

Earnings in private jobs after participation to post-doctoral programs : an assessment using a treatment effect model

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Abstract

This paper proposes a selection model to assess the effect of post-doctoral programs on earnings for young French PhD. It is shown that, as post-doctoral programs are merely used to improve the chances to obtain a job in public research, they don't offer a wage premium in private jobs on the labour market.

Keywords : treatment effect model, post-doctorate, human capital theory, signalling theory, wages.

JEL classification : C5, J4.

1. Introduction

There has been a little or no increase in the number of jobs offered in the French public research system for the last ten years. The queue for permanent research positions has created a specific labour market for PhDs what is characterized by a proliferation of post-doctoral programs mainly financed by public supports immediately after completion of the PhD. However, as far as we know, there is no empirical research on assessment of these post-doctoral programs. This is consequently the main objective of this paper. Stating that post-doctoral programs are devoted to public research carriers, we face to a not unimportant part of post-doctorates which are employed in the private sector afterwards. The question is: do they have a positive wage premium on jobs in the private sector from their post-doctoral experience? The change observed in the career of those who attended a post-doctoral program and then got a job in the private sector could be interpreted as an anti-screening device or/and as a period of human capital accumulation – specific or general. Whereas the identification of screening and human capital remains a well known difficulty in labour economics, the treatment model framework could be a well suited modelling to go further in that way.

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2. A selection model

The econometrical measure of participation to a program has been widely studied in a literature confronted by selection effect (Heckman and Robb, 1985). The main difficulty is that only individuals who have been enrolled in a program are observed. Thus, we ignore what would happen to these individuals if they would have not participated to this program. Furthermore, the decision to participate to a post-doctoral program is certainly not random and we can easily assume that there are selection effects related to unobserved characteristics. The model used in that paper, first presented by Barnow, Cain and Goldberger (1981) is useful to estimate the effect of an endogenous variable, z_j , on a continuous variable, y_j , precisely the earnings three years after PhD award, conditionally to independent variables, x_j and w_j :

$$y_j = x_j\beta + \delta z_j + \varepsilon_j \quad [1]$$

where z_j is a binary endogenous variable indicative of post-doctoral program.

Assuming that participation to a post-doctoral program is a fully random process, an estimation of [1] could be done with standard methods (Ols). However, stating that participation to a post-doctoral program is a non random process and that the selection effect produces a bias when estimating parameters by Ols, we need to estimate a selection model in which we could obtain the structural effect of post-doctoral program. By that way, the estimation strategy proposed by Barnow, Cain and Goldberger is fully convenient.

The binary variable z_j is modelled as the outcome of an unobservable latent variable z_j^* , so that:

$$z_j^* = w_j\gamma + u_j \quad [2]$$

where w_j is a vector of exogenous variables and u_j is an error term.

The participation to a post-doctoral program is the outcome of the following variable :

$$z_j = \begin{cases} 1, & \text{if } z_j^* > 0 \\ 0, & \text{if } z_j^* \leq 0 \end{cases} \quad [3]$$

A selection bias arises since $E(z_j \varepsilon_j | w_j) \neq 0$ or $E(\varepsilon_j u_j) \neq 0$, that means the error terms of the principal equation and that of the selection equation are correlated (Moffit, 1995). So that

we assume that the error terms of the equations [1] and [2] have a bivariate Normal distribution with mean 0 and covariance matrix $\begin{bmatrix} \sigma & \rho \\ \rho & 1 \end{bmatrix}$.

Given this assumption and with the aid of [1] and [3] we derive the wage expectation conditional to the participation to the post-doctoral program :

$$E[y_j | z_j = 1] = x_j\beta + \delta z_j + E[\varepsilon_j | z_j = 1] \quad [4]$$

From a generally point of view :

$$E[y_j | z_j] = x_j\beta + \delta z_j + \lambda h_j \quad [5]$$

with the hazard h_j constructed as follows :

$$h_j = \begin{cases} \phi(w_j\hat{\gamma}) / \Phi(w_j\hat{\gamma}) & z_j = 1 \\ -\phi(w_j\hat{\gamma}) / (1 - \Phi(w_j\hat{\gamma})) & z_j = 0 \end{cases} \quad [6]$$

Finally, it is very useful to derive the estimation of wage expectations differences conditional to participation or not to a post-doctoral program (Greene, 2000):

$$E[y_j | z_j = 1] - E[y_j | z_j = 0] = \delta + \lambda \left[\frac{\phi(w_j\hat{\gamma})}{\Phi(w_j\hat{\gamma}) \{1 - \Phi(w_j\hat{\gamma})\}} \right] \quad [7]$$

The λ parameter measures the selection effect, obtained from a two-step estimation of [5]. Another interpretation is that the model is augmented by a regressor h_j which is the conditional expectation to the participation to a post-doctoral program.

