0.24	0.19	0.39	0.07	0.26
No. of observations		8,978		3,647		3,244		2,118		5,454		1,377	

Table 3. Wages estimation: sciences versus humanities, depending on professional activity.

	University teacher				Other professional activities			
	Sciences		Humanities		Sciences		Humanities	
	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error	Coefficient	Standard error
Constant	2.927 *	0.364	0.833 **	0.461	0.885 *	0.192	1.579 *	0.362
Personal characteristics								
Age	0.047 *	0.011	0.060 *	0.014	0.067 *	0.008	0.003 *	0.015
Age^2	-0.0003 *	0.0001	-0.0005 *	0.0002	-0.0006 *	0.0001	-0.0001 *	0.0002
Male	0.037 *	0.014	0.052 *	0.022	0.076 *	0.013	0.093 *	0.030
Married	0.041 *	0.020	0.055 **	0.029	0.066 *	0.018	0.137 *	0.037
Other marital status	0.074 **	0.041	0.050	0.049	0.065 **	0.036	0.108 *	0.054
People under his responsibility	0.008	0.007	0.017 **	0.010	0.013 *	0.006	0.036 *	0.015
Training								
PhD length	-0.011 *	0.003	-0.003	0.004	0.006 *	0.002	0.002	0.004
Studies and PhD at same university	-0.011	0.015	0.038	0.026	-0.010	0.015	-0.053	0.031
Job characteristics								
Public sector	-0.665 *	0.116	-0.089	0.124	-0.114 *	0.037	0.223 *	0.070
Permanent contract	0.193 *	0.026	0.358	0.029	0.205 *	0.018	0.186 *	0.043
Full time	-0.022 *	0.052	0.043	0.058	0.083 *	0.036	0.115 **	0.061
Relation job-PhD high	-0.143 *	0.045	-0.084	0.115	-0.022	0.023	-0.009	0.057
Relation job-PhD normal	-0.094 *	0.045	-0.119	0.103	-0.020	0.020	0.074 **	0.040
Minimum training level: post-doc	-0.628 *	0.167	0.095	0.212	0.002	0.055	0.138	0.117
Minimum training level: doctor	-0.678 *	0.172	0.103	0.218	0.021	0.056	0.126	0.113
Minimum training level: graduate	-0.605 *	0.159	0.091	0.191	0.195 *	0.045	0.297 **	0.074
Minimum training level: undergraduate	-0.687 *	0.169	0.004	0.195	-0.055	0.058	0.144 **	0.080
Selection bias								
λ_0	-0.060	0.042	-0.058	0.048	-0.132 *	0.047	-0.024	0.061
λ_1	-0.309 *	0.043	-	-	-0.098 *	0.018	-	-
λ_2	-	-	-0.025	0.086	-	-	-0.004	0.044
No. of observations	3,243		2,117		5,450		1,376	
χ^2	939.49		580.55		1,961.71		334.24	
Prob>χ^2	0.00		0.00		0.00		0.00	

Note. Reference variables are *Single, Relation job/PhD low* and *Minimum training level: professional training.*
(*) Significant at 5% (**) Significant at 10%

Table 3 presents the results of such estimations. In general, variables are less significant in the case of the sample of doctors of humanities maybe because the sub samples' size is smaller. The signs of personal characteristics coefficients are as expected for a Mincer's wages equation, whereas for the case of the training variables, we see some differences. In this sense, PhD length is only significant for sciences and with different signs depending on the professional activity. As for university teachers, the longer the PhD the lower the income, maybe because it delays obtaining the PhD title which is an essential requirement to continue their professional promotion within the university. In the case of other professional activities, the positive sign would stand for the extra earnings due to a more specific training.

Regarding job characteristics, the fact of being a public or a private firm does have a clear effect on wages given the signs and meanings obtained. To have a permanent contract has a positive effect on wages, whereas to be full-time only increases wages when working outside the university. On the other hand, the results of the relation between the job and the Ph.D, and those variables showing the effect of the minimum training level required for a job, do not allow reaching any general conclusion.

Finally, variables gathering the selection bias are negative for all the cases, although these are only significant for doctors of science. That is, those characteristics that can not be studied directly and that determine doctor's area of knowledge and his professional activity have negative effect on the wages.

