

PROFILES OF ACADEMIC ACTIVITIES AND CAREERS: DOES GENDER MATTER? AN ANALYSIS BASED ON FRENCH LIFE SCIENTIST CVS¹

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Abstract

The aim of this paper is to analyze the factors that influence the length of time to promotion for male and female academics. Promotion is defined as elevation to a professorship. We examine the role of academic profiles, which are based not only on publications, but also include activities such as fund raising, consulting, teaching, and managerial appointments (dean of a department for instance). The paper examines the factors that speed up or slow down the progress of an academic career for males and females respectively to explore the “glass ceiling” effects. Survival and duration models are used to test whether the gender differential persists after controlling for observed and unobserved heterogeneity. The originality of this paper lies in the use of duration models to track sex differences in promotion criteria. It highlights that the different criteria of promotion for male and female academics: women have to demonstrate higher involvement in different networks in order to be promoted.

Keywords: Academic, career, glass ceiling, duration model, survival model, life science, mentoring

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1. INTRODUCTION

The aim of this paper is to analyze the factors that influence the length of time to promotion for male and female academics. Promotion is defined as elevation to the position of professor. We examine the role of academic profiles, which are not based only on publications, but also include activities such as fund raising, consulting, and teaching, and managerial (administrative) responsibilities such as dean of a department, etc. The paper examines the respective speeding up and slowing down factors that operate on the academic careers of males and females to explore the “glass ceiling” effects.

Why is it that there are many female assistant professors but very few women professors in French academia? Since the 1970s in the developed countries, academic careers have been more accessible to women (ETAN, 2000). However, the proportion of females to males decreases the higher up the career ladder (Levin and Stephan, 1998; Xie and Shauman, 1999). On average, the percentage of women assistant professors is three times higher (30.5%), and the percentage of women associate professors is twice as high (20.5%) as the percentage of women full professors (10.4%). However, this picture has a strong international heterogeneity. For instance, and perhaps surprisingly, of the countries in Europe Turkey has the highest percentage of female full professors (21.5%), and has the smallest gap between "associate" and "assistant" professorships. The Netherlands has the lowest number of females holding full professorships. In France, 44% of assistant or associate professors but only 20% of full professors are women (Boukhobza, Delavault, and Hermann, 2000). Is there a so-called glass ceiling effect operating here? Are the promotion criteria discriminating against women?

Morrison *et al.* (1987) defined the “glass ceiling” effect in describing the existence of a transparent barrier that prevents women from rising above a certain level in large corporations. They considered the barrier for women as a group, indicating that individual advancement is barred because they are women, rather than because they lack the ability to handle high level jobs. The term has also been used to describe a barrier to entry to top level positions based mainly on the discrimination of a group. The glass ceiling effect in large corporations (Powell and Butterfield, 1994), start-ups and US academia (Austin, 2002; Benjamin, 2002; Geraci, 2002; Rothausen and Marler, 2003; Turner, 2003) has been well documented.

Statistical evidence for French academia would seem to be consistent with a glass ceiling phenomenon. However, the observed gender differences among academics could be explained by gender preferences for particular activities. For example, Schneider (1998) noted that women are more involved than men in pedagogical activities, which could explain their lower publication rate and their lower likelihood of being promoted. Indeed, academic activity is multi dimensional: production of certified knowledge, *i.e.* publication of articles and books, dissemination of knowledge (industry/university linkages), and teaching (life long training and initial training). While the profiles of academics may differ according to seniority, experience, incentives or gender it might be that institutions reward some profiles more than others. Does such discrimination introduce gender effects? Is the French academic sector rather specific?

The French academic sector comprises two different types of organizations: universities and national research laboratories. The career structure in both types of organizations is similar: academics are civil servants and after a 12-month probation period, they are guaranteed lifelong employment. To limit heterogeneity due to the multiplicity of organizations, we focused on careers in one national laboratory, INRA – the National Institute of Agronomic Research, which is dedicated to research in life sciences. The recruitment and promotion mechanisms are mainly based on scientific achievements. There are two levels of academics at INRA: researchers (the equivalent of assistant professor), who mainly work within specific teams; and professors who lead a team or an individual laboratory and determine its research avenues. Hiring and recruitment is handled by peers who assess the scientific quality of candidates.