Given equation [5] we can see that since $\lambda = 0$, the estimation of δ is corrected from the selection bias and is no more affected by the correlation of the unobserved terms. In presence of $\lambda > 0$, and if we do not control for the endogenous character of the post-doctoral variable, the δ parameter is underestimated. Conversely, in the case of $\lambda < 0$, the endogenous variable is overestimated, so that the unobserved in the both equations go in the same way. If the unobserved have a positive effect on participation to a post-doctoral program and if the same unobserved have a positive effect on getting highly paid jobs, we can intuitively conclude that the outcome of participation to a post-doctoral program is overestimated.

The treatment effect model could also be expressed in terms of human capital and signalling theory. In this econometric framework, the δ parameter captures the human capital accumulation effect and the λ parameter is the outcome of non random selectivity, coming up from correlation of unobserved terms. It is commonly agreed that participation to post-

doctoral program is related to particular characteristics, nevertheless, in the human capital theory these characteristics are fully unobserved, whereas in the signalling framework the participation to a program is partially founded on existing signals. In the modelling, the selectivity is broken up between human capital accumulation (specific or general) and productivity signalling. In the case of no selection effect and insignificant δ , the human capital accumulated during the post-doctoral experience is not transferable to the firm.

3. Results

The outcome of participation to a post-doctoral program on earnings in private jobs is examined by estimating the previous treatment model for young PhD awarded during the year 1996 and surveyed in 1999 in France¹.

Table 1 – Proportion of post-doctorate, by fields of education

N=1744	% fields	% post-doctorate at least one time on 3 years	% post-doctorate at least one time on 3 years, except those still in post-doctoral position at the time of the survey
Mathematics, physics	16%	18%	20%
Mechanic, engineering sciences, computing	19%	11%	13%
Chemical	13%	18%	22%
Natural sciences	25%	45%	34%
Law, economics, management	13%	4%	6%
Human sciences	14%	4%	5%
Total	100%	27%	19%

The sample -1744 young people- is nationally representative of French PhD awarded in 1996 in exact sciences, human and social sciences. Among the 1744 young PhD, 844 obtained a job in the private sector, nearly 50% of the sample. The main interest of this database is to provide information on participation to post-doctoral program, which is in itself a very scarce information (Recotillet, 2003). More than a quarter of young PhD had attended a post-doctoral program (about an half for natural and life sciences PhD, see table 1) and 20% of them had a job in the private sector afterwards.

Table 2 reports estimates of the treatment effect model. The coefficient of the participation to post-doctoral program is not significant on earnings in private jobs (although the confidence level of 10% being nearly reached). We could conclude that there is no wage premium gained from this experience. Moreover, the estimate of selection parameter is negatively signed, although not significant. An implementation of [7] yields the net wage premium potentially

¹ This longitudinal survey has been carried out by the Centre for Research on Qualifications (French Ministry of Education).

gained from post-doctoral program and reveals that the wage differential expectation is nearly zero. This main result suggests that, conditionally to regressors included, the post-doctorate program does not produce any transferable human capital but does not create either negative signals. Actually, the final result should into account two other variables fundamental in our analysis: the duration of the PhD itself and, more especially, being employed in a company during the PhD. These two variables are supposed to represent human capital or signals to employers. Force is to note that the time elapsed between the beginning of the PhD and its defence is neither a key variable to explain participation to post-doctorate, nor an experience valued in the private sector. In addition, estimates from table 2 show that, whereas being employed in a private company during the PhD is negatively linked to participation to post-doctorate program, conversely, the effect is positive on earnings in private jobs. Furthermore, as, on the one hand, participation to post-doctorate parameter is not significant, we could assert that finally post-doctorate program yields an anti-screening device compared to the effect of job experience during the PhD. It constitutes a way of avoiding unemployment after the PhD, at least for those who were recruited in the private sector.

On the opposite, signals yielded by unemployment are noticeably actives: each unemployment period induces a relative wage loss from approximately 6%. Although few PhDs are frequently unemployed, these young people highly qualified undergo the negative effect of unemployment, since at the same time they have difficulties to get value from their post-doctoral experience.

