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ARTICLE

International mobility of Spanish doctorate-holders: What determinants matters?

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Abstract While science and technology systems are deeply changing in Spain to a more open-based organization, international mobility showed by Spanish doctorate-holders are dramatically increasing. Taking into account this context, article pursuits two objectives. First, we would like to know which factors are mainly explaining the decisions supporting theses abroad mobility processes, paying a special attention to gender and academic career organization. Second, we try to find out why Spanish-doctorate holders differ in term of the intensity of their international mobility. To get it, several econometric models (*probit and ordered probit*) through Spanish Survey of Human Resources in Science and Technology of 2009 (HRST-2009) have been estimated, checking how personal, academic and labour traits affect these decisions. Outcomes point out that abroad mobility of Spanish PhD plays a role like initial condition in order to develop a academic career. Gender differences are also observed against woman, who faces more difficulties compared with man to undertake this kind of human capital investment.

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PALABRAS CLAVE
Economía de la educación;
Capital humano;

Movilidad internacional de los doctores españoles: ¿cuáles son los factores determinantes?

Resumen A la vez que los sistemas de Ciencia y Tecnología se transforman hacia organizaciones más abiertas e internacionales los doctores españoles también están incrementado drásticamente su movilidad hacia el extranjero. En este contexto, nuestro artículo persigue dos objetivos. En primer lugar, identificar cuáles son los factores que explican las decisiones de movilidad hacia el extranjero de los doctores españoles con un especial enfoque al género y a la organización de la carrera académica. Y en segundo lugar, tratar de averiguar por qué la intensidad de la movilidad internacional difiere tanto entre los doctores españoles. Para conseguirlo, se estiman varios modelos econométricos (*probit and ordered probit*) utilizando los datos de

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Eficiencia;
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Doctores españoles

la encuesta española de Recursos Humanos en Ciencia y Tecnología de 2009 (RHCT-2009) comprobando cómo los rasgos personales, académicos y laborales afectan a estas decisiones. Los resultados alcanzados indican que la movilidad hacia el extranjero de los doctores españoles juega un papel inicial en el desarrollo de una carrera académica. Además, se observan diferencias por género en torno a la movilidad internacional en contra de las mujeres, las cuales parecen enfrentarse a mayores dificultades a la hora de llevar a cabo este tipo de inversión en capital humano.

1. Introduction

Currently there is a great deal of agreement on the relevance and importance that science plays in sustaining economic outcomes. The level of economic welfare presently enjoyed by our affluent societies depends on our capacity for economic growth, based on innovative processes in which science and knowledge play a central role.

Science and knowledge are, however, economic factors that are progressively produced within a more complex process. The traditional view of the National Science System, as one that was closed and inward looking with little exposure to foreign influences is increasingly becoming open to alternatives, where international connections and mobility are at the centre of knowledge generation. Policies aimed at researcher mobility are becoming increasingly important elements of science, technology and innovation policies.

To our mind, there are two main factors that are especially relevant to this change in outlook. The first is that economic globalization has profoundly increased the international connection of economic activity in general, and science flows in particular. Nowadays it is almost impossible to create economic value or scientific development without a high degree of international interconnection. Capital, workers, productive input and knowledge flow across a world without frontiers, and national policies are unable of limiting and managing these processes. On the other hand, Information and Communication Technologies, which are fundamental to the construction of the Knowledge Society, increasingly require ideas and information to be able to travel quickly around the world.

Within this context, it is easy to see how both internationally (OECD, 2008; Auriol, 2010) and within Spain (Herrera et al., 2009) the academic mobility of lecturers and researchers is increasing enormously. The structure and organization of Spanish universities are also evolving from a traditional model to one in which mobility and international research experience increasingly support the work of those working in them (Herrera et al., 2009). At least, the development of Spanish universities and the growth of number of doctorate holders among national population have been really remarkable and important case of study (Perotti, 2007).

In accordance with the above mentioned ideas, the aim of this paper is to look into the mobility decisions made by Spanish doctorate holders. More specifically, there are two central objectives to our work. Firstly, we want to identify the most important variables influencing any decision made by Spanish doctorate holders with regard to international mobility. Secondly, we would like to gain a deeper insight into the reasons behind the intensity of decisions on international mobility developed by Spanish PhD. Beyond these general goals, our research analyzes the presence of gender differences and the role played by them in the organization and develop of academic and professional careers of doctorate holders.

The rest of the paper is organized in the following way. In Section 2, relevant economic literature is reviewed. Section 3 shows the main characteristics of databases that have been used and a statistical description of our target population is made. In Section 4, an econometric analysis is carried out on the determinants of international decisions and their intensity. The main conclusions are outlined in Section 5.

2. The economic analysis of international mobility

According to human capital theory (Becker, 1964) people invest in themselves in a variety of ways such as information, education, training or mobility, with the aim of increasing their future earnings. People make human capital investment decisions if the present value of expected earnings is greater than direct and indirect costs. However, if people were showing different costs and benefits associated with human capital, they would make different investment decisions. This occurs because each person's profile differs from a personal, family and professional perspective. The international mobility must be considered as a relevant decision made with future economic outcomes in mind, so that abroad mobility decisions undertaken by doctorate holders usually are analyzed from human capital theoretical and empirical framework.

From the seminal work of Marshall (1964), a great deal of literature has been produced on the economic analysis of academic mobility. To put it simply, it turns out that main stream studies on human resource flows in science focus on a narrow range of analytical questions.

First, we must draw attention to those works that analyze the reasons behind the decision processes involved in academic mobility (Ackers, 2005a,b; Crespi et al., 2005). The objective of this line of work is to isolate the main variables behind academic and international mobility decisions, explaining how they influence these decisions (personal traits or the kind of academic institutions). Studies reach

the conclusion that factors such as individual characteristics (Crespi et al., 2007) as well as institutional and social contexts (Breschi & Lissoni, 2001) or the R&D system (Bozeman & Gaughan, 2007) goes some way towards explaining academic mobility decisions. Closely related to this and deserving of our attention is the literature on public policies that aims to stimulate the abroad academic mobility and international researcher circulation (Goddard & Isabelle, 2006) and consequences derived from this kind of processes to host and origin countries (Beine et al., 2008).

