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academic systems: an analysis of
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Career progress in centralized academic systems: an analysis of French and Italian physicists.

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Abstract

We examined the career profiles of a large sample of French and Italian academic physicists between 2000 and 2003 (France) or 2005 (Italy). In particular, we show that rank advancements are explained by individual variables (such as productivity, seniority and gender) as well as institutional and relational ones (respectively, the affiliation of the scientist's laboratory to important public research organizations, and the scientist's social ties with senior members of the discipline, who exercise control over careers). We find significant differences between the two countries. In particular, scientific productivity and gender are better predictors of advancement in France, while social connections apparently play a major role only in Italy.

JEL codes: I23, J45, M51

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1. Introduction

In the past 15 years or so, the number of empirical contributions to the economics of science has grown considerably (Audretsch et al., 2004). This literature has focused especially on the rate and direction of university research and on how the latter may be affected by changes in university funding patterns (Geuna, 1999) as well as by the spread of commercialization practices (see surveys by Geuna and Nesta, 2006; Siegel et al., 2007). Several essays have also dealt with the issue of scientific productivity and its determinants at an individual level (Stephan and Levin, 1992; Azoulay et al., 2007; Breschi et al., 2007; Hall et al., 2007). None of these studies, however, has examined explicitly the issue of academic careers (for an exception, see Ehrenberg, 2003); only if we leave the economics of science literature do we find isolated contributions from economists who are interested in the analysis of recruitment examinations in their own discipline (Perotti, 2002; Ginther and Kahn, 2004; Combes et al., 2008).

More generally, such economic studies in the economics of science have taken on board, without much discussion, the classical sociological analysis proposed by Merton (1957), as reformulated by Dasgupta and David (1994). Indeed, the coupling of classical sociological assumptions and economic analysis is a distinctive mark of what many now identify as the “new economics of science” (Stephan, 1996). According to such a perspective, scientists progress in their career to the extent that they are given credit for their contribution to knowledge advancement. Credit for such a contribution must be obtained from one’s own academic peers, who rely for their judgement on each individual scientist’s publication record (so that an incentive system comes into place that forces the disclosure and diffusion of data, methods and discoveries).

Although generalizing along these lines is still valid, this theory is not without limitations. Issues related to gender, stratification (by departmental prestige), and social capital may have a part in explaining the progression of scientific careers. These factors may combine with increasing returns to reputation (the ‘Matthew effect’) to create career trajectories that reward disproportionately those scientists who obtain early success (Merton, 1968 and 1988). While a few empirical studies have explored such issues for the US academic labour market (most recently, Long et al., 1993; and Long and Fox, 1995), almost no work has been carried out in European countries, where the institutional setting is both heterogeneous and altogether different from that in the USA.¹

In this paper we aim to fill this empirical gap. In order to do so, we update the conceptual framework of the Mertonian sociology of science (as received from the new economics of science), and examine

¹ Again, a few exceptions are the occasional self-referential studies by economists on the career prospects within their own discipline, such as Checchi (1999) and Perotti (2002) for Italy, Combes et al. (2008) for France, and Coupé et al. (2006) for the USA.

the cases of France and Italy. This requires tailoring the notions of stratification and social capital to the institutional features of academia in the two countries. In both countries, academic advancement is heavily controlled by central government *via* disciplines, the latter to be intended as state-sanctioned guilds of professors, over which universities and departments exercise little control. In addition, both countries host large and powerful public research organizations (the CNRS, *Centre Nationale de la Recherche Scientifique*, in France; and the CNR, *Centro Nazionale delle Ricerche*, in Italy), which act as important channels of funding and legitimization for academic research.

In Section 2, we provide a brief summary of the relevant literature and the key determinants of academic careers it proposes; we also discuss briefly the specificities of Italian and French academic career paths and the consequences they bear for our analysis. In Section 3 we describe our data and methodology. In Section 4 we illustrate the results of our empirical analysis, and Section 5 concludes.

2. Determinants of academic careers: background literature and the cases of France and Italy

In this section, we discuss the key determinants of rank advancement in science, as they emerge from the empirical literature (Section 2.1) and from our own interpretation on the specificities of the recruitment processes in France and Italy (2.2). From the discussion, we derive a number of hypotheses to be tested by the regression analysis that follows.

2.1 Background literature

Both the classical sociology of science and the new economics of science have devoted considerable effort to examining the determinants of *scientific productivity*. The latter is considered to be affected both by biographical variables (such as a scientists' age and gender) and by several "institutional" or "social" variables, such as departmental prestige and the role of 'invisible colleges' (Crane, 1965; Hargens and Hagstrom, 1967; Clemente, 1973; Allison and Stewart, 1974; Reskin, 1977, 1978; Long 1978; Cole, 1979; Allison and Long, 1990; Levin and Stephan, 1991; Xie and Shaumann, 1998; Hall et al., 2007). However, much less attention has been paid to the effects of productivity on academic careers, possibly because of data constraints or because of the common assumption that productivity and career are inextricably linked (Hollingshead, 1940).