The results of the estimations are the base to carry out the decomposition of equations (7) and (8), and the results are stated in Table 4. There are certain differences in every component's value depending on the chosen coefficients structure. However, components' signs remain the same in such a way that contributions' meaning but not their quantity is not conditioned by the structures selection.

Then, as the sample was divided according to the professional activity, wage differences analysed in Table 4 present a wages' gap in favour of doctors of humanities as for university teachers, while it favours doctors of science for the rest of professions. This conclusion will explain how job market's behaviour differs substantially when paying wages to doctors, as it will not only take into account their area of knowledge but also their professional activity. University career (especially at the public) has a series of assessment codes for professional merits both formal (administrative rules) and informal (research and teaching activity assessment carried out by colleagues) which together generate certain mechanisms for assessing their productivity remarkably different from that used at firms. This will allow doctors of humanities to obtain wages higher than those of doctors of sciences at last.

Table 4. Decomposition of wage differences between doctors of science and doctors of humanities, according to their professional activity.

University teachers		
	Decomposition following humanities coefficients	**Decomposition following science coefficients**
Differences in characteristics	**-0.017**	**-0.029**
Differences in coefficients	**0.179**	**0.191**

Differences by selection bias	**-0.168**	**-0.168**
Selection of area of knowledge	0.010	0.010
Selection of profession	-0.178	-0.178
Total difference	**-0.006**	**-0.006**

Other professional activities		
	Decomposition following humanities coefficients	**Decomposition following science coefficients**
Differences in characteristics	**-0.084**	**-0.107**
Differences in coefficients	**0.377**	**0.400**
Differences by selection bias	**-0.225**	**-0.225**
Selection of area of knowledge	-0.038	-0.038
Selection of profession	-0.187	-0.187
Total difference	**0.068**	**0.068**

Wage differences decomposition shows that the differences in characteristics always shorten wage differences as they have a negative sign. That is, regardless the selected coefficient structure to remunerate worker and job characteristics, the characteristics of doctors of humanities and those of their jobs contribute to cut the differences in relation to doctors of science. Such effect is reinforced by the contribution of those unobserved characteristics (selection bias) which have a positive effect on doctor's selection of the area of knowledge and of his profession and which tend to shorten wages differences.

Coefficients' component contribution is positive. That is, once worker and job characteristics are under control and so those unobserved ones that determine doctor's selection of the area of knowledge and of his profession, there is still a series of uncontrolled effects (not explained in the model) linked to doctors of science and which have a positive effect on wage differences as they pay better worker characteristics when being a doctor of science. This behaviour is likely to be related to the differences among the different jobs and to worker's labour conditions at firms due to their PhD speciality.

Taking into account that the behaviour of these component parts into which wages differences have been broken down, it might be analysed what causes university teachers with a PhD in humanities to have higher wages than those of doctors of science as an average. So, if we compare the value of the component parts in relation to the professional activity, we see that these are always lower in case of university teachers. However, the main fact that causes wage differences in favour of doctors of humanities who are university teachers is due to the coefficient structure effect weight to be lower in the cases of other professional activities. This can be caused by the fact that within the university world there are homogenous rules for wages and professional promotion (especially at public universities) and this makes it less likely the existence of different wages for the same characteristics. So, it is expected that outside the university context, workers should receive earnings with less standardized components linked closer to productivity and job market conditions. According to the data we have, this fact must establish favourable conditions for doctors of science because as they carry out a more technical and complex work, they will receive higher wages with more variable components.

As doctors might perceive this situation, apart from their job opportunities related to the professional activity, they will make their labour decisions based on the return of inversion of their training. In fact, doctors of humanities mainly decide themselves to become university teachers (in particular, 61% of those already working). Whereas doctors of science do it so but to develop some other professional activities (63%).

Finally, the selection bias of the area of knowledge shortens wages differences regardless the professional activity (with a positive sign in case of university teachers and negative in case of other professional activities) while the effect of the selection of a professional activity increases wages differences in favour of doctors of humanities working as teachers. In any case, second bias magnitude is much higher than the first's so bias' final effect tends to increase wage differences in favour of doctors of humanities.