This paper analyses the careers of academics in terms of access to professorships related to effective academic activities, *i.e.* profile of activities, to test for glass ceiling effects. Scientific achievements, as assessed by number of publications and scientific visibility (impact of publications in term of citations), are supposed to constitute the criteria for hiring and promotion decisions. As the judgments are made by peers on a scientific basis, they should be free from discrimination (section 1). To test for a gender differential after controlling for observed and unobserved heterogeneity, we built a dataset which describes the academic careers and activity profiles of the 583 life scientists working at INRA. The empirical evidence presented in section 2 clearly indicates that women are under represented at

professorial level. Survival and duration models were used to test whether the gender differential persists after controlling for observed and unobserved heterogeneity. Instead of estimating the probability of being promoted, we estimated hazard rates and duration models from researcher positions to professors (section 3). Evidence from the interaction of gender and other covariates suggests that gender affects promotion duration directly and indirectly through the effects of such factors as the ability to fund raise, and to hold managerial positions. The importance of these factors illustrates the impact of multiple networking in the world of academe (section 4). The originality of this paper lies in its use of duration models to track the sex differences in promotion criteria. It highlights that for male and female academics promotions to professor are linked to different criteria: women are required to demonstrate higher involvement in a variety of networks than men.

2. PEER CAREER MANAGEMENT AND GLASS CEILING

The literature highlights several characteristics of scientific activities that have led to the development of specific career management practices for academics. The need for security and independence, and the desire to recruit the best in the field have been cited to justify the academic labor market which has two main characteristics: a tenure system *i.e.* life-long employment for those who gain access to it, and peer management of a career. As hiring and promotion criteria are mainly based on one single criterion implemented by peers, there should be no gender discrimination.

2.1. Specific needs for career management of those involved in scientific activities

In most developed countries, the specific organization of academic careers is illustrated by two characteristics of scientific activities. First, the randomness of progress in the field of knowledge requires a particular organization of the academic labor market. Because the frontiers of knowledge are constantly being pushed back, it is impossible for any academic to keep all their knowledge in an entire discipline up to date. As a result, as Sow (1998) shows, they have to specialize. However, at an individual level specialization increases the risk of knowledge obsolescence (McPherson and Winston, 1983) and as academics may be risk averse, tenure or life-long employment is seen as an incentive to

specialize. Second, because research is a time consuming process and success cannot be guaranteed, researchers can feel themselves weakened by the success of others. This could induce counter-productive behaviors such as unwillingness to recruit, or to help potentially brilliant young scientists. Thus, some scholars have claimed that to allow the academic system to renew itself, it is necessary to reassure researchers and not to increase competition amongst them (Carmichael, 1988). Tenure is one way to give academics the security to hire brilliant young researchers without seeing them as a threat to the researchers already in post.

Research around the world, with some country specifics, has for a long time been managed on the basis of some kind of tenure system. The French version of this system is that academics are given the status and benefits of civil servants. French academics are hired by universities or national laboratories after completion of their PhD or/and post-doctoral studies. Some positions are short term, for a specific contracted period for junior scientists (under 32 years old). Most of the positions are endowed with civil servant status and assure life long employment. This has implications for salaries, which are determined by status (researcher, professor and their seniority at each level). For a specific status, salaries are not negotiable, and are the same for all universities/research laboratories in France. There is no gender difference in terms of wages for a given level.

In France, as in other countries with a tenure system, career rules have been established to promote equality in promotions. Career profiles are designed to allow academics' work to be monitored, and to indicate how they can succeed in their jobs and what they can expect as a reward for this success. The rewards in terms of promotion must demonstrate impartiality and gender equality in line with the norms of the scientific community.

2.2. Career Management: Peer review process in action

Life long employment and peer evaluation are the two pillars of career management in academia. In France, access to life long employment comes soon after completion of the PhD or post doctoral study. Following the award of the PhD degree, there is a certification process managed by a certification committee composed of peers (*Conceal National des Universities* for universities and *Conceal*

Scientifique for national labs)² which certifies the quality of the student's work. Once this process is completed the new researcher is eligible to apply for a researcher position (equivalent to assistant professor). The short listed candidates must undergo formal interview by a recruitment committee of their peers (assistant, associate and full professors), who vote (by secret ballot) for the candidates in order of preference. The successful candidate (after 12 months probation) becomes a researcher with a life long contract. S/he is a civil servant whose job is secure.