It is worth mentioning that some works introduce a gender-differentiation into its analysis, reaching the conclusion that there are relevant gender differences among those undertaking academic mobility (Ackers, 2003; Moguérou, 2004). These works identify the existence of relevant handicaps to the mobility of women. De Grip et al. (2008), using logit models for nine European countries, analyze the migration of graduates from science and engineering studies. They found evidence of selective migration in that the best graduates are most likely to migrate. The results for women in this paper accord with previous literature and empirical data. Nevertheless, an exception to this point of view can be found in the paper by Faggian et al. (2007). These authors found that U.K. female graduates are generally more migratory in this context, possibly due to a compensation of gender bias in the labour market. What is more, in this case women are more likely to be *repeat migrants*.

Secondly, researchers are interested in the processes of mobility from universities to private firms (Beret et al., 2003; Gottlieb & Joseph, 2006) and their implications for the economic behaviour of firms (Herrera et al., 2009). The central idea is a dual one. On the one hand, research being carried out at universities would be in the explicative core of knowledge formation, entrepreneurial innovation and company productivity. On the other hand, academic mobility should be the path that enables firms to obtain good economic outcomes from these perspectives, catching researchers from international universities and research centres and using them in their work processes. Academic mobility involves knowledge transfers (Moen, 2005), and there is evidence that shows that research carried out by academic researchers and doctors at public institutions has a large impact on the private sector (Czarnitzki et al., 2008). Nevertheless, in Spanish case, the careers and orientations of PhD are more linked to university world than private institutions or business (Canal & Muñiz, 2012).

Along similar lines to the previous ideas, the third aspect of present day work that must be highlighted deals with the connection between academic jobs, mobility processes and knowledge and technology transfers. The main hypothesis now is that, nowadays, knowledge and technology are built from ideas and research that take place in universities, pointing out that these results arise within the context of researchers and lecturers' work (Crespi et al., 2005; Herrera et al., 2009; Edler et al., 2008).

Last, but not least, there is a great deal of literature on the main consequences and effects of international mobility on the outcomes of researchers and doctorate holders that migrate for several reasons. Within this context, it stands out works that focuses on productivity (both from an academic and labour point of view), employment status and careers or salaries of doctors involved in international mobility (Boschma & Fritsch, 2007). These works provide no clear evidence of any significant link between international mobility and salaries (Barbezat & Hughes, 2001),[1] but foreign mobility does have a positive effect on productivity and academic performance (Trajtenberg, 2005; Hoisl, 2007). Gender is also put in the analysis concern with this topic, trying explaining determinants of sex differences in academic career promotion (Scott et al., 1993). Academic career organization is also considered by literature, especially dealing with abroad mobility effects on economic and academic outcomes (Cameron & Blackburn, 1981; Ehrenberg, 1992, for instance).

To sum up, the economic analysis of international mobility by PhD is progressively becoming a fruitful and fully justified line of investigation, with relevant implications for aspects at the centre of knowledge, innovation and productivity as well as links to recent developments in public policies targeted at economic growth and its foundations.

3. Data and descriptive analysis

Data used in this study come from a new Survey on Human Resources in Science and Technology (HRST-2009), carried out by the Spanish Statistical Institute (INE). In 2009, the sample size of this survey reached 6000 Ph-doctorate holders that using several expanding factors by regions and personal characteristics represent he total set of Ph-doctorate holders resident in Spain in 2009 with less than 70 years old.[2] The main aim of HRST-2009 is to know main characteristic and structure of the human resources dedicated to research in Spain. This survey offers information about the personal characteristics of doctorate holders, their level of employment and wages and the international, national and intra-sectoral mobility of this collective. Data focus on 2009, the second wave of this database. It provides new knowledge on the Spanish economy and it is a second edition more consolidated that previous version (HRST-2006).

Doctorate holders are defined as those with level 6 of the ISCED97 international education classification, which defines them as staff dedicated to tertiary education programmes that lead to an advanced research qualification, and are therefore dedicated to advanced studies and original research, and not solely based on coursework. Although the HRST-2009 takes into consideration both native and foreign-born doctorate holders, providing they are living in Spain at the moment of the survey, we focus our analysis only on Spanish citizens. In the HRST-2009 are included people who obtained their doctoral qualification at a Spanish university both public and private.

To study international mobility, the HRST-2009 takes into account movement that occurred in the 10 years prior to the reference period, in our case, from 1999 to 2009. Data were selected so that the international mobility occurs after the end of studies in order to avoid the endogeneity of variables and maintain the temporal consistency of analyzed events.

[1] In general, the salaries of PhD in Spain are lower than in Europe due to the high dedication to teaching activities associated to public sector with lower earnings (Canal & Muñiz, 2012).

[2] For more information about the methodology of HRST-2009 see www.ine.es (exactly this next link).

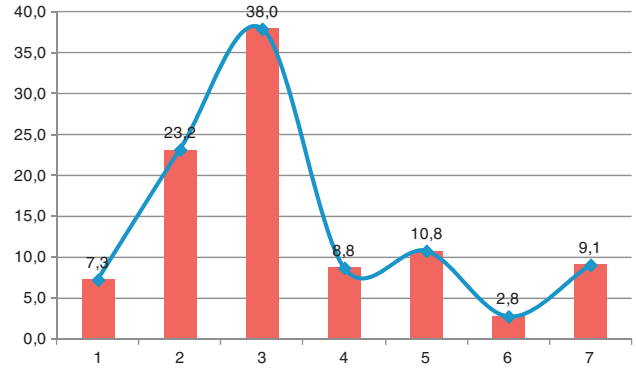

Figure 1 Number of spells in a foreign country. Percentages. Source: HRST-2009.

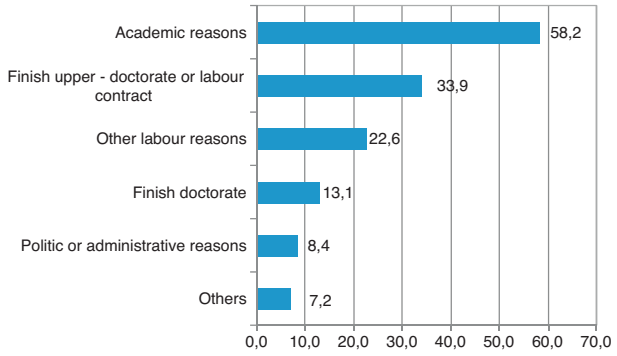

Figure 2 Reasons behind the international mobility of Spanish doctorate holders.
Source: HRST. 2009 (independent questions).