Only a few studies have analysed the two concepts separately, and highlighted explicitly the mechanisms that drive the recruitment process. As Caplow and McGee (1958, p. 109) observe:

A distinction must be made between the two kinds of recruitment in general use - "open", or competitive, hiring and "closed", or preferential hiring. In theory, academic recruitment is mostly open. In practice, it is mostly closed.

Four dimensions of career success can be considered: participation, position, productivity, and recognition (Long and Fox, 1995). In this paper, we focus mainly on position, expressed by rank advancement within or across organizations. In this respect, most of the empirical work has focused on either biographical or individual determinants (seniority, productivity, gender). More rarely, some consideration has been given to institutional and social variables (departmental reputation, sponsorship, inbreeding).

Seniority and scientific productivity

In many jobs, career progress is a matter of time: seniority is rewarded (either formally or informally) with promotion. Academic jobs are no exception (Long et al., 1993, Modena et al., 1999). The time spent by a scientist at a given academic rank is always found to be one of the most important factors determining chances of promotion, either directly (more senior researchers stand higher chances of being promoted, *ceteris paribus*) or indirectly, via scientific production (more senior scientists stand a chance of accumulating a longer list of publications, which may be of help in getting promoted).

Scientific productivity

Classical sociologists of science have long studied scientific productivity, and invariably confirm Lotka's (1926) original results: whenever a large or random sample of scientists is considered, the distribution of scientific productivity is found to be highly skewed to the right. This means that a small minority of highly productive scientists is responsible for the majority of scientific publications, especially of those with large or at least meaningful impact (as measured by citations).

Productivity therefore has also been analysed in relation to rank advancement in academic careers, in particular to try and distinguish the effect of quality versus quantity.

While the impact of quantity is beyond doubt (see, for example, Clemente, 1973), the role of quality is more controversial, usually measured by citations to a paper or journal (impact factor). Hargens and Farr (1973) find that the number of citations received is positively associated with promotion, but their results are not confirmed by other works (such as Long et al., 1993).

Gender

The finding that women are at a disadvantage in terms of career progress is a recurrent one (Everett, 1994; Modena et al., 1999). Gender affects the probability of promotion both indirectly, through the channel of scientific productivity,² and directly. Long et al. (1993) find that even after controlling for

² Gender differences in productivity have attracted the attention of both sociologists and economists (Reskin, 1978.; Cole, 1979; Stephan and Levin, 1992; Prpic, 2002; see also Modena et al., 1999). Several reasons have been put forward to explain why women appear to be less productive than their male counterparts (Xie and Shaumann, 1998; Zainab, 1999): more limited access to relevant social networks (women are more isolated and excluded from "old boys'" social circles; Cole and

productivity, women scientists have a lower promotion probability. Similar results have been found by Cole (1979), Everett (1994) and Modena et al. (1999).

Departmental prestige

Many empirical studies show the importance of departmental prestige for a successful career. On the one hand, graduating and working in a prestigious institution gives visibility and access both to information and to knowledge embedded in other productive scientists, which makes promotion easier, especially if associated with mobility across universities. On the other hand, more prestigious university departments apply more stringent criteria for promotion, which makes internal promotion harder to achieve (Long et al., 1993). Longitudinal studies find evidence that departmental reputation affects productivity and that changes in departmental location are associated with changes in productivity (Allison and Long, 1990). They also find that the ranking of PhD education is one of the most useful predictors of success in academia, where success means getting a job in a highly-ranked academic institution, even after controlling for productivity (Hargens and Hagstrom, 1967).

Stratification by PhD-granting institutions may also be interpreted as a consequence of the Matthew effect, according to which scientific credit is more easily recognized by those scientists who already enjoy it, than by non-tested or less-tested ones (Merton, 1968). Long et al. (1979) find evidence that entry into an academic career does not depend on scientific productivity, if one controls for the effects of doctoral origins and the prestige of a junior scientist's mentor.

Mentoring

The 'mentor' is typically a senior member of an organization who commits to facilitating the careers of his (or less often her) students or junior colleagues (Kirchmeyer, 2005). Mentors may influence the career success of their students and colleagues either indirectly by improving their *protégés'* performance, and/or directly by introducing the *protégés* to their own social network and providing contextual signals of reputation and ability (Kram, 1985; Ferris and Judge, 1991).

Reskin's (1979) study on academic chemists suggests that the direct effect of mentoring is quite relevant during the early years of a scientist's career. Kirchmeyer (2005) obtains similar results for a sample of American accounting academics.