At last, young PhDs who have been recruited as researcher in the private sector take advantage from wages slightly higher when they went through post-doctoral program (the marginal effect is +6%), whereas, at the same time, return from seniority is not significant. This is not surprising that wages expectation are lower in small productive units, since R&D activities are concentrated more around large companies, although a part of R&D activity is externalised more and more frequently. This effect is strengthened for young doctorates employed on temporary jobs, with wages differentials coming close to 15%. As post-doctoral program and jobs as researchers in the R&D activity sector do not provide significant premium wage (the wage differential for researchers in R&D is minor), we could presume that these scientists “pay” to be scientists.

4. Conclusion

The latent difficulties for young PhD to enter academic jobs have been accompanied by the development of post-doctoral programs. In this paper, a treatment effect model is estimated in

order to test the effect of participation to post-doctoral program on wages gained in the private sector. I found that the estimated return to post-doctoral participation on earnings in the private sector is not significant and merely plays the role of an anti-screening device, whereas, at the same time, having been employed in a company during the PhD provides a premium wage. I don't find any transferable human capital effect and the selection effect seems to counterbalance the feasible human capital accumulated during the post-doctorate program. In a context where the links between private and public research appear to make stronger and, moreover, are strengthened by public policies, my main result illustrates that private employers confer a weak value to experiences in the public sector, especially in the case of post-doctoral program.

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Table 2 – A treatment effect model, two-step estimates

	Coef.	Std. Err.	t
Log-wage equation			
Constant term	7.4318	0.1791	41.49
Post-doc. program	0.2800	0.1753	1.60
Job in a company during the PhD	0.077	0.0347	2.22
<i>Years to PhD degree</i>			
> 4 years	0.0039	0.0284	0.14
< 3 years	-0.0051	0.0288	-0.18
Age at graduation (1996)	0.0007	0.0060	0.12
Engineers diploma	0.0281	0.0319	0.88
Male	0.1819	0.0258	7.06
<i>Field of PhD</i>			
Mathematics, physics	0.0051	0.0422	0.12
Mechanics, electronics, engineering, computer sc.	0.0473	0.0374	1.26
Chemistry	0.0316	0.0364	0.87
Natural and life sc.	-	-	-
Law, economics, management	0.2351	0.0469	5.01
Humanities	-0.0261	0.0541	-0.48
Researcher in private R&D	0.0556	0.068	2.08
Number of months in that job	0.0008	0.0006	1.41
<i>Job contract</i>			
Temporary job	-0.1462	0.0343	-4.27
Other job contract	0.0659	0.0321	2.05
Permanent job	-	-	-
<i>Size of the company</i>			
< 50 employees	-0.1333	0.0295	-4.51
50-200 employees	0.0043	0.0352	0.12
200-500 employees	0.0255	0.0351	0.72
> 500 employees	-	-	-
Participation to post-doctoral program equation			
Constant term	-0.4056	0.2384	-1.70
Job in a company during the PhD	-0.6489	0.1696	-3.83
Male	-0.2128	0.1133	-1.88
<i>Field of PhD</i>			
Mathematics, physics	-0.6310	0.1937	-3.26
Mechanics, electronics, engineering, computer sc.	-0.4039	0.1719	-2.35
Chemistry	-0.0223	0.1647	-0.14
Natural and life sc.	-	-	-
Law, economics, management	-0.50027	0.2294	-2.19
Humanities	-0.6269	0.2608	-2.40
<i>Years to PhD degree</i>			
> 4 years	-0.2178	0.1370	-1.59

< 3 years	-0.0622	0.1392	-0.45
<i>Financial support for PhD</i>			
...from Ministry of Research	0.0657	0.1945	0.34
...from other public Institution	-0.1200	0.2419	-0.50
Teacher assistant on temporary job contract	-0.0619	0.3032	-0.20
Researcher assistant on public research program	0.0232	0.2474	0.09
...from private company	-0.0229	0.2389	-0.10
Without any financial support	-0.1617	0.2728	-0.59
Other	-0.3814	0.2392	-1.59
...from Ministry of Research and teacher assistant	-	-	-
<i>Institution where PhD was carried on</i>			
National Center for Research	0.2393	0.1645	1.45
Inserm-Inra	-0.1621	0.2483	-0.65
Other	0.0311	0.1837	0.17
Selection Parameter			
Lambda	-0.1357	0.0988	-1.37
Implementation of eq. [7]			
	0.0215	0.0322	
Number of observations : 844			