Taking into account previous questions and the elimination of some outliers[3] our data include a total of 3969 Ph doctorate holders. In each post estimation models are included the weighted population.

In accordance with the Spanish HRST-2009, international mobility requires doctorate holders to have been living or working in a foreign country for at least 3 months during the ten years prior to the survey. So, it is a significant period of time. We also define a new variable that takes into account the degree of international mobility carried out by Spanish doctorate holders, using both information about the number and length of stays. However, the HRST-2009 restricts this information to a maximum of seven stays during the period 1999–2009. Although, the most part of foreign stays are centred around three times, as can be observed in Fig. 1.

The Spanish HRST-2009 covers a wide range of academic, economic and social aspects related to doctorate holders. In this sense, its variables are related to the personal characteristics of doctorate holders, information about their doctoral circumstances, employment situation, unemployment and inactivity, mobility, professional experience, or academic and scientific productivity. To avoid potential endogeneity we use the information of variables prior to the international mobility.

Table 1 shows descriptive data about Spanish doctorate holders broken down in relation to international mobility.[4] According to the HRST-2009 data, nearly 20 percent of Spanish doctorate-holders had international experience in the ten-year period prior to 2009. This date puts Spanish more or less in the average of the abroad mobility rank among OECD doctorate holders, which varies from 15 to 30 percent (Auriol, 2010).

[3] Due to lack of information, no available answers and the elimination of army labour occupations.

[4] Incidence index comparing the relative frequency of each category with the frequency associated with the overall population. For instance, in relation to sex, the percentage of internationally mobile men (19.4 percent in first line above mobility title) compared to total percentage of internationally mobile doctorate holders (20.0 percent at the end of table) offers an index of 0.97 lower than unit as indicative of less international mobility in these category. In other words, men present a lower international mobility respect to total population that average.

Table 1 shows that women have approximately a 4 percent more of possibilities to develop an international mobility than men; however, this issue is not totally true because other factors do not control and its total amount is small. Comparing the Spanish doctorate holders with an internationally mobile to the population as a whole, the majority is medium-young (under 40 years of age, and over all among 31–35 years old) and single. It can be observed a strong relationship between international mobility and the tenure of higher education by parents. Also it is related to the presence of a higher labour skill.

As the Spanish educational system public education has the highest size, labour mobility is linked mainly with this event. International mobility is more frequent among doctorate holders working in the Natural Sciences and Agricultural Science fields of knowledge, where frequency of international mobility is clearly above the average (1.52 and 1.01 respectively). On the other hand, Medical Science has the lowest rate of international mobility (only 9.0 percent), which is not a surprising outcome take accounting the high dedication required by these types of studies. Grants of doctorate appear to be the most linked to international mobility. Finally, the type of research developed during the PhD does not show higher differences in relation to international mobility.

All this traits fit with main outcome reached by Careers of Doctorate Holders (CDH), a recent large-scale data collection project carried out by OECD (Auriol, 2010). The statistical view reinforces the importance of familiar context in the determination of international mobility.

Finally, Fig. 2 shows reasons for embarking on international mobility. It is worth paying attention to the fact that the majority of international mobility decisions made by Spanish doctorate holders are for academic reasons especially post PhD (58.2 percent). This can also be very important for later models because the mobility periods could be established in line with the academic calendar (with short length) and the end of the career.

4. Factors that determine international mobility of Spanish PhD holders

The main objective of this paper is to understand the reasons for international decisions made by Spanish doctorate

Table 1 Spanish doctorate holders. Descriptive analysis.

Variables		Frequency		Incidence index	
		No mobility	Mobility	No	Yes
Sex	Men	80.6	19.4	1.01	0.97
	Women	79.2	20.8	0.99	1.04
Age	16–30 year olds	61.5	38.6	0.77	1.93
	31–35 year olds	49.6	50.4	0.62	2.52
	36–40 year olds	70.3	29.7	0.88	1.48
	41–50 year olds	88.7	11.3	1.11	0.56
	Over 50	94.7	5.4	1.18	0.27
Level of studies (father)	Primary	82.4	17.7	1.03	0.88
	Secondary	77.6	22.4	0.97	1.12
	Tertiary	77.9	22.1	0.97	1.11
Level of studies (mother)	Primary	82.0	18.0	1.03	0.90
	Secondary	76.6	23.5	0.96	1.17
	Tertiary	75.7	24.3	0.95	1.21
Occupation (father)	Directives	79.9	20.1	1.00	1.00
	Professionals and Scientifics	78.8	21.3	0.98	1.06
	Medium professional and techniques	81.2	18.8	1.02	0.94
Occupation (mother)	Directives	63.0	37.0	0.79	1.85
	Professionals and Scientifics	73.8	26.2	0.92	1.31
	Medium professional and techniques	81.6	18.4	1.02	0.92
School of primary	Public	78.2	21.8	0.98	1.09
	Private	81.4	18.6	1.02	0.93
School of secondary	Public	76.9	23.1	0.96	1.15
	Private	83.2	16.8	1.04	0.84
School of upper secondary	Public	77.9	22.2	0.97	1.11
	Private	82.9	17.1	1.04	0.85
Area of doctorate	Natural Sciences	69.7	30.4	0.87	1.52
	Engineering and Tech	80.9	19.1	1.01	0.95
	Medical Sciences	91.0	9.0	1.14	0.45
	Agricultural Science	79.7	20.3	1.00	1.01
	Social Sciences	83.0	17.0	1.04	0.85
	Humanities	83.2	16.8	1.04	0.84
Financing of doctorate	Public Administration Scholarship	68.3	31.7	0.85	1.59
	Scholarship from other institution	68.3	31.7	0.85	1.59
	Working as a teaching assistant	83.9	16.1	1.05	0.81
	Working as other occupation	93.6	6.4	1.17	0.32
	Other	88.3	11.7	1.10	0.58
Type of research during doctorate	Fundamental	78.4	21.6	0.98	1.08
	Applied	82.2	17.8	1.03	0.89
	Experimental development	79.8	20.2	1.00	1.01
Total		80.0	20.0	–	–

Source: HRST-2009.
In shadows, the cells with incidence index over unit.

holders. In order to achieve this, we are going to focus our analysis on two principal questions:

(a) What are the most relevant factors that determine international mobility by PhD in Spain?
(b) Which factors determine the difference in intensity of international mobility among Spanish doctorate holders?