The formal procedure for appointing professors is similar involving a certification stage and application to an advertised position. At the researcher level, hiring criteria are mainly based on publications and the quality of research performed during the PhD. At the senior level (professor), criteria include PhD supervision, reputation and fund raising record. Both researchers and professors are appointed by their peers through formal review and interviewing procedures. However, the proportion of females recruited that are awarded researcher positions is higher than those that are awarded professorial positions, suggesting the existence of glass ceiling effects.

The somewhat puzzling empirical evidence is open to different interpretations: Long and Fox (1995) reveal that all minorities, including women, enjoy lower level participation, position, productivity and recognition than do white men. Geraci (2002) argued that proportional increases in a minority group usually lead to improvements in the social environment for that group. In other words, as the number of women increases to the point where women achieve more balanced representation in academe, one can expect a proportional increase in the number of women being promoted to professors. Based on US data, Geraci (2002) showed that increases in the overall proportion of women faculty in an institution have a positive, curvilinear impact on the number of women hired both for tenured and untenured positions. Similarly, Esterle and Chapelle (2002) for the case of France reported growing involvement of women in certification and recruitment committees. Such examples emphasize the mechanistic effect of a more balanced representation of gender.

Alternatively, the different dimensions of scientific activities achieved through personal networks and mentoring might have an influence. De Janasz and Sullivan (2004) define mentoring as a powerful

² Comprising approximately 30 academics (50% elected by the academics of the field and 50% appointed by the Minister of Education) who act as committee members for a period of 4 years.

process for enhancing career development. Traditional definitions of mentoring suggest a dyadic relationship in which the more experienced person steers the career of a less experienced colleague by helping him/her to navigate the world of work. Higgins and Kram (2001) underline that in a more complex and more competitive environment, the single master–apprentice mentor model does not suffice, and guidance is needed from several and diverse individuals.

De Janasz *et al.* (2004) argue that academics are better served by a portfolio of mentors, built through personal networks, to facilitate the development of their career competencies. Since Ragins and Cotton's classic paper (1991), various authors have reported on the differing abilities of males and females to acquire mentors (Ortiz-Walters and Powell, 2003; Wallace, 2001). The dimensions of multiple mentoring are linked to learning mechanisms. As access to professorial positions becomes more and more competitive, junior members of faculty must develop the competencies to enhance their reputation and marketability. De Janasz and Sullivan (2004) identify three forms of knowing or career competencies that are manifested in people's beliefs and identities: knowing why, knowledge and skills (knowing how) and networks and relationships (knowing who), dimensions that are closely related to apprenticeship and networking activities.

The development of these competencies is not only enhanced through mentoring, it is also supported by academics' involvement in different networks, which provides them with better connections to facilitate higher performance in the different facets of their activity. Xie and Shauman (1998) argue that sex difference in research productivity and careers can be attributed to sex differences in personal characteristics, structural positions and marital status. Shauman and Xie (1996) underlined sex differences in geographic mobility which may affect the ability of researchers to be connected with colleagues and to form alliances with potential mentors.

To address the effects of sex differences in promotion criteria, it is necessary to go beyond the objective "number" of publications and citations. We need to track indirect effects in the different dimensions of scientific activity which may affect not only the probability of promotion, but also when promotion occurs. It is thus interesting to explore the effects of mobility (international and inter-organizational) on promotion in considering mobility as a learning mechanism used not only to acquire new purely scientific competencies, but also to develop relational dimensions of learning

(working in different environments, working with different people, etc.). Mobility may have a direct and indirect influence: direct in that it increases the number of collaborations and indirect in that it enlarges the network and strengthens existing relationships. If male and female academics have different propensities to move, this may affect their respective careers.

