The effect of supervision on Ph.D. duration, publications and job outcomes[♣].

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Abstract:

The empirical literature on the market for Ph.D. graduates is generally focused on individual characteristics and their effect on scientific achievement, career prospects and/or expected earnings. In this paper, we take a closer look at the context in which graduate training takes place. Using data on 650 Ph.D. graduates from the INRA (the French National Institute of Agronomic Research) we were able to show that supervision (described by characteristics of the Ph.D. lab) strongly affects the number (and quality) of articles published during the Ph.D., as well as its overall duration. Supervision also has a significant influence on job outcomes after the Ph.D. has been completed.

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High-skilled labour force (such as Ph.D. graduates) can be expected to play a major role in a knowledge-based economy. Modern developed economies thus have to face several important questions: what are the incentives to start a Ph.D. ? How to successfully complete it ? What are the forces that shape a Ph.D. graduate's early career ? In their attempts to answer these questions, economists have traditionally focused on differences in individual characteristics (such as performance, effort, Ph.D. funding, etc.). However, several clues indicate that scientific production has become increasingly collective, especially in areas such as biology and the life sciences. Stephan (1996) shows that the average number of authors of an article in a scientific journal has raised from 2.5 in 1979 to 3.5 in 1993, and points out that collaborative research leads to higher and better scientific output. Similarly, Sauer (1988) shows that co-authorship leads to substantially higher returns in terms of wages. According to these findings, scientific production can be seen as a collective effort, the efficiency of which relies on the division of (scientific) labour.

In that context, it seems fairly improbable that the success of a Ph.D. student, in terms of scientific achievement and in terms of career, depends only on individual factors. In this paper, we develop an analysis taking into account, alongside individual characteristics, the effect of supervision. The term "supervision" will be used here in a broad sense, to denote the context in which the Ph.D. research was conducted. This context encompasses several elements, such as: the intellectual framework in which the Ph.D. research is led, the financial and material resources the Ph.D. student has access to, etc. This larger notion of supervision leads us to focus on the Ph.D. lab as a relevant unit of analysis, rather than on the sole supervisor.

To measure scientific achievement and the career prospects of a Ph.D. student, several proxies can be used. After a short review of the existing literature (Section 1), we present our data and methodology in Section 2. Three main proxies are identified in this section. For each one of them, we conduct an econometric analysis (in Sections 3 to 5). Conclusions are given in a final section, and an Appendix is devoted to variables definition and summary statistics.

1. Survey of the literature.

In this paper, we are interested in two aspects of the Ph.D. degree: we want to explain the differences in the scientific achievement of Ph.D. graduates on the one hand, and in returns to the Ph.D. on the other. Presumably, these two aspects are not independent, but rather closely related, a greater scientific achievement leading to higher returns. The question of scientific achievement of Ph.D. graduates has not been widely addressed by economists. Nonetheless, Abedi & Benkin (1987), and, more recently, Ehrenberg & Mavros (1995) have proposed explanations for the differences in the time to completion. Both papers focus primarily on individual characteristics, such as gender, ethnicity, postdoctoral plans or financial support patterns. Using time to completion is a first sensible way to describe the scientific achievement of a Ph.D. student: a (comparatively) better student may be able to graduate more rapidly than the other ones.

However, another sensible, commonly used measure of scientific achievement is the number and quality of publications. Although many economists have written on scientific production, there are but few papers dedicated to Ph.D. scientific productivity. Papers are more traditionally devoted to that of graduate researchers, either to explain its determinants (Levin & Stephan, 1991), or to analyse its effect on wages and/or careers (Tuckman & Leahey, 1975; Diamond, 2001). We feel that the number (and quality) of papers published in scientific journals during the Ph.D. may be a good measure of the scientific achievement of Ph.D. graduates.

This indicator might seem restrictive, given the increasing delays between submission and publication. In that perspective, a graduate whose time to completion is short might have a comparatively lower publication record at the end of the Ph.D. If this were true, there may be an opposition between the two indicators of scientific achievement that we have just considered. However, this should not be a major concern in the present study, since it focuses on life sciences, a discipline in which the delays for academic publishing are still rather short. One reason for this is that co-authorship is a common practice in that field, allowing a researcher to submit several papers at a time. This tendency to an increasingly collective research activity has accompanied the transition of life sciences from a "hand craft" to a quasi-industrial production sector of science, similar in that respect to physics (cf. Acharya *et al.*, 1998; Henderson *et al.*, 1999; Orsenigo *et al*., 2001).

Contrary to scientific achievement, expected returns from doctoral training have been the subject of many papers. Attempts to evaluate the returns to Ph.D. have been conducted primarily in Northern America: Hansen and al. (1980) evaluates pecuniary returns, in terms of wages received in the academic and government sectors, while Ehrenberg (1992) extends the analysis to non-pecuniary benefits. Studies in the United States (Stern, 1999), Sweden (Tasiran & al., 1997), and France (Martinelli, Paul et al., 1998; Robin & Cahuzac, 2001) suggest that non-pecuniary returns are fundamental in the decision to start doctoral training. Indeed, a majority of Ph.D. students are attracted by the prospect of an academic career, even at the cost of lower wages. It seems that academic employment yields specific advantages (autonomy, lifetime employment / tenure, intellectual freedom, prestige, etc.) that compensate the loss in earnings. These findings are consistent with the theory of compensating wage differentials (Ehrenberg & Smith, 2000). In that perspective, career prospects seem to be a very relevant and promising variable for who wants to evaluate the returns to a Ph.D. degree.

2. Data and methodology.

To investigate the respective effects of individual characteristics and supervision on the scientific achievements and early careers of Ph.D. graduates, we will focus on a single country (France) and a single field of research (the life sciences). There are, as yet, few studies devoted to this topic in the case of France. As far as the field of research is concerned, our choice was oriented by the fact that the medical and agricultural applications of life sciences (commonly referred to by the term “biotechnology”) may have in the coming years important economic returns. However, although European authorities have expressed their will to develop biotechnology, the structure of research in that field is still far from well know in France (cf. Lemarié & al., 2000, for a statistical survey).

The database used in this paper compiles information about 650 French Ph.D. graduates in life sciences who completed their Ph.D. in an INRA (National Institute for Agronomic Research) laboratory between 1988 and 1998. Data concerning the years prior to 1988 could not be recovered. The database was the output of a survey conducted in 1999 by the INRA unit in Grenoble, on behalf of the institute. The INRA laboratories provided the names and addresses of 1600 Ph.D. graduates. Data was then collected by means of a questionnaire mailed to the graduates, providing a rate of return of 41%

The INRA graduates are not representative of the whole population of French Ph.D. graduates in life sciences: relying on a comparison with the DGRT[1] data (cf. DGRT, 1992, to DGRT, 1998), the final report of the survey (Mangematin & Mandran, 2000) reveals that only 13% of all Ph.D.s who graduated in life sciences between 1988 and 1998 were trained at the INRA. This is not a major concern for this study, since its objective is not to draw general conclusions, which could be applied to all Ph.D. graduates, but rather to illustrate possible links between supervision, early careers, and skills acquisition. In that perspective, the INRA

[1] General Direction for Research and Technology (part of the French Ministry of Research).

data may provide interesting examples, all the more since the research conducted in this institute encompasses almost every aspect of biology and life sciences[2].