We will pay special attention both to gender and academic career organization when we tried answering these questions. On the basis of previously mentioned human capital theoretical framework, the most frequent methodological approach usually involves the econometric estimation through generalized linear model of how a wide range of traits affect the probability of investing in human capital. In pursuit of these goals, several discrete choice (*probit and ordered probit*) models have been estimated using data from the Spanish HRST-2009. The choice of these models, usually applied on economic analysis, is based on their adequate adaptation and prediction of the discrete events. We estimated *probit* models even *logit* to offer an estimation of marginal effects that in our mind is easier to understand. The authors have decide to maintain the same homogeneous estimation along the paper (both in linear and

ordered models) offering always estimations of probabilities based on normal and standard distribution N (0, 1). Additionally, *probit* is an excellent instrument to calculate the deviation to normality.

Econometric strategy is developed according to the next paths:

- First model (Table 2) we estimate the probability to develop an international mobility using the whole population like reference. It is the main and essential model to establish the crucial factors to explain the international mobility of Spanish doctorate-holders in relation to their personal and familiar conditions.
- Previous model only establishes general determinants of international mobility. However, it is also worth to pay attention to the quality of these movements. Regard to this matter, we think that is important to consider both the numbers of stays and the duration of them. So, in next models (Tables 3 and 4) determinants of intensity of stages are estimated using the numbers of abroad stays and the length of international mobility (in terms of sum of months in a foreign country) like proxies.
- Obviously those models are estimated only for people with international mobility. In this case we have included new variables exactly the age of first mobility and the motivation, both only available to Doctorate holders with an abroad mobility, at least one, which it could be important determinants of the intensity of mobility.

All models offer different information but complementary. Some factors could be important in the mobility decision but others could be determinants in the characteristics of the mobility, in terms of duration and number of stays. The influence which is offered by explained variables has not been the same inside different estimated models, it is more, or should be different. For example, being woman in relation to total population could be related with a lower possibility to make an international mobility. But, considering only the PhD that made an international mobility maybe the women could make longer stays. In that case, the same characteristic being a woman could show a negative coefficient in first model and positive en second model. In our mind, using both perspectives (determinants to undertake an international mobility and about their intensity) get a deeper knowledge about human capital decision carried out by doctorate-holders that we want to look into.

4.1. The factors that determine the international mobility for Spanish doctorate holders

First at all, we specify a binary *probit* model in which the dependant variable shows value 1 if the Spanish doctorate-holders who were included in the Spanish HRST reported in 2009 had experienced at least one spell abroad in the previous 10 years,[5] and 0 if they had not. We take the following variables into consideration:

- *Gender*: We include this variable in attempt to discover whether gender plays a part in determining international mobility among Spanish doctorate holders.
- *Age*: The age of doctorate holders when the survey was carried out. The idea is to determine whether undertaking an academic stage abroad is more frequent in the early stages of an academic career, before a PhD dissertation or not. This will make it possible to throw light on when international mobility experiences are located in an academic career.
- *Familiar variables*: Needless to say that family plays a central role in explaining a wide range of social and labour decisions. The information included is the father and mother's educational level, and their labour occupation.
- *Variables about academic career organization*: Oriented to show the public or private characteristic and structure of process of education.
- *Area of doctorate*: Field of knowledge in which PhD dissertation was written can introduce differences in academic behaviour and as a result, in the role played by international mobility. It is possible that obtaining a doctorate in Social Science or Natural Science was linked to different patterns of international mobility.
- *Financing the doctorate*: We distinguish between the different ways in which PhDs are funded. Obtaining a grant or working, for instance, involves very relevant differences for doctorate holders in terms of academic position and also the effects on their academic career.
- *Type of research during doctorate*: This variable might establish the necessity or possibility to go outside.
- *And, the duration of doctorate*: To determine the relation between international mobility and the existence of long period of studies.
- The region of residence is used as variable of control.

As gender is a variable that is usually central to performance and outcomes in the Spanish labour market, we also expect to be able to identify the existence of different patterns in international mobility decisions based on gender. Men and women might present some differences on how international mobility decisions are reached. So, we estimate the *probit* model for the population as a whole and for men and women separately as well. First estimate outlines a couple of interesting patterns that explain international decisions by Spanish doctorate holders (Table 2). The factors with a coefficient over cero establish a positive contribution in the explanation of abroad flows. So, they are characteristic linked to higher probability of developing an international mobility:

(a) Gender matters. Being a female Spanish doctorate holder has an important negative effect on the probability of undertaking international mobility. The previous incidence index is questioned by these results. Controlling with others factors, women present a lower probability to develop an international mobility (on average, women have a one percent lower probability than men of undertaking international mobility). The direction of this issue is according with the majority literature collected in last section.
(b) Spending a period of time abroad is more frequent among the young, lower than 35 years old. So, it is

[5] Specifically, having lived in a foreign country at least once during 1999–2009.

Table 2 Probability of international mobility by PhD holders in Spain (probit model).