As involvement in the management of a research organization (team, academic department) may play a role in the time to promotion, we explore sex differences in involvement in organizational life. Being a dean or a team leader reveals high personal commitment. It also connects the researcher with the hierarchy and with external networks that will provide the team or the department with resources: financial resources from foundations or the private sector, and equipment; and even position of fulltime researchers from the hierarchy of the national laboratory³. Do males and females demonstrate the same involvement in managerial functions? Are male and female similarly chosen by the hierarchy to be team leader or dean?

Finally, academic careers are regulated by a few formal opportunities to make in-depth presentations and to discuss personal research. The PhD and the “habilitation⁴” dissertations and defenses provide such opportunities. In each case, candidates are supported by a mentor, the PhD supervisor or the Habilitation advisor *i.e.* the professor who advises the researcher for her/his Habilitation. Do males and females manage these opportunities to present their work and to form dyadic relationship with a mentor in different ways? Do they develop different behavior towards mentors in those situations, and does this play a role in their careers?

All the learning processes may affect the respective speed of career progression of males and females. However, their influence is not mechanistic. It may be direct or indirect. The variables may be the same for males and females, or they may affect their careers in different ways. Inspired by the work on personal networks and multiple mentoring, we explored sex differences in the “speeding up” and “slowing down” factors affecting careers.

³ National laboratory and institute are synonymous in the paper.

⁴ The habilitation is a diploma which allows a researcher to become a PhD advisor. This diploma is necessary to become a professor. The researcher has to write a document showing her/his contribution to science. S/He also has to present a defence in front of her/his peers *i.e.* four or five professors. It is usually written around ten years after the PhD defence.

3. DATA AND METHODS

The analysis of the career paths of researchers in France is based on an *ad hoc* dataset built using administrative data from one of the national research laboratories dedicated to life sciences. INRA focuses on developing scientific knowledge in the fields of plant biology, agriculture, food and the environment. In 2003, INRA employed around 8,600, of which 2,200 were researchers, 37.2% of whom were women. As in all public sector research organizations in France, the academic careers of researchers at INRA consist of two stages: researchers (equivalent assistant or associate professors) and senior scientists (equivalent to professors). As already mentioned, in the French academic system generally women are under represented in the senior positions, while there is parity at the researcher level. However, at INRA the situation for women is worse than the average. Table 1 shows that the share of women among professors is 10 points lower at INRA than in the other public research institutes.

[Please insert table 1 around here]

Promotion and recruitment mechanisms take place at national level and the selected candidates are assigned to specific teams. The processes of recruitment and promotion are formal: once a year, available positions are advertised in French newspapers and on INRA's website. Candidates have to apply by submitting their curriculum vitae, an outline of their recently completed research projects and their research perspectives for the next future. Recruitment and promotion committees examine the applications (certification process) and make a shortlist of candidates to be formally interviewed. Based on deliberations following the interviews, the candidates are ranked and eventually offered positions. Committees are composed of research peers *i.e.* academics from the institute and other French academics.

We focus on a specific scientific field *i.e.* scientists involved in biology, in order to have comparable behaviors and scientific communities. We can thus collect comparable data in terms of publications, patents and scientific activities. As scientists at INRA have no teaching duties, their activity profiles

are less heterogeneous than those of academics in universities. Our sample contains 583 researchers for whom different datasets have been matched in order to describe their careers and scientific activities. The first dataset is administrative. It describes the speed of the career, *i.e.* the time spent at the level of researcher before promotion to professor. The second dataset comes from INRA's human resource management office, which collects every two years the curriculum vitae of its researchers to assess their activity. Curriculum vitae (Dietz, Chompalov, Bozeman, O'Neil-Lane, and Park, 2000; Mangematin, 2000) were used to characterize the activity profiles of researchers, from year of recruitment to a researcher position at INRA to the time of promotion to professor, or to the end of 2002 if they were still in a researcher position at that time. It should be noted that more than 50% of a cohort will never be promoted. In order to have complete information about researchers' publications, we matched our data with a third dataset. Publications data from the Science Citation Index (SCI) provides information about the number of publications per researcher per year from 1990 to 2002, and the quality index of the journal (impact factor of a specific journal per year). Using these two variables, we constructed a publication score (articles published weighted by journal quality), reflecting publishing productivity.