Inbreeding

Academic 'inbreeding' occurs whenever an academic institution tends to recruit its scientists chiefly from among those who took their degrees within it, either at the undergraduate and/or at the graduate

Zuckerman, 1984); less interested in pure research; lower graduation rate from prestigious universities; more severe family-career trade-offs.

level. Inbreeding has been viewed as an expression of academic particularism. However, McGee (1960), through an investigation of the junior faculty of the University of Texas, found that 29 per cent of the full-time professors had a University of Texas degree and justified the use of inbreeding for financial reasons and geographical isolation. In this view, inbreeding can be seen as an efficient way for selecting people, in proper circumstances.

The relationship between academic inbreeding and scientific performance has been examined by Hargens and Farr (1973). For scientists in their first academic job, no relationship appeared to exist between their academic origins and scientific performance (either at the quantity or quality level). For scientists at their second and/or successive career step, it is found that those “who have been inbred throughout their careers [...] tend to be less productive” (Hargens and Farr, 1973, p. 1392). Hargens and Farr (1973) also look at how many years it takes for an assistant professor to be promoted to an associate position, and find that inbred scientists wait for longer than others, even after controlling for differences in terms of productivity.

Social capital

The existing literature suggests that social connections affect promotion chances indirectly through productivity. Gonzalez-Brambila et al. (2006) find that networks promote the creation of new knowledge, by granting greater access to resources and information: the individuals who occupy central positions in their academic network have a propensity to create more knowledge, while the number of ties has a positive impact on future productivity.

It is possible to hypothesize a direct relationship, in particular through two different channels:

1. Following again Gonzalez-Brambila et al. (2006), it is reasonable to assume that universities, after deciding to fill a vacancy, give positive consideration to the candidates' academic networks, to the extent that the latter may add to the university's visibility and access to resources; however, no author has apparently investigated this possibility, either theoretically or empirically.
2. The individual with a strong network position may be perceived as more influential within the scientific community (Kilduff and Krackhardt, 1994). As individual performances are often hard to evaluate only on the basis of past scientific production and citations (especially when recent publications are considered), prospective recruiters may look for other signals of quality, such as the position of the scientist in his or her community, and the influence he/she is expected to exert on his/her peers.³

One should note, however, that when it comes to the empirical analysis of junior scientists' careers it may be hard to distinguish these network effects from mentoring. Junior scientists working in

³ For some evidence in this direction, albeit not within the academic realm, see Seibert et al. (2001)

association with influential mentors will tend to occupy a more central position in the social network than other colleagues of the same age and with similar productivity. As a result, it will be hard to say whether their higher promotion chances are explained, *ceteris paribus*, by the recruiters' consideration of their social capital, or by the influence exercised by their mentors on the recruiters.

An important issue related to social capital is that of measurement. Social network analysis based upon co-authorship data has a long tradition of application in the sociology of science, dating back to the early identification of 'invisible colleges' (Crane, 1965 and 1972), up to the recent application of small-world theory to the description of collaboration patterns (Newman, 2001).⁴ Co-authorship is usually seen as proof of collaboration and knowledge exchange between two or more scientists. However, more complete measures also take into account sociometric information, such as the individual scientist's dependence on another for advice or mentoring. In our study, in the absence of sociometric data, we will make use of refined bibliometric indicators aimed at capturing (at least partially) the same type of information.

2.2. Academic careers in France and Italy

As one can easily gather from checking the references in the previous section, most of the applied and quantitative literature on academic careers derives from US scholars, whether economists or sociologists. As stressed by many authoritative studies (Ben-David, 1977; Clark, 1993) however, the US system has unique features in terms of university autonomy and academic labour market mobility. Universities select candidates for professorial jobs in total autonomy, with no control from the central (federal) or state governments. Once selected, professors become university employees and can bargain for their wages and working conditions on an individual basis (as opposed to many of their colleagues in Europe, who are civil servants in the public administration, whose wages are set or capped by law). In addition, the sheer number of US academic institutions, together with a competitive funding system, allow US-based scientists with a strong publication record the opportunity to move from one university to another in search of better paid, or better funded research positions (Ehrenberg et al., 1990). Finally, the system is openly stratified according to the research *vs.* teaching intensity of the academic institutions, and the latter's wealth: two- and four-year colleges follow different recruitment criteria to the 200 or so "research universities",⁵ and the latter differ widely in terms of financial resources, with private institutions most often being in a better-off position than the public ones.

⁴ For a different approach to the social network analysis of science, see Mullins et al. (1977), who base their graphs on co-citation patterns. For a different use of co-authorship data, see Gonzalez-Brambila et al. (2006)

⁵ Research universities are commonly identified as those granting PhDs, and are ranked according to a number of criteria. The original classification was proposed in 1970 by the Carnegie Commission of Higher Education, which has updated it since then (<http://www.carnegiefoundation.org/classifications/>)

On the contrary, both the Italian and French academic recruitment processes derive from a mix of state control and professional corporatism. As such they represent, at an extreme level, the common situation throughout Europe. All French and Italian professors are civil servants, whose recruitment regulations, duties and wages are fixed by national laws, and cannot be bargained for at the local level, let alone the individual one. The French academic system has two main positions called “*Maitre de conference*” (MCF) and “*Professor*” (PR). In Italy there are three positions called “*Ricercatore universitario*” (RU), “*Professore associato*” (PA) and “*Professore ordinario*” (PO). Here we are concerned mainly with career advancements, from MCF to PR in France, and from RU to PA or PO in Italy.