		Total				Men				Women			
		Coef.	$P>z$	Sig.	Average marginal effects (dy/dx)	Coef.	$P>z$	Sig.	Average marginal effects (dy/dx)	Coef.	$P>z$	Sig.	Average marginal effects (dy/dx)
Gender	Women	−0.042	0.000	**	−0.010	–	–	–	–	–	–	–	–
Age	16–30 year olds	1.006	0.000	**	0.230	1.341	0.000	**	0.278	0.510	0.000	**	0.124
	31–35 year olds	1.355	0.000	**	0.309	1.495	0.000	**	0.310	1.203	0.000	**	0.293
	36–40 year olds	0.901	0.000	**	0.206	0.972	0.000	**	0.201	0.778	0.000	**	0.189
	41–50 year olds	0.296	0.000	**	0.067	0.281	0.000	**	0.058	0.246	0.000	**	0.060
Level of studies (father)	Secondary	0.173	0.000	**	0.039	0.082	0.000	**	0.017	0.266	0.000	**	0.065
	Tertiary	0.146	0.000	**	0.033	0.168	0.000	**	0.035	0.177	0.000	**	0.043
Level of studies (mother)	Secondary	0.028	0.020	**	0.006	0.205	0.000	**	0.042	−0.196	0.000	**	−0.048
	Tertiary	−0.086	0.000	**	−0.020	−0.070	0.001	**	−0.014	−0.169	0.000	**	−0.041
Occupation (father)	Professionals and Scientifics	−0.061	0.000	**	−0.014	−0.146	0.000	**	−0.030	−0.025	0.273		−0.006
	Medium professional and technique	−0.050	0.003	**	−0.011	−0.095	0.000	**	−0.020	0.000	0.987		0.000
Occupation (mother)	Professionals and Scientifics	−0.383	0.000	**	−0.087	−0.279	0.000	**	−0.058	−0.525	0.000	**	−0.128
	Medium professional and technique	−0.568	0.000	**	−0.130	−0.393	0.000	**	−0.081	−0.830	0.000	**	−0.202
School of primary	Private	0.004	0.703		0.001	−0.017	0.237		−0.003	0.019	0.164		0.005
School of secondary	Private	−0.153	0.000	**	−0.035	−0.217	0.000	**	−0.045	−0.109	0.000	**	−0.026
School of upper secondary	Private	0.028	0.025	**	0.006	0.146	0.000	**	0.030	−0.039	0.033	**	−0.009
Area of doctorate	Natural Sciences	0.483	0.000	**	0.110	0.654	0.000	**	0.136	0.332	0.000	**	0.081
	Engineering and Tech	0.295	0.000	**	0.067	0.173	0.000	**	0.036	0.575	0.000	**	0.140
	Agricultural Science	0.379	0.000	**	0.086	0.339	0.000	**	0.070	0.437	0.000	**	0.106
	Social Sciences	0.265	0.000	**	0.060	0.543	0.000	**	0.113	−0.015	0.441		−0.004
	Humanities	0.354	0.000	**	0.081	0.317	0.000	**	0.066	0.389	0.000	**	0.095
	Public Administration	0.277	0.000	**	0.063	0.207	0.000	**	0.043	0.356	0.000	**	0.087
Financing of doctorate	Scholarship												
	Scholarship from other institution	0.390	0.000	**	0.089	0.278	0.000	**	0.058	0.553	0.000	**	0.135

Table 2 (*Continued*)

		Total				Men				Women			
		Coef.	$P>z$	Sig.	Average marginal effects (dy/dx)	Coef.	$P>z$	Sig.	Average marginal effects (dy/dx)	Coef.	$P>z$	Sig.	Average marginal effects (dy/dx)
	Working as a teaching assistant	0.089	0.000	**	0.020	−0.059	0.001	**	−0.012	0.257	0.000	**	0.062
	Working as other occupation	−0.271	0.000	**	−0.062	−0.411	0.000	**	−0.085	−0.140	0.000	**	−0.034
Type of research during doctorate	Fundamental	0.001	0.922		0.000	−0.070	0.000	**	−0.015	0.067	0.000	**	0.016
	Applied	−0.126	0.000	**	−0.029	−0.212	0.000	**	−0.044	−0.080	0.000	**	−0.019
	Experimental development	−0.088	0.000	**	−0.020	−0.011	0.351		−0.002	−0.177	0.000	**	−0.043
Duration of doctorate		−0.015	0.000	**	−0.003	−0.026	0.000	**	−0.005	−0.005	0.058	*	−0.001
Constant		−1.030	0.000	**	–	−1.232	0.000	**	–	−0.669	0.000	**	–
Weighted Population		196,920				109,877				87,043			
LR $chi^2(45)$		32,263.4				22,405.3				12,810.0			
Prob > chi^2		0.000				0.000				0.000			
Pseudo R^2		0.175				0.225				0.150			

Source: HRST-2009.

Reference person: men, over 50 years of age, the level of studies of father was primary, the level of studies of mother was primary, the occupation of father was directive, the occupation of mother was directive, the school of primary, secondary and upper-secondary was public, with a doctorate in the field of Medical Sciences, with doctorate financed differently, the type of research during doctorate was differently and now live in Andalusia. Dummies of regions of residence included.

* $p \leq 0.1$.

** $p \leq 0.05$.

Table 3 Factors determining the degree of international mobility by PhD holders in Spain. Number of stays in a foreign country (ordered probit model).

		Total			Men			Women		
		Coef.	$P>z$	Sig.	Coef.	$P>z$	Sig.	Coef.	$P>z$	Sig.
Gender	Women	−0.037	0.002	**	–	–	–	–	–	–
Age	31–35 year olds	−0.638	0.000	**	−0.612	0.000	**	−0.464	0.000	**
	36–40 year olds	−0.668	0.000	**	−0.618	0.000	**	−0.554	0.000	**
	41–50 year olds	−0.604	0.000	**	−0.587	0.000	**	−0.510	0.000	**
Level of studies (father)	Secondary	−0.048	0.006	**	−0.102	0.000	**	−0.130	0.000	**
	Tertiary	−0.101	0.000	**	−0.237	0.000	**	−0.010	0.716	
Level of studies (mother)	Secondary	0.103	0.000	**	0.002	0.951		0.128	0.000	**
	Tertiary	−0.262	0.000	**	−0.505	0.000	**	−0.054	0.106	
Occupation (father)	Professionals and Scientifics	−0.121	0.000	**	−0.415	0.000	**	0.243	0.000	**
	Medium professional and technique	−0.182	0.000	**	−0.532	0.000	**	0.093	0.014	**
Occupation (mother)	Professionals and Scientifics	−1.231	0.000	**	−1.016	0.000	**	−1.250	0.000	**
	Medium professional and technique	−1.459	0.000	**	−1.421	0.000	**	−1.273	0.000	**
School of primary	Private	−0.055	0.000	**	−0.092	0.000	**	−0.011	0.624	
School of secondary	Private	0.199	0.000	**	−0.043	0.182		0.474	0.000	**
School of upper secondary	Private	−0.141	0.000	**	0.407	0.000	**	−0.782	0.000	**
Area of doctorate	Natural Sciences	−0.070	0.001	**	0.264	0.000	**	−0.149	0.000	**
	Engineering and Tech	0.225	0.000	**	0.338	0.000	**	0.259	0.000	**
	Agricultural Science	0.072	0.059	*	0.417	0.000	**	−0.216	0.000	**
	Social Sciences	0.334	0.000	**	0.652	0.000	**	0.335	0.000	**
	Humanities	0.325	0.000	**	1.009	0.000	**	0.085	0.009	**
	Public Administration	0.149	0.000	**	0.340	0.000	**	−0.098	0.001	**
Financing of doctorate	Scholarship									
	Scholarship from other institution	−0.090	0.000	**	−0.207	0.000	**	0.032	0.412	
	Working as a teaching assistant	0.205	0.000	**	0.426	0.000	**	−0.109	0.001	**
	Working as other occupation	−0.063	0.031	**	−0.044	0.292		−0.116	0.011	**