According to Mangematin & Mandran (2000), the INRA sample (650 records) can be considered as representative of the survey population (1600 addresses). First of all, the gender composition of the sample is almost the same as the composition of the population (50% of women in each case). Moreover, the proportion of ASC (a Ph.D. funding that is specific to the INRA) in is approximately the same in the sample and in the population (16% of ASC in the sample, and 13% in the population). Last but not least, the proportion of individuals occupying academic jobs at the time of the survey are quite close in the sample and in the population (approximately 40% in each case).

For each graduate, the database gives information on:

- Personal characteristics (Date of birth, Gender, etc.)
- Starting date and completion date of the Ph.D. (allowing to calculate the Ph.D. duration)
- Career plans considered at the beginning of the Ph.D.
- Education background and characteristics of the Ph.D. (Last diploma awarded before the Ph.D., Type of funding during the Ph.D., etc.)
- Research experience (number of publications in national peer-reviewed journals during the Ph.D., number of publications in international peer-reviewed journals during the Ph.D., number of communications during the Ph.D., etc.)
- Post-doc experience (Post-doc in a university, post-doc in a firm, etc.)
- Description of the first job obtained after the Ph.D. (including unemployment and other non-employment situations).
- Description of the job occupied at the time of the survey (i.e. in 1998).

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[2] Some units are devoted to social sciences (e.g. agricultural economics, sociology of science), but these were left out of the survey.

Moreover, the questionnaire provides a detailed description of the Ph.D. lab, including the nature of its scientific activity (theoretical work, applied research, etc.), its relations with the academic community, its relations with the private sector, etc. The main limit of this database, however, is that it does not include longitudinal data describing individuals' trajectories on the labour market. We can only observe the first job obtained after the Ph.D., and the labour market situation at the time the survey was conducted.

The survey of the literature conducted in Section 1 lead us to identify two measures of scientific achievement (time to completion and scientific productivity) and a measure of the returns to a Ph.D. (career prospect). Proxies for these measures were readily available in our database. We used respectively the total duration of the Ph.D. (measured in years), the number and quality of the articles published in scientific journals during the Ph.D., and the description of the first job obtained after the Ph.D. For each of these proxies, econometric estimations were conducted to estimate the impact of individual characteristics, as well as that of supervision. The results of these estimations are given in the next three sections.

3. A significant impact of supervision on time to completion.

The duration of the Ph.D. was available as a discrete variable; for most observations, the value of the variable was 3, 4 or 5 years (cf. Appendix, Table A). In France, a formal rule states that a Ph.D. thesis should be completed in three years. This duration can be exceeded, however, if the Ph.D. student obtains an authorisation from his/her university (and, ultimately, from the Ministry of Education). Completing a Ph.D. in three years is no menial task, however, and deviations from the three-years rule are fairly common. As long as his/her supervisor guarantees that significant advance has been made in his/her research work, a Ph.D. student will generally be able to carry on with his/her research beyond the third year.

However, students who complete their Ph.D. in three years or less will generally be considered as more efficient (or able) than their counterparts.

To determine how supervision affect the chance to finish one's Ph.D. in three years or less, we estimated a binomial Logit model:

$$(1) \qquad \ln\left(\frac{p_i}{1-p_i}\right) = X_i.\beta \text{, with } p_i = \Pr(y_i = 1)$$

where y_i is a dichotomous variable equal to 1 if the Ph.D. was completed in 4 years or more, and to 0 if the Ph.D. was completed in 3 years or less, X_i is a vector of explanatory variables (including characteristics of the Ph.D. lab), and β its associated vector of parameters.

In order to obtain more detailed results, we also estimated an ordered Logit model:

$$(2) \qquad \ln\left(\frac{P_{ij}}{1-P_{ij}}\right) = \alpha_j + X_i.\beta \text{,} \qquad j = 2, 3.$$

with $P_{ij} = \Pr(DUREE_i \geq j)$, where $DUREE_i$ is the observed endogenous (categorical) variable, X_i is a vector of exogenous variables, β the associated vector of parameters, and α_j a category-specific constant. Variable $DUREE_i$ has three categories:

$$\begin{cases} DUREE_i = 3 \text{ (Ph.D. completed in 5 years or more)} \\ DUREE_i = 2 \text{ (Ph.D. completed in 4 years)} \\ DUREE_i = 1 \text{ (Ph.D. completed in 3 years or less)} \end{cases}$$

The category $j = 1$ is not taken into account in Equation (2) for an obvious reason: when $j = 1$, then $P_{ij} = 1$ by definition, and Equation (2) does not make sense. Equation (2) predict the probability for variable $DUREE_i$ to be in a higher rather than a lower category, or, in other words, the probability for an individual to experience a comparatively longer Ph.D. duration.

Both models were estimated with the Maximum Likelihood method; the results are given in Table 1. The definitions of the explanatory variables are given in Tables D and E of the Appendix. For the sake of readability, we focus on the results that are recurrent across both specifications.