All positions are tenured, and for all of them salaries are defined by national laws. All academic personnel are classified by the government according to their discipline. Disciplines fulfil a role similar to professional guilds: their members, and not individual universities or departments, retain formal control over the recruitment process.

In Italy, disciplinary classification is very detailed, and it is negotiated periodically between the Ministry and the leading senior professors of the country. Over the past 20 years, the classification system has grown larger and more fragmented, and at present it includes more than 170 disciplines just for science, medicine and engineering alone.⁶ Any university wishing to fill a vacancy or simply to offer a new position has first to specify for what discipline the position is offered; then it has to launch a call for applications (*concorso*) and set up an examining committee. All the committee members must belong to the same discipline for which the position is offered; one of them is chosen by the university, most often from among the internal faculty, and two to four others are elected with a national secret ballot by all professors ranked as high, or higher than the position on offer, also from the selected discipline. Nominally, the commission does not have the task of picking the most suitable candidate for the university that launched the call (on the basis, for example, of the candidate’s and the university’s research interests coinciding), but the best possible candidate in absolute terms, who should be the one with the best publication record (called “*idoneo*”, which means *fit-for-the-job*). In principle, if the university does not like this candidate, it can always refuse to nominate him/her and launch a new job call. In practice, most commissions try to steer the selection process towards candidates who they know

⁶ Overall there are no less than 300 disciplines; some of them, such as “*Naval Architecture*” and “*Naval and Marine Engineering*” – notice they are considered separately - counted less than 30 affiliates in 2005.

will be acceptable to the university.⁷ In some job competitions, the commissions are also allowed to declare two winners (two *idonei*), only one of which will be selected by the university.⁸

The French recruitment system follows different procedures for different disciplines, the most notable differences being between the natural sciences and the social sciences, including humanities and law. Differences also exist between procedures for the recruitment of “*Maitres de conférence*” (MCFs) and “*Professors*” (PRs). For MCFs seeking promotion to PRs in physics (who are studied in this paper), the so-called *concours* runs over two phases. The first phase, called “*qualification*” is centrally managed by the National Council of Universities (*Conseil National des Universités*, CNU), an overseeing body under governmental control. The second phase, on the contrary, is up to the individual universities that have to fill the vacant positions.⁹

The CNU is divided into sections and each section has to evaluate the candidates in each single discipline. Each CNU section is made up both of members elected by the professors in the discipline, and of members appointed by the minister. All members serve for more than one year. As in the Italian system, professors are classified according to their disciplines, although the latter are not divided up into as many categories (there are 73 of them overall). Each year, the CNU releases a list of “qualified” candidates on the basis of their publication and teaching records.

In the second phase of the recruitment process, the qualified candidates apply for professorial jobs at local institutions (after four years, candidates who have not found a job lose their qualification). Each university has recruitment committees (*commissions de spécialistes*) devoted to the evaluation of applicants, one for each discipline or at least for each group of related disciplines in small universities. The committees, elected every four years, are composed of members of the faculty and invited members from other institutions or disciplines.

⁷ This requires a lot of political background work to be done by the university, in order to steer the secret ballot in the direction of selecting at least a majority of external commissioners on good terms with the university. Once that result has been achieved, those commissioners will take care of letting some prospective candidates know their presence would be an embarrassment to the commission (these are typically those candidates who have a strong publication record, so that they could be potential winners, but are not considered suitable by the university issuing the *concours*). On the long-standing importance of such practices in the Italian academic system, see Clark (1977).

⁸ In this way, the examining commission is free to let both the strongest candidate and a local insider win. Then the latter will be chosen for the job, and the former will possibly be called by some other university. A controversial rule, in fact, allows fit-for-the-job (*idonei*) candidates, who have not been recruited, to be offered a job position by other universities, which in this case will be exempted from the duty of launching a national call for applications. Needless to say, this possibility is often exploited for more political bargaining among the professoriate: external commissioners may agree to trade the nomination of a local candidate from the university which has issued the job call, in exchange for a ‘fit-for-the-job’ certificate for another candidate, who they wish to recruit in their own university (Moscati, 2001).

⁹ For the physical or natural sciences, in France, promotion from MCF to PR can be granted only to prospective candidates who have obtained a qualification to act as PhD supervisors (*Habilitation à diriger des recherches* or HDR). MCFs obtain such a qualification from the same university where they are employed, upon presentation and discussion of a synthesis of the research work they have produced over the years. However, holding a HDR does not change the scientist’s wage and duties, nor does it guarantee promotion to PR. In social sciences and law, the HDR requirement is superseded by the possibility of sitting a special examination at a national level (*Concours d’agrégation*) which leads directly to the PR position.