6. Conclusions

This paper is meant to analyse wages differences among workers who have doctoral studies depending on their specialized area of knowledge, humanities or science, and the type of work they develop, university teachers or other professional activities. Traditionally, it has been accepted that science activities earnings were higher than the ones for the humanities field given that the market tended to better value the productivity of the so called science matters. To deal with this situation, it has been used the information about a sample of Spanish doctors included in "2006 Survey on Human Resources in science and technology". Some interesting conclusions derive from this survey and they may be useful when designing forthcoming doctoral studies target.

In the first place, as it happens in the nearby countries, it is observed a constant increase in the graduation of new doctors caused by the Spanish public university need to expand continuously and by a firm sector (public and private) encouraged by the economic growth of our country during the last decades and demanding highly qualified labour work. In this sense, the survey data reveal that doctors' professional target has undergone a remarkable change. Currently, less than half of the interviewed working people work for higher education institutions, so this means that public and private firms begin to hire an increasing number of them, even though university education keeps on being the commonest target.

Such changes in the professional target imply also changes in the income level of the individuals, as many doctors swift from traditional university jobs with little flexible promotion and wages rules to others in the firm sector with predominant productivity and market criteria.

This current paper deals with the analysis of possible wages differences between the areas of knowledge and the professional activities. As doctors' labour conditions and professional activities present remarkable differences depending on whether they are developed within or without the university world, we have proceeded to divide doctors' sample between those taking a university career and those devoted to the firm world (public or private). When doing this division, wages differences in favour of doctors of humanities who are university teachers and in favour of doctors of science working in other professional activities are observed. The reasons could be found in a greater standardization of university teachers' wages systems and promotion policies. This fact may favour doctors of humanities comparing to the earnings they could achieve at a firm while being a negative effect on the wages of doctors of science.

Therefore, it seems that some humanities and science areas of knowledge have a more interesting professional projection outside the university in terms of wages while others are clearly university focused. If a doctor does not get a professional job suitable for his training profile, the job market will penalize him by offering lower earnings than the ones he would have logically expected. This is an important fact if we mean to carry out changes to make PhD more firms oriented, because if people realize that certain areas of knowledge are wage-penalized when changing from the university world to the firm (particularly humanities) world, then the potential number of doctors could be dramatically reduced.

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APPENDIX I

Table A1. Definition of variables found in the estimations

Dependent variable	
Annual wages logarithm	Wages are specified in eight annual wage intervals
Independent variables	
Worker characteristics	
Age	Age of worker
Age^2	Squared age of worker
Male	Dummy variable that takes value 1 if the worker is a man and 0 if the workers is a woman
Married	Dummy variable that takes value 1 if the worker is married and 0 otherwise
Single	Dummy variable that takes value 1 if the worker is single and 0 otherwise
Other marital status	Dummy variable that takes value 1 if the worker has a marital status which is not either married or single and 0 otherwise
People under his responsibility	Number of people who financially depend on the worker
Training and research	
PhD length	Time passed from the beginning of the doctoral studies until title is obtained
Studied and got PhD at the same university	Dummy variable that takes value 1 if the worker studied and got PhD at the same university and 0 otherwise
Taking post-doc studies	Dummy variable that takes value 1 if the worker is taking post-doc studies and 0 otherwise
Doing research on December 2006	Dummy variable that takes value 1 if the worker was doing research on December 31st 2006 and 0 otherwise
Published books	Number of published books between 2003 and 2006
Published papers	Number of published papers between 2003 and 2006
International mobility	Dummy variable that takes value 1 if the worker has international mobility and 0 otherwise
University	Dummy variable that takes value 1 if the worker has become a doctor at this university in particular and 0 otherwise
Job characteristics	
Public sector	Dummy variable that takes value 1 if firm's activity belongs to the public sector and 0 otherwise
Permanent contract	Dummy variable that takes value 1 if the worker has a permanent contract and 0 if it is a temporal one
Full time contract	Dummy variable that takes value 1 if the worker has a full-time contract and 0 if it is part-time one
Worked hours	Number of hours worked during the week of reference
PhD /job relation: high	Dummy variable that takes value 1 if PhD /job relation is high and 0 otherwise
PhD / job relation: normal	Dummy variable that takes value 1 if PhD / job relation is normal, and 0 otherwise
PhD / job relation: low	Dummy variable that takes value 1 if PhD / job relation is low and 0 otherwise
Minimum training level: post doctoral	Dummy variable that takes value 1 if minimum training level for a job is post doctoral and 0 otherwise
Minimum training level: doctor	Dummy variable that takes value 1 if minimum training level for a job is to be a doctor and 0 otherwise
Minimum training level: graduate	Dummy variable that takes value 1 if minimum training level for a job is to be a graduate and 0 otherwise
Minimum training level: undergraduate	Dummy variable that takes value 1 if minimum training level for a job is to be a undergraduate and 0 otherwise
Minimum training level: professional training	Dummy variable that takes value 1 if minimum training level for a job is to have taken a professional training and 0 otherwise