Table 2 lists the available variables, after matching the three data sets. Our final dataset tracks the whole careers of researchers, from their PhD until 2002. Five kinds of information were gathered: Through the administrative database and CVs, we were able to obtain information about the career (year of recruitment, year of promotion, year of defense of the "Habilitation", managerial responsibilities, and professional affiliations). Through CVs, we obtained details of individual characteristics (gender, age, university of graduation). However, personal details like marital status, the number of children and the position of the partner are not available. A careful examination of CVs gives information on the geographical mobility of researchers before their recruitment (post doc, PhD abroad, positions in another country) and after being hired (sabbatical abroad, visiting professorship, etc.). They also give information about inter-organizational mobility before and after recruitment. From CVs it is possible to get in-depth knowledge about activities that cover most of the dimensions of the researchers' work: e.g. fund raising – assessed by involvement in scientific projects as participants or principal investigator (PI); and administrative duties (dean, associate dean, etc.). The

third dataset provides us with information about scientific production and academic visibility, assessed by the quantity and quality of publications.

[Please insert table 2 around here]

Table 3 presents descriptive statistics relating to the overall sample and the sub-samples based on gender and/or rank. Among the 583 individuals in the sample, 37.4% are female and 32.4% are professors. Figures of Table 3 reflect the overall situation at INRA (*i.e.* for all disciplines): women are under represented in the most senior positions. Also from Table 3 it can be seen that the profiles of average researchers show wide differences based on gender and rank. First, in terms of rank, only 17.4% of professors are women (20 percentage points less than the proportion of women in the sample). Those that were promoted were on average recruited much earlier: in 1976 on average (rather than 1985 for the full sample). One feature need to be highlighted: first, women at the researcher level have lower publishing scores,⁵ and greater involvement in administrative activities. Second, more women are found at the researcher level, with only 15% been promoted to professor (against 43% of male researchers). The women who were promoted to professors were recruited, on average, more recently than the men. They have a higher median publishing score than the men and fewer administrative activities.

These simple descriptive statistics highlight that gender and rank together have a joint effect. By interacting these two variables, we find that in all grades, men and women have very different median profiles. A key point is that while female researchers have lower publishing scores than their male colleagues, the reverse applies to female professors. Table 3 also reveals that certain variables (for example mobility, publishing scores, etc.) are necessarily correlated with time. The longer the tenure at INRA, the higher the probability of moving, of getting published, and so forth. In order to control for this, we do not use these variables in the econometric analysis, but divide by length of tenure at INRA.

4. MODELING THE DETERMINANTS OF PROMOTION DURATION

The under representation of women at the level of professor at INRA calls for in-depth analysis of the determinants of promotion. Our estimation strategy is based on duration models rather than probit and logit models to identify the factors that speed up or slow down promotion. Indeed, the timing of promotion is important and in our case is crucial as the proportion of female has increased over the past twenty years.

The determinants of promotion duration

As employed by other empirical analyses (unemployment duration, job duration, firms' duration, etc.), we use duration analysis to model time to promotion (Gaughan and Robin, 2004). Although these data are continuous, ordinary least squares cannot be used. Indeed, duration is often censored. Censored observations occur when, at the survey date, the length of an event is observed, in spite of its duration. Specific models must be estimated to take account of censored observations (Kiefer, 1988). These models, known as duration models, are used to estimate:

- hazard rate (or risk function), denoted by $\lambda(t)$: the probability of switching of state at time t , given that the observed individual has survived until t .

- survival function, denoted by $S(t)$: the probability of surviving in a particular state after t , given that the observed individual has survived until t .

Our aim here is to test whether this gender differential remains after controlling for observed and unobserved heterogeneity. Instead of estimating the probability of being promoted, we estimate the time taken to be promoted, *i.e.* hazard rate, denoted by $\lambda_i(t)$. This hazard rate can be written as:

$$\lambda_i(t) = \frac{p(t \leq T < t + dt / T \geq t)}{p(T \geq t)} = \frac{f(t)}{S(t)}$$

where T is the length of time passed in the "Researcher" rank, $f(t)$ is the density distribution and $S(t)$ the survival function.