So, the main difference between Italian *concorsi* and French *concours* lies at the qualification stage. While French candidates achieve it through a committee which is both national and under some degree of ministerial control, in Italy the qualification has to be obtained through strategic agreements among members of the many commissions scattered across the individual universities.

Both the Italian and the French recruitment systems have been severely criticized in recent years, resulting in a succession of reforms shifting the balance of decision-making in recruitment matters back and forth between national and local levels (Moscati, 2001; Musselin, 2005). None of these reforms, however, has gone as far as to grant universities total freedom in recruitment matters, or to re-establish total control by government. As for the role of disciplines, this has possibly increased in Italy, due to progressive fragmentation, which makes it easier to control elections.

This brief examination of the recruitment process in the two countries suggests a few observations on the factors affecting academic careers, as derived from the US-centric literature we examined in Section 2.1.

Length of career, in principle, should not affect rank advancement chances, since seniority does not enter the examination criteria of *concorsi* either. On the contrary, productivity should be a key determinant of career advancement in both countries, and more so in Italy than in France.

The egalitarian norms typical of French and Italian legislation forbid the consideration of departmental prestige as a factor to be evaluated by the examining commissions: all PhD titles have to be considered equal, since no official ranking of universities or department exists, and no unofficial information can be deemed as relevant by examiners. Similarly, mentoring should have no role, since no reference letters are admitted into the process. However, in the Italian system, mentors may either lobby in order to be elected onto the examination committee, or ensure that some close colleagues of theirs are elected in their place, so they can exert direct influence on the recruitment process. In France, this result is also possible but harder to achieve, as the national examination committee is not entirely elected, and the disciplines are too large for their members' voting intentions to be easily steered. Both in France and in Italy, in addition, departments are visibly ranked according to the strength of their ties to the two largest public research organizations, respectively the CNRS (*Centre Nationale de la Recherche Scientifique*) and the CNR (*Centro Nazionale delle Ricerche*). In France, the CNRS has traditionally played a more important role in research than universities. It receives the largest portion of research funds from the government, some of which it redistributes to academic scientists via collaborations and partnerships. However, since the 1970s, policy-makers have pushed for a better integration of the CNRS and academic research structures. Nowadays, the CNRS operates mainly through laboratories located within universities, and universities compete to host such laboratories. As a result, departmental laboratories are nowadays ranked according to a vertical hierarchy: at the top (by prestige and

resources) we have the laboratories staffed only by CNRS personnel and funded directly by the CNRS and the Ministry of Education; then, those staffed by both CNRS and university personnel (known as UMR, *Unité Mixte de Recherche*); and finally those exclusively staffed by university personnel, with little or no access to CNRS funds (Mustar and Laredo, 2001).¹⁰ In Italy, CNR laboratories do not, in general, have the same importance as their CNRS equivalents. However, in nuclear physics, the CNR often controls key research tools and infrastructures, so that participating in their research programmes is, for academic scientists, a necessary precondition of conducting research. In material physics, a similar role is played by the INFN (*Istituto Nazionale di Fisica della Materia*), a research organism that was for a long time independent of the CNR (it was absorbed by the latter only in 2005). The INFN operates via a network of laboratories, all except one of them located within different universities and staffed by academic personnel. Such a *modus operandi* creates a hierarchy not dissimilar to the one we described above for the CNRS in France.

Inbreeding is a major force behind recruitment in both countries. Again, in principle, it should not be so, but in practice all peripheral universities face the problem of fending off candidates who, although qualified, would not be dedicated to the institution. This situation is due to the civil servant status of professors in both countries: a professor's salary profile over time does not depend upon the university's decision, but is fixed by law and linked exclusively to seniority; universities have no power to fire absentee professors, or to moderate the balance between their research and teaching duties according to the university's needs (teaching loads are also determined by law). So, brilliant scientists from top universities (or foreign ones) are seen by peripheral, teaching-oriented universities as a threat: once recruited, they try to spend as little time as possible locally, in order to maintain informal research ties with their *alma mater* (Musselin, 2005). Accordingly, more peripheral universities will try to play the system in order to push forward their internal candidates, rather than recruiting external ones.

As for gender, no apparent reason exists to think of peculiarities for France and Italy with respect to the US-based evidence at hand. However, a quick look at available statistics show women are under-represented at the higher levels of the academic ladder.