Table A2. Probability of becoming a doctor of science.

	Coefficient	Standard Error
Constant	2.542*	0.364
Personal characteristics		
Age	-0.076*	0.016
Age^2	0.001*	0.000
Male	0.104*	0.026
Married	0.042	0.036
Other marital Status	-0.115**	0.063
People under his responsibility	0.119*	0.015
Training		
PhD length	-0.046*	0.005
Studied and got PhD at same university	-0.125*	0.033
Job characteristics		
Public sector	-0.358*	0.037
Permanent contract	-0.076*	0.034
Full time contract	0.536*	0.053
PhD /job relation high	0.216*	0.040
PhD /job relation normal	0.115*	0.034
Minimum training level: post-doc	0.723*	0.099
Minimum training level: doctor	0.251*	0.088
Minimum training level: graduate	0.392*	0.084
Minimum training level: undergraduate	0.072	0.104
No. of observations	12,181	
χ^2	1,310.13	
Prob>χ^2	0.00	
Pseudo R^2	0.11	

Note. Reference variables are: *Single, PhD /job relation: low* and *Minimum training level: professional training*. The University where he took his PhD courses has been also controlled (57 universities).
(*) Significant at 5%
(**) Significant at 10%

Table A3. Probability of working as university teacher.

	Doctors of science		**Doctors of humanities**	
	Coefficient	Std. err.	Coefficient	Std. err.
Constant	-3.908*	0.634	-2.138*	0.834
Personal characteristics				
Age	0.009	0.023	0.012	0.034
Age^2	-0.0003	0.000	-0.0002	0.000
Male	0.113*	0.036	-0.291*	0.060
Married	0.127*	0.049	0.026	0.079
Other marital Status	0.279*	0.100	0.105	0.119
People under his responsibility	-0.058*	0.017	-0.008	0.027
Training				
PhD length	0.015*	0.007	0.001	0.009
Studied and got PhD at same university	-0.045	0.041	-0.031	0.068
Job characteristics				
Public sector	2.249*	0.105	1.665*	0.132
Permanent contract	0.513*	0.049	-0.126	0.082
Full time contract	-0.538*	0.100	-0.343*	0.123
Worked hors	-0.012*	0.002	-0.004	0.003
PhD /job relation high	-0.694*	0.065	-1.254*	0.099
PhD /job relation normal	-0.238*	0.046	-0.584+	0.067
Minimum training level: post-doc	1.821*	0.394	1.326*	0.356
Minimum training level: doctor	2.339*	0.391	2.168*	0.336
Minimum training level: graduate	1.249*	0.393	0.803*	0.332
Minimum training level: undergraduate	2.078*	0.405	0.433	0.352
Research				
Taking post-doc studies	-0.523*	0.052	-0.046	0.093
Researching on December 2006	1.033*	0.054	0.776*	0.076
Published books	0.002	0.006	0.013**	0.008
Published papers	-0.003	0.003	-0.007	0.005
International experience	-0.061	0.044	0.243*	0.080
No. of observations	8,693		3,493	
χ^2	2,049.46		1,052.95	
Prob>χ^2	0.00		0.00	
Pseudo R^2	0.40		0.50	

Note. Reference variables are: *Single, PhD /job relation: low* and *Minimum training level: professional training*.
(*) Significant at 5%
(**) Significant at 10%

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