Table 1 : Logit models estimates for Ph.D. duration

Exogenous Variables		Binomial Logit (reference : y_i=0)	Ordered Logit
		Parameter *(Std Deviation)*	Parameter *(Std Deviation)*
Constant (binomial Logit)		-0.2891 *(0.8804)*	
Constante1 (Ordered Logit)			-0.8483 *(0.8319)*
Constante2 (Ordered Logit)			2.0576 *(0.8399)*
Gender	*Male*	0.2417 *(0.2316)*	0.2575 *(0.2158)*
	Female	.	.
Student's nat. pub.		-0.1143 *(0.0901)*	-0.0892 *(0.0859)*
Student's inter. pub.		-0.0758 *(0.0465)*	-0.0079 *(0.0453)*
Expert activity of the lab	*Important*	-0.5465 *(0.5028)*	-0.6017 *(0.4818)*
	Moderate	0.1142 *(0.2673)*	-0.0039 *(0.2443)*
	None / Unknown	.	.
Contracts between lab & private sector	*Numerous*	-0.5399 *(0.4036)*	-0.5289 *(0.3810)*
	Moderate	-0.4359 *(0.2901)*	-0.4400 *(0.2646)**
	None / Unknown	.	.
Contracts between lab & public sector	*Numerous*	-0.0593 *(0.3664)*	-0.1453 *(0.3341)*
	Moderate	-0.1850 *(0.3137)*	-0.1810 *(0.2884)*
	None / Unknown	.	.
Contracts between lab & European Union	*Numerous*	-0.3172 *(0.3660)*	-0.3097 *(0.3374)*
	Moderate	0.0082 *(0.2808)*	0.0056 *(0.2598)*
	None / Unknown	.	.
Publications of the lab (national journals)	*Numerous*	0.9045 *((0.4518)***	1.0024 *(0.4279)***
	Moderate	0.5827 *(0.3842)*	0.6801 *(0.3663)**
	Few / Unknown	.	.
Publications of the lab (international journals)	*Numerous*	-0.7198 *(0.3520)***	-0.6730 *(0.3374)***
	Moderate	-0.3213 *(0.2526)*	-0.3563 *(0.2333)*
	Few / Unknown	.	.
Part of basic research in global lab activity	*Important*	0.4465 *(0.3597)*	0.1008 *(0.3415)*
	Medium	0.1304 *(0.3523)*	-0.1182 *(0.3381)*
	Small /Unknown	.	.
Part of applied research in global lab activity	*Important*	0.6988 *(0.4568)*	0.5245 *(0.4388)*
	Medium	0.6858 *(0.4416)*	0.5611 *(0.4254)*
	Small /Unknown	.	.
Part of teaching in global lab activity	*Important*	-0.3917 *(0.4413)*	-0.4568 *(0.4183)*
	Medium	0.1008 *(0.3787)*	-0.0658 *(0.3579)*
	Small /Unknown	.	.
Ph.D. Funding	*INRA*	-0.4238 *(0.3567)*	-0.520 *(0.3413)*
	Other public	-0.1162 *(0.3717)*	-0.7970 *(0.3375)***
	Private	-0.1800 *(0.5603)*	-0.4393 *(0.5365)*
	Other / none	.	.
Partnership with a firm during Ph.D.	*Yes*	-0.5231 *(0.2839)**	-0.6041 *(0.2718)***
	No	.	.
Ph.D. student's teaching activity	*Important*	1.1917 *(0.4296)****	1.2170 *(0.3548)****
	Medium	-0.1467 *(0.2768)*	-0.1328 *(0.2626)*
	Low / Null	.	.
Year of completion		0.0800 *(0.0431)**	0.0563 *(0.0403)*
			.
Discuss. voc. Plans with lab member(s)	*Yes*	0.0381 *(0.2439)*	0.0524 *(0.2244)*
	No	.	.
Lab helped to define vocational plans	*Yes*	-0.1521 *(0.2605)*	-0.2279 *(0.2406)*
	No	.	.
Considered career in academia	*Yes*	-0.1956 *(0.4831)*	-0.4294 *(0.4505)*
	No	.	.
Considered career in industry	*Yes*	-0.2431 *(0.2386)*	-0.3246 *(0.2213)*
	No	.	.
Log-likelihood		-246.51	-336.52

*** 1% significance level; ** 5% significance level; * 10% significance level

Two results involve the graduates' characteristics. First, a partnership with a firm decreases the probability of experiencing a longer time to completion. The second result is that an important teaching activity during the Ph.D. significantly increases this probability. This second result seems consistent with the personal experience of many Ph.D. graduates. Doctoral research funding at the INRA comes from a variety of sources: some Ph.D. are funded by the Ministry of Research, some rely on private funds, and some are funded by the INRA itself. Thus, some INRA Ph.D. students have the opportunity to do their Ph.D. without having to teach, concentrating only on their research. Others may choose/have to teach, either to accumulate experience or as an additional source of income. For these individuals, completing the Ph.D. may naturally take more time.

Among the variables describing the Ph.D. lab, two have a significant impact on the duration of the Ph.D. Thus, doing a Ph.D. in a team which publishes mainly in national journals increases the probability of experiencing a longer duration. On the contrary, completing a Ph.D. in a lab with numerous international publications decreases the probability of a longer time to completion. In the light of these results, one may conclude that the duration of a Ph.D. depend both on individual characteristics and on characteristics of the organisation where the doctoral research is conducted.

4. A strong impact of supervision on the number and quality of Ph.D. publications.

In the database, the number of scientific articles published in peer-reviewed journals during the Ph.D. is coded as a discrete variable. National (French) and international articles are coded as two distinct variables. This is the only indicator we have as far as the quality of publications is concerned. Previous studies (Diamond, 1986; Sauer, 1988; Diamond, 2001) showed the importance of taking into account the quality of the scientific output. Given the nature of our data, the simplest analytical method was to study national and international publications separately, since internationals journals have a greater impact factor than national ones (as can easily be checked in the *Science Citation Index*). In each case, we first estimated a Negative Binomial (NegBin) regression model, using the Maximum Likelihood technique (preliminary tests revealed that a Poisson model was significantly biased by overdispersion). The NegBin model is written:

(3) $\ln \lambda_i u_i = X_i.\beta + \varepsilon_i, \qquad i = 1, 2, \ldots, N$

where $u_i = \exp(\varepsilon_i)$, and $\exp(\varepsilon_i) \sim \Gamma(1/\alpha, 1/\alpha)$. For both types of publications, a chi-square test led to the rejection of the null hypothesis « $H_0 : \alpha = 0$ », which did confirm the presence of overdispersion in the ordinary Poisson model.

However, the important percentage of graduates who did not publish (67.9% had no national publication, and 32.9% no international one) also pleaded for the estimation of a zero-inflated NegBin (ZINB) model (Ridout *et al.*, 1998; Ridout *et al.*, 2001). This model, which stems from the zero-inflated Poisson (ZIP) model (Lambert, 1992; Greene, 1999), is estimated by Maximum-Likelihood. The ZINB model is written :

(4.a) $$\ln \lambda_i u_i = X_i.\beta + \varepsilon_i, \qquad i = 1, 2, \ldots, N$$

(4.b) $$\ln \frac{\omega}{1-\omega} = Z_i.\gamma, \qquad i = 1, 2, \ldots, N$$

where λ_i is the expected number of publications for individual i, and ω the proportion of Ph.D. graduates who *do not publish*. X_i and Z_i are two vectors of exogenous variables; β and γ represent their respective associated vectors of parameters. Finally, $u_i = \exp(\varepsilon_i)$, where ε_i is a random error term and $\exp(\varepsilon_i) \sim \Gamma(1/\alpha, 1/\alpha)$.

Table 2, sub-section 4.1., and Table 3, sub-section 4.2., compare the results of the NegBin and ZINB models, for the national and international publications respectively. To make comparisons easier, Equation (4.b) is not presented. Both tables suggest that scientific productivity during the Ph.D. is influenced by organisational as well as individual variables.

4.1. NATIONAL PUBLICATIONS.

Table 2: count models estimates for the expected number of national publications during the Ph.D.