Table 3 (*Continued*)

		Total			Men			Women		
		Coef.	$P>z$	Sig.	Coef.	$P>z$	Sig.	Coef.	$P>z$	Sig.
Type of research during doctorate	Fundamental	−0.045	0.004	**	0.092	0.000	**	−0.177	0.000	**
	Applied	−0.026	0.052	*	0.217	0.000	**	−0.197	0.000	**
	Experimental development	0.172	0.000	**	0.164	0.000	**	0.225	0.000	**
Duration of doctorate		0.015	0.000	**	−0.030	0.000	**	0.037	0.000	**
Age of first mobility		−0.075	0.000	**	−0.087	0.000	**	−0.067	0.000	**
Motivation to Mobility	Finish doctorate	0.572	0.000	**	0.423	0.000	**	0.762	0.000	**
	Finish upper-doctorate or labour contract	0.080	0.000	**	0.174	0.000	**	−0.012	0.566	
	Other labour reasons	0.226	0.000	**	0.124	0.000	**	0.422	0.000	**
	Academic reasons	0.309	0.000	**	0.230	0.000	**	0.510	0.000	**
	Politic or administrative reasons	0.223	0.000	**	0.309	0.000	**	0.136	0.000	**
	Others	0.606	0.000	**	0.624	0.000	**	0.325	0.000	**
cut1[a]			−5.608			−5.667			−5.235	
cut2			−4.587			−4.707			−4.017	
cut3			−3.424			−3.473			−2.816	
cut4			−3.097			−3.168			−2.427	
cut5			−2.593			−2.640			−1.885	
cut6			−2.444			−2.444			−1.770	
Weighted population			39,408			21,270			18,137	
LR $chi^2(50)$			9254.8			6837.3			5836.9	
Prob > chi^2			0.000			0.000			0.000	
Pseudo R^2			0.076			0.106			0.103	

Source: HRST-2009.

Reference person: men, over 50 years of age, the level of studies of father was primary, the level of studies of mother was primary, the occupation of father was directive, the occupation of mother was directive, the school of primary, secondary and upper-secondary was public, with a doctorate in the field of Medical Sciences, with doctorate financed differently, the type of research during doctorate was differently and now live in Andalusia. Dummies of regions of residence included.

[a] The cut points are really just coefficients of the model (constants) several intercepts for the estimations in different categories or considered term following a normal distribution.

* $p \leq 0.1$.

** $p \leq 0.05$.

Table 4 Factors that determine the degree of international mobility by PhD holders in Spain. Total length of foreign stays, aggregations of months (ordered probit model).

		Total			Men			Women		
		Coef.	$P>z$	Sig.	Coef.	$P>z$	Sig.	Coef.	$P>z$	Sig.
Gender	Women	−0.062	0.000	**	–	–	–	–	–	–
Age	31–35 year olds	−2.431	0.000	**	−1.736	0.000	**	−3.959	0.000	**
	36–40 year olds	−1.743	0.000	**	−1.173	0.000	**	−2.906	0.000	**
	41–50 year olds	−0.750	0.000	**	−0.435	0.000	**	−1.158	0.000	**
Level of studies (father)	Secondary	−0.222	0.000	**	−0.058	0.074	*	−0.573	0.000	**
	Tertiary	0.029	0.252		0.280	0.000	**	−0.266	0.000	**
Level of studies (mother)	Secondary	0.395	0.000	**	0.303	0.000	**	0.653	0.000	**
	Tertiary	0.072	0.009	**	0.112	0.008	**	−0.128	0.004	**
Occupation (father)	Professionals and Scientifics	0.150	0.000	**	0.293	0.000	**	0.216	0.000	**
	Medium professional and technique	0.379	0.000	**	0.525	0.000	**	0.338	0.000	**
Occupation (mother)	Professionals and Scientifics	0.059	0.403		−0.690	0.000	**	0.905	0.000	**
	Medium professional and technique	0.058	0.401		−0.460	0.000	**	0.508	0.000	**
School of primary	Private	−0.059	0.002	**	−0.008	0.778		−0.101	0.001	**
School of secondary	Private	0.283	0.000	**	0.111	0.006	**	0.407	0.000	**
School of upper secondary	Private	−0.128	0.000	**	0.014	0.708		−0.330	0.000	**
Area of doctorate	Natural Sciences	−0.116	0.000	**	−1.002	0.000	**	0.044	0.276	
	Engineering and Tech	−0.285	0.000	**	−1.215	0.000	**	−0.072	0.181	
	Agricultural Science	−0.414	0.000	**	−1.153	0.000	**	0.038	0.602	
	Social Sciences	−0.114	0.000	**	−0.973	0.000	**	0.364	0.000	**
	Humanities	0.154	0.000	**	−0.923	0.000	**	0.752	0.000	**
Financing of doctorate	Public Administration Scholarship	−0.003	0.899		0.205	0.000	**	−0.244	0.000	**
	Scholarship from other institution	−0.282	0.000	**	−0.102	0.025	**	−0.498	0.000	**
	Working as a teaching assistant	−0.046	0.082	*	0.349	0.000	**	−0.830	0.000	**
	Working as other occupation	0.653	0.000	**	0.626	0.000	**	0.599	0.000	**

Table 4 (*Continued*)