Finally, as far as social ties are concerned, one should note that in the French and Italian systems they do not only serve the purpose of information sharing and knowledge creation. Prospective candidates for professorial positions have an incentive to nurture ties with senior members of their discipline, the latter being very likely to sit on their examination boards. This ought to be especially true of Italy, where both stages of the recruitment process are in the hands of local committees. When attempting to

¹⁰ In the life sciences, the role of the CNRS is often taken by INSERM (*Institut National de la Santé et de la Recherche Médicale*). Similarly, in more applied disciplines other public research organizations may play a similar role (as is the case of INRA, *Institut National de la Santé et de la Recherche Médicale*, for agricultural studies). We focus on the role of the CNRS due to its dominant influence on physics, to which our data will refer

measure the importance of junior scientists' social capital, an effort should be made to distinguish between contacts that have the potential to increase a scientist's productivity (such as those described in Section 2.1), and those that are more instrumental, and serve the purpose of linking up with decision-makers at a disciplinary level.

3 Data and methodology

This section provides a description of the data and the model we will use to assess the determinants of academic promotions in France and Italy. Section 3.1 outlines the covariates and some statistics about their distributions. Section 3.2 shows the statistical models estimated.

3.1 Data

The data collected for this paper are drawn from a complete list of Italian and French academic scientists active in the academic year 2004/2005, which we obtained from the Ministries of Education in the two countries. In particular, we focus our attention on physics, with particular emphasis on material physics. Due to the need for reconciling differences in the French and Italian classification system of disciplines, we were forced to use quite broad disciplinary categories, so that our sample ended up including also a large number of nuclear physicists (although not the majority of them; no astrophysicists were included).¹¹ We concentrate on rank advancements between 2000 and 2005 for Italy, and between 2000 and 2003 in France (that is, our dependent variable is the promotion for which a scientist may apply).

We recall from Section 2.2. that steps in an academic career are country-specific. The French academic system has two main positions called “*Maitre de conference*” (MCF) and “*Professor*” (PR). In Italy there are three positions called “*Ricercatore universitario*” (RU), “*Professore associato*” (PA) and “*Professore ordinario*” (PO). Since a direct comparison between the careers of academic scientists in the two countries cannot be made without an aggregation of two of the three Italian positions, we decided to compare the promotions from MCF (in France) and RU (in Italy) to higher ranks; and to examine separately the promotion from PA to PO (which applies only to Italy).

¹¹ The disciplinary fields we considered, as described by the extant classifications, are, for France: *Milieux denses et materiaux* (28) and *Milieux dilues et optique* (30); for Italy: *Fisica Sperimentale* (Fis/01), *Fisica Teorica, Modelli e Metodi Matematici* (Fis/02), *Fisica della Materia* (Fis/03) (codes in brackets are from the classification systems). Other physics-related fields which are present in the two countries' classification system, and which we excluded, are, for France: *Constituants elementaires* (29) and *Astronomie & Astrophysique* (34); and, for Italy: *Fisica Nucleare e Subnucleare* (Fis/04), *Astronomia e Astrofisica* (Fis/05), *Fisica per il Sistema Terra e il Mezzo Circumterrestre* (Fis/06), *Fisica Applicata* (Fis/07). For Italy, we also did not consider a number of classes within the engineering disciplines.

The main reason for this choice is that academic careers (acquisition of the MCF or RU rank) start roughly at the same age (33 years, on average) in both countries (see Table A1 in the Appendix); this allows us to consider a uniform starting point for admission to higher ranks. However, the age structure of MCFs and RUs is not the same, the former usually being younger than the latter. Therefore, in order to increase comparability, we excluded from both the MCF and RU samples those scientists who were either too young or too old to be considered for promotion, namely those younger than 30 or older than 50. This leaves us with a total number of scientists in our sample of 1285, of which 816 French and 469 Italian. Of these, less than 14 per cent were promoted to a professorial position in France, as compared to 45 per cent in Italy, with differences across disciplines for Italy (see Table 1 and Table A2 in the Appendix). Most of the promoted scientists did not change affiliation after promotion: only 20 per cent changed university in France, and less than 6 per cent in Italy. Some gender gap also appears to be significant, and it is more visible for France.

[TABLE 1 NEAR HERE]

We then went on to build three classes of explanatory variables: individual (productivity, inbreeding, age, and gender), stratification-related (that is, proxies of departmental prestige), and mentoring- or social capital-related (which we derive from analysis of co-authorship patterns). A complete list of these variables is reported in Table 2.

[TABLE 2 NEAR HERE]

3.1.1 Individual covariates

As discussed in Section 2, scientific productivity is nominally the main determinant of rank advancement in both Italy and France. Publications in national and international scientific journals are widely recognized to be an indicator of the scientist's research productivity although other measures exist such as, for example, books and book chapters or, in some fields, patents and prototypes. In order to identify those publications we rely upon a database we compiled from the ISI-Web of Science, which contains all scientific articles published between 1975 and 2000, authored by at least one professor of physics active in an Italian or French university during the academic year 2004/2005. We consider only articles published in journals with an impact factor higher than 0.5.¹²

¹² The impact factor of a scientific journal is calculated by “...dividing the number of times a journal has been cited by the number of articles it has published during some specific period of time. The journal impact factor will thus reflect an average citation rate per published article...” (Garfield, 1972). We consider the average impact factor of each journal calculated as in the latter definition in a time window of 5 years. The first year of observation varies according to the journal and, on average, we observe citations in each