Exogenous Variables		**NegBin model**	**ZINB model, equation (4.a)**
		Parameter *(Std deviation)*	**Parameter *(Std deviation)***
Constant		-0.4677 *(1.8617)*	-1.8255 *(1.4852)*
Age at completion		-0.0514 *(0.0590)*	0.0219 *(0.0476)*
Gender	*Male*	0.1309 *(0.2028)*	0.2697 *(0.1845)*
	Female	.	
Supervising committee	*Yes*	-0.4159 *(0.2682)*	-0.2394 *(0.2279)*
	No	.	
Expert activity of the lab	*Important*	0.0847 *(0.4327)*	0.1658 *(0.3653)*
	Moderate	0.1291 *(0.2419)*	-0.0440 *(0.2198)*
	None / Unknown	.	
Contracts between lab & private sector	*Numerous*	-0.3022 *(0.3648)*	-0.3311 *(0.3178)*
	Moderate	-0.3878 *(0.2594)*	-0.3130 *(0.2285)*
	None / Unknown	.	
Contracts between lab & public sector	*Numerous*	1.0611 *(0.3684)****	0.7309 *(0.3197)***
	Moderate	0.9851 *(0.3230)****	0.6980 *(0.2742)***
	None / Unknown	.	
Contracts between lab & European Union	*Numerous*	0.2567 *(0.3232)*	0.1210 *(0.2847)*
	Moderate	0.2279 *(0.2548)*	0.1587 *(0.2281)*
	None / Unknown	.	
Publications of the lab (national journals)	*Numerous*	1.2692 *(0.5207)***	0.7986 *(0.4157)***
	Moderate	0.9377 *(0.4911)**	0.3351 *(0.3801)*
	Few / Unknown	.	
Publications of the lab (international journals)	*Numerous*	-1.2036 *(0.9632)*	
	Moderate	-1.2728 *(0.9678)*	
	Few / Unknown	.	
Implication of the lab in editorial board of international journals	*Strong*	-0.2643 *(0.3318)*	
	Moderate	-0.2931 *(0.2304)*	
	Weak /Unknown	.	
Part of basic research in global lab activity	*Important*	-0.3415 *(0.3371)*	-0.4114 *(0.2899)*
	Medium	0.3491 *(0.3114)*	0.3179 *(0.2788)*
	Small /Unknown	.	
Part of applied research in global lab activity	*Important*	0.6383 *(0.4740)*	0.2500 *(0.3885)*
	Medium	0.7556 *(0.4692)*	0.3595 *(0.3876)*
	Small /Unknown	.	
Part of teaching in global lab activity	*Important*	0.0122 *(0.4213)*	-0.0710 *(0.3665)*
	Medium	0.1043 *(0.3624)*	-0.3248 *(0.3219)*
	Small /Unknown	.	
Ph.D. Funding	*INRA*	-0.0330 *(0.3192)*	
	Other public	0.1785 *(0.3251)*	
	Private	0.3107 *(0.4988)*	
	Other / none	.	
Partnership with a firm during Ph.D.	*Yes*	0.0319 *(0.2572)*	
	No	.	
Ph.D. student's teaching activity	*Important*	-0.1946 *(0.3774)*	0.0419 *(0.3030)*
	Moderate	0.4725 *(0.2434)***	0.3758 *(0.2202)**
	Low / Null	.	
Year of completion		-0.0297 *(0.0383)*	-0.0413 *(0.0342)*
Discuss. Voc. plans with lab member(s)	*Yes*	-0.1184 *(0.2195)*	-0.1844 *(0.2003)*
	No	.	
Lab helped to define vocational plans	*Yes*	-0.0989 *(0.2437)*	-0.1798 *(0.2157)*
	No	.	
Considered career in academia	*Yes*	0.1813 *(0.3993)*	
	No	.	
Considered career in industry	*Yes*	0.2050 *(0.2042)*	
	No	.	
Log-likelihood		-383.30	-475.92
α		1,3966 *(0,2982)****	1.4581 *(0.2899)***

*** 1% significance level; ** 5% significance level; * 10% significance level

According to Table 2, the expected number of national publications is influenced by several characteristics of the Ph.D. lab. Focusing on results that are common to both models, we can give a "typical profile" for a lab where a Ph.D. student can increase his/her rate of publication at the national level. This "typical lab" has a regular contractual practice with the public sector (government, ministries, etc.), and publish the results of its research primarily in national journals (which is far from surprising). The models also indicate that, on average, the number of national publications is higher for the graduates who had a *moderate* (rather than *important*) part of their working time dedicated to teaching obligations during their Ph.D.

4.2. INTERNATIONAL PUBLICATIONS.

Table 3 (on the following page) reveals a significant effect of several characteristics of the Ph.D. lab on the expected number of *international* publications of a Ph.D. student. These characteristics sketch the typical profile of a lab where a Ph.D. student can expect to have a high number of articles published in international journals. This "typical lab" has a strong orientation towards basic research, the results of this research being published mainly in international, peer-reviewed journals. Alongside this contextual variables, three significant individual variables draw the typical profile of a Ph.D. student whose expected number of international publications is relatively higher than the average. This "typical student" is a male, with an INRA Ph.D. funding, and planning to follow an academic career path (either as his/her only objective, or as a possible objective).

These results call for further comments. First, the positive effect of an INRA funding may be seen as a proxy for the scientific ability of a Ph.D. graduate: indeed, only a few selected students may pretend to such a funding. In that case, this result simply means that a higher ability yields a greater number of (good quality) publications. Lacking other proxies for ability, it is difficult to further investigate this assumption.

Table 3 : count models estimates for the expected number of international publications during the Ph.D.

Exogenous Variables		**NegBin model**	**ZINB model, equation (4.a)**
		Parameter *(Std deviation)*	**Parameter *(Std deviation)***
Constant		-1.0973 *(1.0962)*	-1.4419 *(1.0522)*
Age at completion		-0.0344 *(0.0279)*	-0.0208 *(0.0269)*
Gender	*Male*	0.2704 *(0.0963)****	0.2725 *(0.0909)****
	Female	.	.
Supervising committee	*Yes*	-0.1595 *(0.1248)*	-0.1256 *(0.1201)*
	No	.	.
Expert activity of the lab	*Important*	-0.1299 *(0.2059)*	-0.0512 *(0.1941)*
	Moderate	-0.0701 *(0.1107)*	-0.0504 *(0.1040)*
	None / Unknown	.	.
Contracts between lab & private sector	*Numerous*	0.2464 *(0.1595)*	0.2313 *(0.1458)*
	Moderate	0.0315 *(0.1179)*	0.0635 *(0.1118)*
	None / Unknown.	.	.
Contracts between lab & public sector	*Numerous*	-0.1161 *(0.1522)*	
	Moderate	0.0353 *(0.1276)*	
	None / Unknown	.	
Contracts between lab & European Union	*Numerous*	0.0205 *(0.1485)*	-0.0011 *(0.1304)*
	Moderate	-0.1358 *(0.1168)*	-0.1497 *(0.1094)*
	None / Unknown	.	.
Publications of the lab (national journals)	*Numerous*	-0.3072 *(0.1883)*	
	Moderate	0.0293 *(0.1585)*	
	Few / Unknown	.	
Publications of the lab (international journals)	*Numerous*	1.9308 *(0.7716)***	2.0531 *(0.7581)****
	Moderate	1.7926 *(0.7733)***	1.9329 *(0.7592)***
	Few / Unknown	.	.
Implication of the lab in editorial board of international journals	*Strong*	0.2233 *(0.1476)*	0.1835 *(0.1389)*
	Moderate	-0.0750 *(0.1058)*	-0.1229 *(0.0991)*
	Weak / Unknown	.	.
Part of basic research in global lab activity	*Important*	0.3629 *(0.1727)***	0.3052 *(0.1663)**
	Medium	0.3640 *(0.1647)***	0.2931 *(0.1599)**
	Small / Unknown	.	.
Part of applied research in global lab activity	*Important*	0.0322 *(0.1938)*	-0.0606 *(0.1901)*
	Medium	0.0906 *(0.1882)*	0.0393 *(0.1858)*
	Small / Unknown	.	.
Part of teaching in global lab activity	*Important*	-0.0966 *(0.1862)*	
	Medium	0.0302 *(0.1616)*	
	Small / Unknown	.	
Ph.D. Funding	*INRA*	0.3175 *(0.1521)***	0.2840 *(0.1462)***
	Other public	0.2355 *(0.1555)*	0.2467 *(0.1516)**
	Private	0.3172 *(0.2413)*	0.2688 *(0.2266)*
	Other / none	.	.
Partnership with a firm during Ph.D.	*Yes*	-0.1237 *(0.1228)*	-0.1091 *(0.1179)*
	No	.	.
Ph.D. student's teaching activity	*Important*	0.1029 *(0.1532)*	
	Moderate	-0.1756 *(0.1202)*	
	Low / Null	.	
Year of completion		0.0265 *(0.0189)*	0.0234 *(0.0179)*
Discuss. Voc. plans with lab member(s)	*Yes*	0.0195 *(0.1014)*	-0.0164 *(0.0947)*
	No	.	.
Lab helped to define vocational plans	*Yes*	-0.0533 *(0.1067)*	-0.0456 *(0.1016)*
	No	.	.
Considered career in academia	*Yes*	0.4594 *(0.2338)***	0.5016 *(0.2252)***
	No	.	.
Considered career in industry	*Yes*	-0.1448 *(0.0964)*	-0.1754 *(0.0925)***
	No	.	.
Log-likelihood		-792.79	-789.55
α (NegBin model only)		0.3672 *(0.0597)****	0.2377 (0.0528)***