		Total			Men			Women		
		Coef.	$P>z$	Sig.	Coef.	$P>z$	Sig.	Coef.	$P>z$	Sig.
Type of research during doctorate	Fundamental	0.128	0.000	**	0.033	0.264		0.194	0.000	**
	Applied	0.221	0.000	**	0.194	0.000	**	0.150	0.000	**
	Experimental development	0.270	0.000	**	0.239	0.000	**	0.409	0.000	**
Duration of doctorate		0.029	0.000	**	0.068	0.000	**	0.027	0.000	
Age of first mobility		−0.163	0.000	**	−0.135	0.000	**	−0.252	0.000	
Motivation to mobility	Finish doctorate	−0.347	0.000	**	−0.263	0.000	**	−0.591	0.000	**
	Finish upper-doctorate or labour contract	0.081	0.000	**	0.164	0.000	**	0.001	0.963	
	Other labour reasons	−0.067	0.000	**	−0.031	0.268		−0.079	0.006	**
	Academic reasons	−0.154	0.000	**	−0.277	0.000	**	−0.026	0.331	
	Politic or administrative reasons	−0.039	0.153		0.363	0.000	**	−0.390	0.000	**
	Others	0.290	0.000	**	0.225	0.000	**	0.276	0.000	**
cut1			−7.959			−7.283			−11.996	
cut2			−7.599			−6.983			−11.505	
cut3			−7.228			−6.690			−10.970	
cut4			−6.457			−5.929			−10.034	
Weighted population			39,408			21,270			18,137	
LR $chi^2(50)$			8174.7			4423.9			7145.6	
Prob > chi^2			0.000			0.000			0.000	
Pseudo R^2			0.122			0.127			0.224	

Source: HRST-2009.

Reference person: men, over 50 years of age, the level of studies of father was primary, the level of studies of mother was primary, the occupation of father was directive, the occupation of mother was directive, the school of primary, secondary and upper-secondary was public, with a doctorate in the field of Medical Sciences, with doctorate financed differently, the type of research during doctorate was differently and now live in Andalusia. Dummies of regions of residence included.

* $p \leq 0.1$.

** $p \leq 0.05$.

probable that increased age will produce a negative relation. International mobility could be a requisite to the start of an academic career rather than a consequence of its development. Therefore, considering that majority of Spanish PhD holders are working at the university developing teaching tasks. Or maybe, it could be a new social pattern developing preferably in the younger generation.

(c) The father's educational level has an important effect over international mobility. The tertiary and secondary levels offer positive probabilities or coefficients. In the case of mother, it is only true for secondary but the obtained coefficient it is really reduced.

(d) The antecedents variables (parents occupations and type of school in studies previous to university, exert little effect, and in any case, is not positive). To have a professional mother or father, or to have studied in private schools are not factors that favours later international mobility.

(e) There are considerable differences depending on the scientific field in which doctorate holders are working. The most frequent international mobility result for PhD was for Natural Sciences, Agriculture Sciences and Humanities. However, all categories produced a positive coefficient when compared to the reference category. So, international mobility is less frequent in the field of Medical Science. This result can be explained by the greater dedication requiring by the study and practice of Medicine.

(f) International mobility increases if the doctorate was funded with a public grant or other type of private school ship. Obviously, the presence of economic resources and funding facilities favours the international mobility.

(g) If the research of doctorate was applied or experimental, it reduces the probability to go abroad.

(h) And finally, the duration of doctorate presents a minimum relation with the international mobility but it is negative.

The patterns that determine men and women's decisions on international mobility display differences. Although both groups show a negative relation with regard to age (older Spanish doctorate holders have a lower probability to develop an international mobility) the effect is greater for men than for women. Other interesting difference is that the mobility of women is conditioned to a greater extent than men for the variables of father related to educational level. In general, the area of doctorate offers very important differences by gender perhaps conditioned by the basic or previous decision, the choice of type to study to be performed. To our mind, this result may be an expression of the gender differences with regard to university access that existed in the past in our country, differences that were highly pronounced and which have only been corrected in recent years. The choice on the types of studies, in terms of areas of knowledge, nowadays in Spain is not really similar for men and women, although the differences are decreasing. Finally, funding the doctorate with a grant is more important for female mobility, over all in case of public grants.

4.2. Factors that determine the intensity of international mobility for Spanish doctorate holders

An additional aspect of our analysis of the international mobility experiences of Spanish doctorate holders is the study of the factors that determine the intensity of these decisions. Spanish HRST-2009 survey allows us to establish a double approach, by using information about the number of times a PhD has spent abroad together with the aggregated length of all stays abroad undertaken by doctorate holders.

The first approach involves creating a new variable with categories ranging from only one period abroad to a maximum of seven according with the information from the HRST-2009. In the second approach, we have taken into account the total number of months that Spanish doctorate holders spent abroad between 1999 and 2009. Over a maximum of 131 months, the length of stays abroad is aggregated in next five categories: lower than 12 months, 12–23 months, 24–59 months, 60–119 months and higher to 120 months.[6] In this case the categories offer an ordered structure too.

Several *ordered probit* models have been estimated for that section of the population that has undertaken a period of international mobility, using both previously defined dependent variables. In addition, following our methodology, several models have been estimated, for both the whole population and differentiating by gender. The explanation variables are the same ones included in previous *probit* models. However, we introduce new variables. First, the age of first mobility because, as previously has been proven, youth is strongly related with the possibility to develop an international mobility. And last, the motivation of abroad mobility included with several independent items as dummies variables.

Table 3 shows results for all Spanish doctorate holders using the first dependant variable (number of stays). In this case, the ordered *probit* model is developed over event count data that could be treated as continuous variables. The number of stays goes from one to seven due to the own elaboration of HRST-2009 following a censured cumulative distribution function. There are a linearity and the categories are not independent.[7] So, the positive coefficients show which are factors that favour a great numbers of abroad stays for Spanish doctorate holders.

Outcomes clearly point out that international mobility is more frequent among men (the estimated coefficient for women in negative, so, the female number of stays is lower), young, those whose mothers had secondary as level of education, who have studied secondary education in a private school, whose area of doctorate was Social Sciences, who worked as teaching assistant to finance a PhD and whose research was experimental. Among the new variables it could be observed that the length of the PhD has a little influence over number of stays of international

[6] Similar estimation had been developed considering percentage of time obtaining the same results.

[7] This dependent variable allows the estimation of discrete linear models but the authors have established the estimation of *ordered probit* for maintaining the consistency and homogeneity throughout the article and to make some comparisons.

mobility. However, the age of the first mobility shows a strong and negative influence. At last, to finish the doctorate and other undefined reasons are the main foundations of the length of abroad mobility. The motivation is one of the most important determinants in the number of abroad stays.