We do not distinguish between quality and quantity of the publications, but we use a summary index that accounts for both these features. First, we weigh each publication for the impact factor of the journal. Second, we take into account multiple authorship by assigning to each individual author a fraction of publication, which we calculate as $1/(1+\alpha)^{aut-1}$, where α is a parameter greater or equal to zero, and aut is the number of co-authors of the publication considered. Equation 1 shows the productivity measure of scientist i between the time interval (t_0, T) :

$$Productivity_{i,t}(\alpha) = \sum_{a=1}^{n_i} \frac{imp_a}{(1+\alpha)^{aut_a-1}} \quad (1)$$

where articles are indexed from $a=1$ to $a=n_i$, n_i is the number of articles signed by scientist i from the beginning of his/her career up to the year t ($\alpha=1999$, in our application) $imp_{a,i}$ is the impact factor of the journal where article a is published, and $aut_{a,i}$ is the number of co-authors of a .

We experiment with different values for α , such as $\alpha=0$ (each publication is assigned to the scientist in its entirety, no matter the number of co-authors) and $\alpha=1$ (which is such that a publication with two co-authors counts for exactly half a publication, while a publication with $n>2$ co-authors counts for a fraction smaller than $1/n$, which declines faster than $1/n$ as n grows).

We also experiment with the simple count of publications (*Articles*) over the time interval (t_0, T) , a measure that does not take into account the number of co-authors nor the impact factor of journals. Correlation matrixes in the Appendix (Table A4a,b) show that all such measures of productivity are highly correlated.¹³

[TABLE 3 NEAR HERE]

Table 3 (which reports descriptive statistics for all the covariates) shows that, whatever adjustment we make to the index, the productivity of Italian scientists appears to be more than three times higher than that of their French colleagues, with a higher standard deviation. In a few regressions we also control for cross-disciplinary differences in productivity by adjusting the productivity index for the average productivity in the discipline, as shown in Equation (2)

$$Relative\ Productivity_{i,t} = \frac{Productivity_{i,t}(a=1)}{Average\ Productivity(a=1)_{discipline,t}} \quad (2)$$

journal for a period of 13 years. The complete list of selected journals is available on request, while a selection of the most relevant ones (by number of articles published by scientists in our sample) is reported in the Appendix (Table A2)

¹³ We also experimented with citation-weighted article counts, where each publication was multiplied by the number of citations it received up to 2008 (our data do not allow us to classify citations according to the year of publication of the citing article). The regression results did not change much (and are available on request).

Other variables of interest at the individual scientist's level are age (which we treat as a proxy for the scientist's career length)¹⁴ and gender. Table 3 shows that French MCFs are on average younger than Italian RUs, even if they reach that position (on average) at the same age of 33 (see Table A1 in the Appendix): this is due to the higher recruitment rates of MCFs than of RUs.

3.1.2 *Stratification by departmental prestige*

We measure stratification by means of a set of variables based upon information on scientists' affiliation, as derived from the ISI-Web of Science records.¹⁵ Each ISI record lists, in separate fields, the author's or co-authors' names, and affiliations at the department or laboratory level, with information on whether the department/laboratory is affiliated to the CNRS for France, and the CNR or INFN for Italy. Unfortunately, there is no one-to-one correspondence between names and affiliations. As a consequence, we cannot derive from publication records the exact affiliation of each scientist; at most, we can say that either the scientist and/or one or more of her co-authors belong to such types of research units. However, this is still quite a useful piece of information, because at the very least it signals some connection between the latter and the scientist.¹⁶

For each French scientist, we build a *CNRS* variable, which represents the percentage of a scientist's papers (from 1995 to 1999) which list at least one CNRS or UMR affiliation. Similarly, for Italy, the *CNR* and *INFN* variables measure the percentage of papers with at least a CNR or INFN affiliation.

3.1.3 *Social capital covariates*

The most intuitive form of social capital relates to inbreeding, which we defined in Section 2 as a tendency of several universities to recruit higher-ranked scientists from within their own departments. Data in Table 1 have shown how little mobility we observe in Italy, which is a sign of inbreeding. In order to capture this effect we consider how well positioned a prospective candidate is for promotion in the university to which he/she is affiliated (and where he/she stands the best chances of being promoted, as discussed in Section 3.1). In particular, we measure *Inbreeding* as the ratio between the

¹⁴ In the absence of information on their actual date of completion of PhD studies, we assume all scientists start their academic career at 25 (which is the lowest possible age of completion of a PhD, for students who followed standard lower and higher education curricula). As a consequence of assuming the same starting year of careers for all scientists, we have perfect correlation between a scientist's career length (measured in years) and age.

¹⁵ Our lists of scientists, obtained from ministerial records, also list the scientists' affiliation, but only at the university level. That is, they do not provide information on the specific department to which the scientist is affiliated, nor on the association between such departments to the large public research organizations from which prestige and resources may derive.