*** 1% significance level; ** 5% significance level; * 10% significance level

The second result raise the problem of rationalisation. Since the graduates were questioned ex-post, they may have declared the job they occupy at the time of the survey was the one they planned to occupy at the beginning of the Ph.D. Descriptive statistics show that approximately 90% of the sample declared academia as a possible objective (66% of the sample declaring an academic career as their primary objective). However, only 40% of the sample occupied a permanent academic position[3] in 1998. Similarly, approximately 60% of the sample declared having considered a career in industry as possible at the start of their Ph.D. (while only 10% of the sample declared a career in industry as their primary objective). Little more than 20% of the sample were occupying a position in industry at the time of the survey. This suggest that, in both cases, rationalisation biases should not be a major concern.

Finally, the significant impact of gender on the expected number of international publications suggests that some sort of sexual discrimination stills prevails in the French academic system. This result is consistent with European and French studies on the inequality between men and women in academic careers (e.g. European Commission, 2000; Esterle *et al.*, 2000).

5. A significant effect of supervision on first job outcomes.

As mentioned in Section 2, the returns to a Ph.D. are measured by job outcomes after the Ph.D. Our data, however, is not longitudinal data. Therefore, we can only use a variable describing the nature of the first job obtained after the completion of the Ph.D. The access to this first job will be described by a multinomial Logit model:

(5) $\ln\left(\frac{p_{ij}}{p_{i0}}\right) = X_{i}.\beta_j$, where $j = 1, 2, \ldots, m$ and where the category 0 is taken for reference.

[3] In France, assistant professors ("Maîtres de Conférence") positions are permanent, with no possibility of dismissal except for misconduct.

In Equation (5), p_{ij} = Prob(y_i = j), j = 1, 2, …, m, and p_{i0} = Prob(y_i = 0), where y_i is the observed endogenous (categorical) variable describing the first job. The endogenous variable has m + 1 categories (coded y_i = 0, 1, 2, …, m), and category 0 is taken for reference. X_i is a vector of exogenous variables, β being its associated vector of parameters. In our empirical applications, we experimented with two different codes for the endogenous variable, leading to two different models.

The first model describes the opposition between research and non-research jobs, without distinguishing permanent and temporary positions. In this model, y_i has 3 modalities:

- first job is a public research labour contract.
- first job is a private research labour contract.
- first job is another labour market situation (reference). This category includes unemployment.

The second model is more detailed, y_i now having four modalities:

- first job is a permanent academic position
- first job is a non-academic permanent position (an "open-ended contract")
- first job is a temporary academic position : post-doc, ATER (teaching assistant in a university) or ASC (research assistant at the INRA).
- first job is another labour market situation (including unemployment) This last category is taken for reference.

Models estimations were conducted with the Maximum Likelihood technique.

Each model was estimated with several alternative sets of exogenous variables; we've retained the models for which Akaike's and Schwarz's information criteria were minimal. The results of the estimations are given in Table 4 for the first model and Table 5 for the second one. Both models suggest that, alongside individual variables, contextual variables may have a significant influence on the type of job a Ph.D. student can obtain after graduation.

5.1. Research jobs versus non-research jobs.

The first model shows that some supervision variables have a direct impact on first job outcomes. Three results are particularly significant: first, the chances for a graduate to get his/her first job in public research are significantly higher if the staff of the Ph.D. lab is involved in the editing of international peer-reviewed scientific journals. Second, if a lab has a strong *applied research* activity, then its Ph.D. graduates stand higher chances to get their first job in private R&D. Finally, a lab that helps its students define their career plans do give them a significantly higher probability to obtain a public research job.

The first job outcome is also influenced by a number of characteristics which depend both on the individual and his/her Ph.D. lab. Thus, the probability for the first job to be a research (rather than a non-research) job tends to increase with the number of international publications. There may be an indirect effect of supervision here, since the expected number of publications during the Ph.D. depends on both individual and contextual variables (cf. Section 4). Similarly, industrial partnerships during the Ph.D., which affect positively the probability to obtain a private research job, obviously depend both on the individual's willingness and on the opportunities a lab can offer. Last, a Ph.D. graduate has higher chances of obtaining a public research job if his/her research was supported by an INRA or another public funding. The type of financial support a Ph.D. student may receive depends both on his/her preferences, and on a selection process operated by the Ph.D. lab.

Finally, job outcomes also depend on variables that are more strictly individual. First, graduating with the highest distinction (among four possible levels) increases the probability for the first job to be a public research job. In the French academic system, the distinction is supposed to reward a student's own efforts, and thus may depend less on supervision than, say, his/her publication record.

Table 4: factors influencing the probability for the first job to be a research job.