⁵ It must be noted that the SCI publication inventory began in 1991. In order to control for the possible artificial link between publications and entry date, we introduced into the econometric analysis an interaction

As each t is identically and independently distributed, we have:

$$DURATION_i = \frac{1}{\lambda_i(t)}$$

For example, let suppose that, each month, the probability of being promoted for a given researcher, i , is 10%. Then it would take 10 months to be promoted.

Besides, using McDowell *et al.*'s (2001) model, λ can be viewed as the probability at time t that an individual's productivity exceeds the scientific department's productivity threshold (probability of being promoted), given that this productivity is lower at least until t (probability of not being promoted until t). As both individual productivity and the scientific department's norm are latent variables, λ denotes the probability of being made a professor, given that no promotion has yet occurred.

Estimating this hazard rate involves the use of duration models (Lancaster, 1990). This methodology allows for the fact that 67.6% of the individuals are still within the "researcher" rank at the sample date, that is more than two thirds of observed duration are right-censored. We first estimated a non-parametric duration model, using the Kaplan-Meier method. This gives us the unconditional hazard rate, that is the rate without taking account of the explanatory factors of promotion duration (Figure 1). The solid line represents male hazards and the dashed line female hazards.

[Please insert figure 1 around here]

Figure 1 shows that (1) the hazard is non-monotonic, increasing on average up to 120 months, and then decreasing. Access to the professor rank is more difficult after the tenure threshold in the "researcher" position. Beyond this threshold, continuing at "R" rank seems to produce negative signals for promotion; and (2) the hazard rate for women is noticeably lower than for men, and this applies throughout their careers. The hazard functions have a similar form, but the functions for males are systematically above those for women. However, this result cannot be interpreted as evidence of a glass ceiling, because the determinants of promotion are not included in this analysis. In order to explore the so-called glass ceiling effects, it is necessary to employ a parametric model to allow both

observed and unobserved explanatory factors to be controlled for. As hazard rates are non-monotonic, we thus assumed that observed durations follow a log-normal distribution.⁶

In our parametric specification, the hazard rate, λ_i , depends on three aspects: a vector of observable characteristics X_i , an individual specific effect v_i , and an error term ε_i . The X vector includes gender, mobility characteristics, publishing scores, involvement in fund raising, and administrative activities. The v_i term is added to capture the individual unobserved heterogeneity. Several attributes are lacking, such as number of children, or characteristics of the research departments. As noted earlier, other studies have found significant effects for these variables (McDowell *et al.*, 2001). Omitting these variables, therefore, could bias the estimated gender effect. To remove this bias, heterogeneity terms are introduced. They are assumed to follow a gamma distribution ($\Gamma(v_i)$) with unit mean and variance θ .

The survival function, denoted $S(t)$, can then be written as:

$$S(t_i) = \int_{v_i} S(t_i / v_i) f(v_i) dv_i$$

with :

$$S(t_i / v_i) = \Phi[-\sigma \ln(\lambda_i t_i)], \text{ where } \lambda_i = e^{-\beta' X_i}$$

$$f(v_i) = \frac{k^k}{\Gamma(k)} e^{-kv_i} v_i^{k-1}, \text{ where } k = \frac{1}{\theta}$$

From this general specification, three different models are estimated. Model 1 assumes that unobserved heterogeneity terms are zero ($\theta = 0$), while model 2 relaxes this assumption. In model 3 we test for interaction terms between gender and the other explanatory variables, to explore multiple mentoring dimensions. This should allow us to control for multicollinearity. For each estimated model, robust t-statistics are calculated (White, 1982). Table 4 presents the estimated effects of covariates on the promotion duration. A significant and positive sign for a given X then highlights that, *ceteris paribus*, having the characteristic X increases the promotion duration.

⁶ Various specifications for distributions of durations (log-logistic, weibull, etc.) were tested. The results are not affected by this choice.