Breaking down the latter estimation by gender, the next some relevant differences arise in favour of women. The father's occupation is a major determinant in the female abroad mobility establishing a higher probability to make a great number of international stays among those father's occupations related to Professionals and Scientifics. PhD area is other feature that provides greater differences between men and women. Having studied doctorate Humanities, Social Sciences and Agricultural Sciences is strongly related with the possibility of developed several abroad stays only in the case of men. For women, only studying Social Sciences or Engineering and Tech present a positive effect. The uneven distribution in academic men and women by areas of study is again linked with different probabilities of both. The financing of the doctorate also unequally affects the international stays for men and women. A public scholarship and working as teaching assistant to financing the doctorate only favours the male foreign stays. While for in women the international stays are related to receive a private scholarship. The type of research during doctorate is too relevant, only in the case of experimental development offers a positive coefficient for women. Finally, motivation is also the foundation of the existence of significant and important gender differences. Women are associated with greater number of foreign stays especially in the case that the motivation was is finishing the doctorate or labour and academic reasons.

Moving on to the alternative dependent variable definition (the aggregation of total number of months during abroad mobility), Table 4 displays results obtained by estimating *ordered probit* first for whole population and then for men and women separately. Although the dependent variable has a categorical structure, also establish an ordered sequence. So, it is applied an *ordered probit*. In this case, the probabilities are no exact, but positive and higher coefficient indicates which factor promotes a higher duration of abroad mobility, in the sense of move from ones categories to superiors.

Regarding the outcomes, the probability to have a long duration is higher among these people: men (again, the result is contrary to women; in other words, the probability to develop a long stay in a foreign country is lower for women), young, among those whose mothers had secondary as level of education and whose father was employed as medium professional or technique, who studied the secondary level inside a private school, whose area of doctorate was Humanities, which funded the doctoral working in various occupations and whose research was experimental, with a long duration of doctorate and over a motivation linked to finish the upper-doctorate or to get a labour contract. So, the result of age points out that in order to complete an extended period of time abroad it is necessary to start the experience as early as possible. In our mind, this result reinforces the previous conclusion that a period of international mobility is a prerequisite to an academic career or linked to development to doctorate in a foreign country. In any case, an extensive international mobility is reinforced between young.

Focusing in the new variables it could be observed that the duration of PhD has again a little impact. However, the age is really relevant to determining the length of international mobility. So, if the first international mobility is made with a higher age, the length of mobility will be short. Maybe it is related with the possibility of development a higher number of abroad stays more frequent among young. And finally, the motivation defined as other reasons is the main cause for longer durations.

In relation to gender, the differences between men and women are important again comparing the last columns could be established the next issues. The age is determining factor slightly in women than in men to set the length of international mobility. Unlike men, for women the occupation of father is strongly related to the probability of making longer stays. But generally, a different influence of parental variables could be observed in men and women. Like previous results, the area of doctorate is one of the variables that differentiate the behaviour of men and women. Areas of Humanities and Social Sciences favour higher durations for women. Lastly, the way of financing of doctorate also causes different probabilities by men and women generally all of then higher in men. Regardless of the result obtained for men, the only way to development longer stays in function of the way of financing of doctorate for women is related with working as other occupation.

5. Conclusions

The aim of this paper has been to study international mobility decisions made by Spanish doctorate holders. Using data from Human Resources in the Spanish Science and Technology Survey-2009 (HRST-2009), our analysis has tried to reach conclusions about the principal factors determining these decisions and their intensity. Paper also looks into whether gender plays a significant role in these processes and the place occupied by abroad mobility in academic career organization. Analysis that has been carried out support some results that in our mind are relevant conclusions.

Firstly, the way in which researching career is organized in our country, seems to require to doctorate holders to undertake a stay outside our borders as an initial condition. International mobility seems not to be a consequence of the development of research activity but a prerequisite for its initiation. A period of international mobility appears strongly related with early ages and young. Knowing that most part of Spanish PhD are employed or are just at the University, it seems that for Spanish doctorate holders international mobility is a condition of the development of an academic career. Or at least, this issue establishes a new pattern of behaviour inside younger generation.

Secondly, in some remarkable extent, the level of education of father determines a greater probability to develop an abroad stay. Then, abroad mobility, or may be to get a PhD, could arise like an element inside intergenerational linkages between parents and sons, transmitting economic advantages and disadvantages. The willingness of to face an abroad experience can be an economic element produced by parents and transmitted to daughter and son. Also, the

scientific field also introduces relevant differences in international mobility patterns. As such, international mobility is more frequent among people whose area of doctorate was Natural Sciences, Agriculture Sciences and Humanities.

Thirdly, scholarships rather than other possibilities linked with working stand out like the best option to fund international mobility undertaken by Spanish doctorate holders. In our mind, it is worth to pay attention to this outcome because it holds relevant implications for Educational and Economic Policy design. May be some reflection should be done about the matter, especially if our objective is to support our researching system.

If we pay attention to the degree of international mobility (the number and length of abroad stays), results also support the idea that international mobility is especially determinated by area of doctorate and financing of doctorate. The motivation of mobility is important only in the case of the number of abroad stays. Finishing the doctorate is the most relevant aspect to increase the number of abroad stays.

Finally, gender introduces differences in both decisions the development and the intensity of Spanish doctorate holders' international mobility. Age appears to be slightly restrictive for women than men, making it necessary for women to undertake a period of international mobility early. The parental variables are more important in the case of women, even all the variables related to father. And, lastly the area and financing of doctorate are the main foundations of existing differences by gender. This issue is related with the different types of studies developed by men and women although this gap might have been reduced in future generations. Additionally, financing the doctorate by grants and scholarships produces different effects by gender. The policy-makers should consider those results for an efficient design of the scholarships. Any way, economic policy which is currently applied in Spain pointing out to gender goals must also take into account the different context which define the decision undertaken by women and men when both collective are dealing with PhD careers.

Nerveless, our results have taken account as a first step in a long way. In our survey is not available information about personal income or familiar economic sources, social context. On the other hand, data about the country of destination is insufficient. In other words, other determining factors have to be considerate inside the analysis of international. Following the same argument, with better survey could be improved the estimated models over the both last about number of stays and length of abroad stays.

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