Exogenous Variables		**Public Research**	**Private Research**
		Parameter *(Std deviation)*	**Parameter *(Std deviation)***
Constant		-0.8435 *(1.0198)*	-4.9956 *(1.6694)****
Gender	*Male*	0.1633 *(0.2758)*	0.6797 *(0.3617)**
	Female	.	.
Ph.D. student's nat. Publications		-0.1595 *(0.1263)*	0.0330 *(0.0986)*
Ph.D. student's international pub.		0,1216 *(0,0650)**	0.1721 *(0.0791)***
Expert activity of the lab	*Important*	-1.0923 *(0.6304)**	0.4631 *(0.6569)*
	Moderate	0.1494 *(0.3143)*	0.4374 *(0.4290)*
	None / Unknown	.	.
Contracts between lab & private sector	*Numerous*	-0.7126 *(0.4834)*	-0.6953 *(0.6257)*
	Moderate	0.0832 *(0.3299)*	-0.5006 *(0.4669)*
	None / Unknown	.	.
Contracts between lab & public sector	*Numerous*	0.3665 *(0.4351)*	-0.2477 *(0.6052)*
	Moderate	-0.3443 *(0.3602)*	0.1507 *(0.4901)*
	None / Unknown	.	.
Contracts between lab & European Union	*Numerous*	-0.3062 *(0.4326)*	0.5692 *(0.5790)*
	Moderate	-0.1962 *(0.3299)*	0.2726 *(0.4471)*
	None / Unknown	.	.
Publications of the lab (national journals)	*Numerous*	-0.6526 *(0.5218)*	-0.1132 *(0.7607)*
	Moderate	0.3262 *(0.4451)*	0.1033 *(0.6920)*
	Few / Unknown	.	.
Implication of the lab in editorial board of international journals	*Strong*	1.0677 *(0.4545)****	0.3001 *(0.6247)*
	Moderate	0.4079 *(0.2992)*	0.2615 *(0.3884)*
	Weak / Unknown	.	.
Part of basic research in global lab activity	*Important*	-0.0393 *(0.4270)*	-0.3172 *(0.5529).*
	Medium	0.2226 *(0.4278)*	0.0860 *(0.5304)*
	Small / Unknown	.	.
Part of applied research in global lab activity	*Important*	0.7496 *(0.5362)*	2.5516 *(1.1557)***
	Medium	0.0832 *(0.5048)*	1.4212 *(1.1402)*
	Small / Unknown	.	.
Part of teaching in global lab activity	*Important*	0.1758 *(0.5088)*	-0.1379 *(0.7026)*
	Medium	0.3115 *(0.4387)*	-0.2746 *(0.6114)*
	Small / Unknown	.	.
Ph.D. Funding	*INRA*	0.9038 *(0.4033)***	-0.0396 *(0.5749)*
	Other public	0.7820 *(0.4064)***	0.9290 *(0.5668)*
	Private	-0.4239 *(0.6938)*	0.5302 *(0.7971)*
	Other / none	.	.
Partnership with a firm during Ph.D.	*Yes*	-0.1718 *(0.3433)*	0.9536 *(0.4581)***
	No	.	.
Ph.D. student's teaching activity	*Important*	0.4900 *(0.4568)*	-0.2293 *(0.6751)*
	Medium	0.2365 *(0.3466)*	1.1535 *(0.4333)****
	Low / Null	.	.
Year of completion		-0.0787 *(0.0518)*	-0.0105 *(0.0694)*
Distinction	*Highest*	0.8569 *(0.2712)****	0.1180 *(0.3658)*
	Other / none	.	.
Discussed vocational plans with lab member(s)	*Yes*	-0.4489 *(0.2936)*	0.1567 *(0.3780)*
	No	.	.
Lab helped to define vocational plans	*Yes*	0.9508 *(0.3260)****	0.4509 *(0.4381)*
	No	.	.
Considered career in academia	*Yes*	0.0562 *(0.5643)*	0.9234 *(0.7005)*
	No	.	.
Considered career in industry	*Yes*	-0.5575 *(0.2874)***	-0.5591 *(0.3841)*
	No	.	.
Log likelihood		*-319.4649*	
Pseudo-R^2 (Mc Fadden)		*0.19*	

*** 1% significance level ; ** 5% significance level ; * 10% significance level

Second, being a female researcher decreases the probability to obtain a private research job after the Ph.D., which reveals, again, some gender discrimination. Third, a *moderate* teaching activity during the Ph.D. increases one's chances to get a private research contract. In that respect, teaching skills may act as a signal of one's communicative skills (ability to express oneself in front of an audience, for instance), a type of skills highly valued by firms. Last but not least, an individual with a private-sector-oriented career plan decreases his/her chances to obtain a public research job.

5.2. PERMANENT ACADEMIC POSITIONS AND OTHER LABOUR MARKET SITUATIONS.

The second model takes into account the dichotomies between academic and non-academic jobs on the one hand, and between permanent and temporary jobs on the other hand. Table 5 shows that the type of supervision given to a Ph.D. student does affect his/her job outcomes. To enter a permanent academic position directly after graduation (which is possible in the French academic system), a student should not prepare his/her Ph.D. in a lab whose activity is mainly oriented towards expertise. He/she should rather favour teams where a part of the activity is dedicated to fundamental research. The implication of the Ph.D. lab in the editorial boards of international journals is a most prominent feature, which should not be overlooked by students with academic career objectives. Finally, it appears that a team which helps its Ph.D. students define their career plans significantly increases their chances to obtain a permanent academic position.

Table 5: factors influencing the access to the first job (reference: other situation).