[Insert Table 4 about here]

First, we focus on the importance of taking into account the unobserved heterogeneity. Model 2 provides an estimate of the θ parameter, which is significantly different from zero. This indicates that unobserved factors must be taken account of in the model. We therefore prefer model 2 over model 1, since neglecting the v_i terms would introduce bias into the estimated effects, including gender impact. More precisely, this would lead to a slight overestimate of the gender effect. Models 1 and 2 indicate significant and positive effects of gender, but the estimated coefficient is slightly higher in model 1 than in model 2. Model 2 indicates that it takes longer for the "average woman" to be promoted. Surprisingly, the weighted number of publications has a negative effect on the promotion duration. However, number of publications per year in relation to hiring date has a positive effect, as has the holding of an administrative position. These effects are inconclusive. This is due to the fact that observed and unobserved heterogeneity are taken into account in model 2. Among the differences we can see that women have lower predicted hazard rates in only the first half of their careers, not over the whole length of their careers (in contrast to figure 1). The gender gap appears after 50 months of tenure. Furthermore, women have slightly higher hazard rates from 180 months onwards. Surprisingly, there is no cohort effect. Cohort effects are estimated by the variable year of recruitment ("RECRUIT_Y") which is never significant.

Table 4 highlights the role of additional variables in the time to promotion. Organizational mobility before INRA recruitment speeds up the career as does the holding of a managerial position. Table 4 shows that promotions are also influenced by hierarchy. Indeed, deans and team leader are chosen according to hierarchy. Even though hierarchy does not directly influence promotion, it does have an indirect effect by choosing team leaders and dean. Table 4 reveals the role of the hierarchy in the speed of promotion. Does it introduce any discrimination?

Sex difference in promotion criteria

The results of model 3 show that gender does not have a uniform effect on promotion duration, but interacts with other covariates. "Speeding-up" and "slowing-down" effects are present and are presented in Table 5.

[Please insert table 5 around here]

Model 3 shows evidence of interaction between gender and other covariates. This suggests that gender affects promotion duration directly and indirectly through the effects of explanatory factors of promotion. For women, connection with different networks plays a crucial role. For the whole population, organizational mobility speeds up promotion. But for women, other factors have an effect: three factors have speeding up or slowing down effects for women:

Women who have graduated from top universities of being are likely to be promoted sooner than those who have graduated from other universities. This is a pure interpersonal network effect, which speeds up the career in academia. Gaughan and Robin (2004) found that graduation from top universities increases the probability of recruitment after the PhD.

Mobility has a balancing effect: postdoctoral fellowships and institutional mobility after recruitment to INRA significantly slows down the promotion process, while international and organizational mobility before recruitment speed up career progress. This underlines that mobility is important, but mostly before recruitment to INRA. After recruitment, it is the involvement within the institution that matters, as shown by the positive effect of occupying a managerial position within the institute (BOSS). Before being recruited, scientific networks play an important role while after the recruitment, internal networks are more important. The hierarchy within INRA identifies those who can play a managerial role and gives them positions. The holding of these positions speeds up the careers of researchers. The effect was even stronger at the beginning of the period (before the 1990s).

Acting as a PhD supervisor increases the chances of a woman being promoted to a professor position. Like the PhD dissertation, writing the habilitation dissertation implies a dyadic relationship with the

habilitation advisor. This dyadic relationship is in fact a mentoring relationship. The habilitation advisor is chosen from amongst those seen as being able to help the researcher in her/his career, to define stimulating and “publishable” research avenues, and finally to connect her/him to the “good” networks.

Sex differences play a role in speeding up or slowing down time to promotion. There is neither a clear discrimination nor a glass ceiling effect, but rather a sum of involvements which prove to be higher for women than for men. Women academics need to demonstrate higher performances than their male counterparts. And, if in line with most other contributions on gender, it appears more difficult for women to be very mobile, or heavily involved in the life of the organization because of greater family responsibilities.

CONCLUSIONS

Based on duration models designed to track the sex differences in promotion criteria, our contribution highlights that promotion to professor is linked to different criteria for male and female academics. To be promoted, women have to demonstrate greater involvement in the different dimensions of scientific activities than men. This work also underlines the indirect role of hierarchy in the promotion process. Indeed, it is mainly through internal networks and mentoring that researchers are chosen to be team leaders or deans.

This paper reveals that, even in a national laboratory, careers are influenced not only by the number of publications, but also by personal involvement in different dimensions, research management, fund raising and research. Interpersonal networks and mentoring appear to be important in the speed of career progression although their impact is indirect, mostly through external and internal networks. The analysis reveals sex differences in promotion criteria which handicap women’s career progression.

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