Exogenous Variables		Permanent Academic position	Other permanent position	Temporary academic position
		Parameter *(Std dev.)*	Parameter *(Std dev.)*	Parameter *(Std dev.)*
Constant		-1.7131 *(1.3285)*	0.2983 *(1.4962)*	-2.6716 *(1.6175)**
Gender	*Male*	-0.0483 (0.3255)	0.3916 *(0.3900)*	-0.1512 *(0.3362)*
	Female	.	.	.
Ph.D. student's nat. Publications		-0,0503 *(0,1483)*	0.1558 *(0.0990)*	-0.2275 *(0.1888)*
Ph.D. student's international pub.		-0,0575 *(0,0704)*	-0.1746 *(0.1044)**	0.1482 *(0.0666)*
Expert activity of the lab	*Important*	-2.2247 *(0.8567)****	0.0257 *(0.7433)*	-0.7506 *(0.8801)*
	Moderate	0.3789 *(0.3663)*	0.2366 *(0.4693)*	0.2220 *(0.3786)*
	None /Unk.	.	.	.
Contracts between lab & private sector	*Numerous*	0.0271 *(0.5601)*	0.0687 *(0.7280)*	-1.3694 *(0.6661)***
	Moderate	0.1750 *(0.4001)*	0.3946 *(0.5146)*	0.2755 *(0.3855)*
	None /Unk.	.	.	.
Contracts between lab & public sector	*Numerous*	0.4959 *(0.5177)*	-0.6862 *(0.6631)*	-0.0706 *(0.5231)*
	Moderate	-0.1759 *(0.4511)*	0.0218 *(0.5108)*	-0.4192 *(0.4226)*
	None /Unk.	.	.	.
Contracts between lab & European Union	*Numerous*	-0.3513 *(0.5279)*	-0.1513 *(0.6254)*	-0.8684 *(0.5068)**
	Moderate	-0.1672 *(0.3981)*	-0.9520 *(0.4603)***	-1.1144 *(0.3979)****
	None /Unk.	.	.	.
Publications of the lab (national journals)	*Numerous*	-0.7367 *(0.6362)*	0.4088 *(0.9384)*	-0.1849 *(0.6482)*
	Moderate	0.1688 *(0.5408)*	0.7637 *(0.8521)*	0.3977 *(0.5333)*
	Few /Unk.	.	.	.
Implication of the lab in editorial board of international journals	*Strong*	1.3007 *(0.5057)****	-0.0627 *(0.7368)*	0.6494 *(0.5467)*
	Moderate	0.2086 *(0.3549)*	-0.8677 *(0.4423)***	0.2917 *(0.3630)*
	Weak / Unk.	.	.	.
Part of basic research in global lab activity	*Important*	0.7245 *(0.5340)*	-0.0812 *(0.6200)*	-0.2623 *(0.5268)*
	Medium	1.2443 *(0.5351)***	0.7424 *(0.5762)*	0.2580 *(0.5294)*
	Small / Unk.	.	.	.
Part of applied research in global lab activity	*Important*	0.2964 *(0.6144)*	0.2417 *(0.9250)*	0.3904 *(0.7203)*
	Medium	-0.2920 *(0.5937)*	0.2990 *(0.8949)*	0.6269 *(0.6837)*
	Small / Unk.	.	.	.
Part of teaching in global lab activity	*Important*	0.2718 *(0.6788)*	0.1488 *(0.7765)*	0.1483 *(0.5781)*
	Medium	0.7396 *(0.6010)*	0.3668 *(0.6630)*	-0.2721 *(0.5007)*
	Small / Unk.	.	.	.
Ph.D. funding	*INRA*	1.6836 *(0.5379)****	0.5666 *(0.6009)*	0.5846 *(0.5084)*
	Other public	1.0156 *(0.5445)**	0.0587 *(0.6178)*	0.2903 *(0.4932)*
	Private	-0.1751 *(1.0530)*	1.5742 *(0.8359)**	0.8597 *(0.8643)*
	Other / none	.	.	.
Partnership with a firm during Ph.D.	*Yes*	-0.4386 *(0.4006)*	0.4011 *(0.4785)*	-0.5681 *(0.4552)*
	No	.	.	.
Ph.D. student's teaching activity	*Important*	0.5966 *(0.5546)*	0.4625 *(0.6891)*	0.7780 *(0.5079)*
	Medium	-0.4055 *(0.3910)*	-0.3205 *(0.5059)*	-0.0006 *(0.4048)*
	Low / Null	.	.	.
Year of completion		-0.3405 *(0.0643)****	-0.2278 *(0.0766)****	0.1567 *(0.0768)***
Distinction	*Highest (THF)*	1.1214 *(0.3240)****	0.7293 *(0.3948)**	0.5022 *(0.3372)*
	Other / none	.	.	.
Discussed vocational plans with lab member(s)	*Yes*	-0.2643 *(0.3412)*	-0.4422 *(0.4218)*	-0.8133 *(0.3709)***
	No	.	.	.
Lab helped to define vocational plans	*Yes*	1.2995 *(0.3500)****	-0.0133 *(0.4910)*	0.4742 *(0.3900)*
	No	.	.	.
Considered career in academia	*Yes*	0.5277 *(0.7962)*	-1.1119 *(0.6502)**	0.6905 *(1.1463)*
	No	.	.	.
Considered career in industry	*Yes*	-0.4953 *(0.3234)*	-0.4821 (0.4224)	-0.7828 *(0.3421)***
	No	.	.	.
Log Likelihood			-382.8798	
Pseudo R² (Mc Fadden)			0.26	

*** 1% significance level ; ** 5% significance level ; * 10% significance level

The contracting activity of the lab also matters: an important number of contracts with private firms, and/or a moderate number of contracts with the European Union significantly decrease the probability for a Ph.D. graduate to end up on a temporary position (post-doc, ATER, ASC). The contracting activity of the lab may provide the students with extra funds, and extra employment opportunities. For instance, doing research on the basis of private funds can send a positive signal to potential employers in the private sector.

With respect to individual characteristics, two results can be highlighted. First, having one's Ph.D. funded by the INRA does significantly increases one's probability of obtaining a permanent academic position. This may be linked to the specificity of the INRA funding: it is often attributed to a Ph.D. student whose profile present some *ex ante* interest for the Institute, and who will often be recruited by the Institute after graduation. The second result is simply that graduating with the highest distinction significantly increases the chances to obtain a permanent academic position. Finally, we observe a significant effect of the year of completion over the period 1988-1998: the more recent generations of Ph.D. graduates face lower probabilities to obtain a permanent position, be it academic or not. Those generations have higher chances to obtain a temporary academic position. Over the period, employment conditions on the academic labour market have thus worsened; it has gradually become more and more difficult to obtain good returns to a Ph.D..

6. Conclusion: implications and directions for further research.

The aim of this paper was to explore the following hypothesis: a Ph.D. student's scientific achievements and career prospects may not be determined solely by his/her individual characteristics. Contextual elements (namely, the type of training and supervision) may also have an impact. Our first empirical results tend to validate this hypothesis: the Ph.D. duration, the expected number of publications during the Ph.D., and early careers, are all influenced both by individual and organisational variables (the latter mainly describing the Ph.D. lab). This result do not deny the possibility for some students to have a higher scientific potential (or to be able to work harder) than others.

In fact, the significant impact of (some) characteristics of the Ph.D. lab may be interpreted in two different ways. On the one hand, it could mean that the type of training received during the Ph.D. *actually* helps fostering and shaping an individual's scientific skills. According to this interpretation, the Ph.D. students benefit largely from their lab's resources, reputation and scientific network. On the other hand, it may simply be seen as the observable effect of unobserved individual characteristics. This may occur if the INRA laboratories exert some strong selective pressure when recruiting their Ph.D. students. In that case, the most prestigious Ph.D. labs (e.g., those where the valorisation of the research is done through publications in international journals) simply select the more able students.

It may be necessary, in some further research, to try and distinguish between these alternative interpretations, using appropriate techniques (such as treatment effect models) and keeping in mind that each one of them may have some relevance. Meanwhile, some implications can nevertheless be derived from our results, both for prospective Ph.D. graduates and for science policy makers.

Students should consider the possibility that individual performance may be a *necessary*, but not *sufficient*, condition for success (in terms of scientific achievement and/or careers). They should carefully choose their Ph.D. labs, according to their career plans. For instance, students planning an academic career should try to find a lab with an international scientific recognition, whereas those looking for a career in private R&D should choose a lab where contracting with firms is a common practice. However, French research laboratories are often very reluctant to inform students about their publication activity, academic ranking, or contractual practices. The decision to start a Ph.D. is not a minor one: it has long-term consequences on an individual's career and personal life. Students should therefore be given detailed prior information in order to be able to take the most appropriate decision.

Other implications, regarding science policy, may stem from our empirical analysis. Admittedly, scientists are a key input in the innovation process, which can spur economic growth. However, most Ph.D. graduates are trained primarily for academic research. To foster private R&D and thus increase economic growth, more Ph.D. graduates have to be trained for research in the private sector. This argument has been developed by Romer (2000) in the USA, but still holds on the case of France. Our results may be helpful in indicating how to achieve this objective in a French context: broadly speaking, the government could support laboratories that can provide effective training for private R&D. For instance, a budget bonus could be given to labs that develop partnerships with firms, and encourage their students to participate. Such measures should be carefully thought over, in order to develop the national private R&D effort without weakening the existing scientific institutions.

To ascertain all these implications, however, more empirical research is needed. The sample used in this paper was rather specific, since it did only consist of Ph.D. graduates from the INRA. To broaden the scope of the analysis, data on other Ph.D. graduates (from several disciplines and/or countries) is required. Moreover, the possibility of gender discrimination (as that unravelled in our data) pleads for more comparative studies on male and female Ph.D. graduates. More detailed information about individual performance before the Ph.D. may also be helpful if treatment effects models are to be estimated, as we suggested above. Finally, longitudinal data on individual career paths (and possibly on individual publication records) would also be quite useful: our data did not allow us to look beyond the first job, nor did it provide a yearly record of publications. The use of duration models on longitudinal data would make a "long run" analysis possible. However, databases combining such data with detailed information on supervision are still rather hard to come by.

APPENDIX: SUMMARY STATISTICS

Table A: Ph.D. duration

Ph.D. duration in years	Number of graduates	Percentage
Less than 3 years	34	5.2 %
3 years	224	34.4 %
3.5 years	210	32.2 %
4 years	123	18.9 %
More than 4 years	57	8.7 %
Missing values	4	0.6 %

Maximal duration: 10 years; average duration: 3.5 years (Std deviation : 1.17); median duration: 3.17 years.

Table B: publications during the Ph.D.

Publications	Number of graduates	Percentage
In national peer-reviewed journals:		
Zero	439	67.9 %
1 or 2	159	24.5%
More than 2	49	7.6 %
In international peer-reviewed journals:		
Zero	213	32.9 %
1 or 2	183	28.3 %
More than 2	251	38.8 %
In both type of journals :		
Zero	167	25.8 %
1 or 2	167	25.8 %
Plus de 2	313	48.4 %

NB : 5 missing values.

Table C: first job outcomes

First job (research versus non-research)	Number of graduates	Percentage
Public research job	279	56.7
Private research job	71	14.4
Non-research job	142	28.9
Total	**492**	**100,0 %**
First job (four-categories variable)	**Number of graduates**	**Percentage**
Permanent academic position	157	31,9 %
Other permanent position	57	11,6 %
ATER, ASC, Post-doc	95	19,5 %
Other situation	183	37.0 %
Total	**492**	**100,0 %**

Table D : Summary statistics for the lab-specific explanatory variables (all models)

Variable		Mean *(Std Deviation)*
Student had a supervising committee[4] (1 if yes, 0 if no)		0.21 *(0.41)*
Expert activity of the Ph.D. lab is:	Important (1 if yes, 0 if no)	0.08 *(0.27)*
	Moderate (1 if yes, 0 if no)	0.36 *(0.48)*
	None/unknown (1 if yes, 0 if no)	0.56 *(0.50)*
Contracts between lab & private sector are:	Numerous (1 if yes, 0 if no)	0.20 *(0.40)*
	Moderate (1 if yes, 0 if no)	0.53 *(0.50)*
	None/unknown (1 if yes, 0 if no)	0.27 *(0.44)*
Contracts between lab & public sector are:	Numerous (1 if yes, 0 if no)	0.32 *(0.47)*
	Moderate (1 if yes, 0 if no)	0.48 *(0.50)*
	None/unknown (1 if yes, 0 if no)	0.20 *(0.40)*
Contracts between lab & European Union are:	Numerous (1 if yes, 0 if no)	0.25 *(0.44)*
	Moderate (1 if yes, 0 if no)	0.47 *(0.50)*
	None/unknown (1 if yes, 0 if no)	0.27 *(0.45)*
Publications of the lab in national journals are:	Numerous (1 if yes, 0 if no)	0.23 *(0.42)*
	Moderate (1 if yes, 0 if no)	0.67 *(0.47)*
	Few/unknown (1 if yes, 0 if no)	0.10 *(0.30)*
Publications of the lab in international journals are:	Numerous (1 if yes, 0 if no)	0.68*(0.47)*
	Moderate (1 if yes, 0 if no)	0.29 *(0.46)*
	Few/unknown (1 if yes, 0 if no)	0.02 *(0.15)*
Implication of the lab in editorial board of international journals is :		
	Strong (1 if yes, 0 if no)	0.15 *(0.36)*
	Moderate (1 if yes, 0 if no)	0.41 *(0.49)*
	Weak/unknown (1 if yes, 0 if no)	0.44 *(0.50)*
Part of basic research in global lab activity is:	Important (1 if yes, 0 if no)	0.47 *(0.50)*
	Moderate (1 if yes, 0 if no)	0.38 *(0.49)*
	Small/unknown (1 if yes, 0 if no)	0.15 *(0.36)*
Part of applied research in global lab activity is:	Important (1 if yes, 0 if no)	0.51 *(0.50)*
	Moderate (1 if yes, 0 if no)	0.40 *(0.49)*
	Small/unknown (1 if yes, 0 if no)	0.09 *(0.28)*
Part of teaching in global lab activity is:	Important (1 if yes, 0 if no)	0.22 *(0.41)*
	Moderate (1 if yes, 0 if no)	0.68 *(0.47)*
	Small/unknown (1 if yes, 0 if no)	0.10 *(0.31)*
Student discussed vocational plans with lab member(s) (1 if yes, 0 if no)		0.42 *(0.49)*
Ph.D. lab helped to define vocational plans (1 if yes, 0 if no)		0.34 *(0.48)*

[4] Some Ph.D. students can, in addition to their supervisor's help, benefit from the scientific advises of a "supervising committee", whose members are other senior researchers and/or industrial experts. The committee meets at regular intervals during the course of the Ph.D.

Table E : Summary statistics for the other explanatory variables (all models)

Variable		Mean *(Std Deviation)*
Age at completion (in years)		28.4 *(2.0)* Median: 28
Gender (1 if male, 0 if female)		0.46 *(0.50)*
Student's national publications (number of)		0.58 *(1.37)* min: 0 Max: 20
Student's international publications (number of)		2.56 *(2.76)* min: 0 Max: 30
INRA Ph.D. Funding		0.33 *(0.47)*
Other public Ph.D. Funding		0.45 *(0.50)*
Private Ph.D. Funding		0.06 *(0.24)*
Other Ph.D. Funding		0.09 *(0.29)*
Partnership with a firm during Ph.D.		0.26 *(0.44)*
Ph.D. student's teaching activity was:	Important (1 if yes, 0 if no)	0.12 *(0.33)*
	Moderate (1 if yes, 0 if no)	0.21 *(0.41)*
	Low / null (1 if yes, 0 if no)	0.64 *(0.48)*
Year of completion, coded from 1 (1988) to 11 (1998)		7.1 *(2.7)* Median: 7
When student started Ph.D., he/she considered academic career as a possible outcome (1 if yes, 0 if no)		0.94 *(0.23)*
When student started Ph.D., he/she considered career in industry (private sector) as a possible outcome (1 if yes, 0 if no)		0.60 *(0.49)*

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