¹⁶ In particular, for France, affiliation information may contain references to either the CNRS or UMR, which signal respectively the presence of a CNRS laboratory within the university or of a mixed CNRS-university research unit (see Section 2.2). As for Italy, any mention of the CNR in the affiliation field of an academic scientist's publication record signals most often the presence, among co-authors, of one or more CNR employees. Also for Italy, any mention of INFN may signal that either the author and/or one or more co-authors are academic scientists working for an INFN-affiliated laboratory.

number of a scientist's co-authors (of publications up to 1999) still active in the same scientist's university, over the total number of co-authors.

While Inbreeding refers exclusively to scientists' relationships within their own university, the importance of disciplinary control over careers, both in France and in Italy, suggests that an analysis should also be carried out of the relationships scientists may entertain with colleagues from the same disciplines, but not necessarily from the same institution. We do so by examining the scientists' co-authorship networks, between 1995 and 1999.¹⁷

In particular, we have built two distinct networks, one for Italy and one for France, each of them having only the academic physicists of our sample as nodes, and the co-authorship ties between them as ties, to the exclusion of any other co-authors. This means that we concentrate on national networks, and deal separately with the publication records of the Italian and French physicists. This choice has both a practical and a theoretical explanation. On practical grounds, the inclusion of all the co-authors of the French and Italian scientists in our sample as network nodes would have required also collecting all the publications of such co-authors, including those written in collaboration with scientists outside our sample. This was well beyond our means. Alternatively, including foreign, retired or student co-authors as nodes of our networks, without including also the co-authorship ties between them, would have meant introducing a severe distortion in our measurements of the network structure.

On theoretical grounds, networks of collaboration may be seen as systems for the distribution of various types of resources: information (on research questions, data sources, methods...); knowledge (such as expertise or tacit skills); and status or power (the scientist's position in the network conveying information on his/her social capital or influence). In this paper, we stress the status/power interpretation. Due to their national dimensions, our networks convey information on the various scientists' standing within the national community, not the international one.¹⁸ In terms of pure scientific reputation and access to knowledge, it is the latter that matters most. But when it comes to getting a job or promotion in France and Italy, where jobs and promotions are decided by the highest ranked and influential members of the discipline, it is the latter that counts.¹⁹

[TABLE 4 NEAR HERE]

¹⁷ The 5-year window is meant to capture ongoing research partnerships, or at least those partnerships that involve scientists still active between 2000 and 2005. The same time window was used by Newman (2001) and related to work on small worlds in science, so is comparable with our work. For the selection of journals see footnote 12.

¹⁸ A scientist's position in our national networks is not necessarily correlated to his/her international standing. For example, some isolated nodes in our network could be scientists with limited connections to their national communities, but many co-authorship ties with foreign colleagues (as may happen for young scholars with a PhD from a foreign institution).

¹⁹ However, we have also controlled for the role of international networks, within the limits of our data. In particular, we have controlled our regressions for the number of international affiliations for each researcher's paper over a 5-year window, from 1995 to 1999. This variable plays no role on the probability of being promoted and does not affect the estimated marginal effects of all other covariates. We do not report the results due to space limitations (but they are available upon request).

Table 4 demonstrates that our national networks show both low density and a “giant” component, that is, a principal component (the largest in the network) which collects the vast majority of connected scientists (between 64 and 83 per cent, excluding isolates), many more than any other cluster of scientists (see the very low size ratio between the second largest and the principal component). These are common features to all co-authorship networks in science, as measured in the literature. Notice also that the relative size of the principal component for Italy is quite a lot larger than its counterpart for France. This is explained by the much higher rate of co-authorship in Italy (for a discussion of this, see Lissoni et al., 2009).

In our regressions, we consider four different synthetic measures of a MCF or RU in his/her national network: *Principal Component*, *Closeness*, *Credit*, and *Weighted_Credit* (see also Table 2b above).

Principal Component is a dummy that takes the value one if the scientist belongs to the principal component in his/her national network and indicates merely whether the scientist is somehow connected to the core of his/her national scientific community.

Closeness is the reciprocal of the mean geodesic distance between the node and all the other nodes in the principal component (it is set to zero for all nodes that do not belong to the principal component; it has a maximum value equal to one, which can be achieved only by a central node in a star network).²⁰

More precisely, we measure the *Closeness* of scientist (node) i as follows:

$$Closeness_i = \begin{cases} 0 & \text{if } i \text{ does not belong to the principal component} \\ \frac{1}{\frac{1}{V} \sum_{v=1}^V g(i,v)} & \text{if } i \text{ belongs to the principal component} \end{cases}$$

(3)

where $v=1 \dots V$ are the nodes (scientists) in the principal component and $g(i,v)$ is the geodesic distance (shortest path) between nodes i and v .

Credit is a more accurate measure of the social (political) capital because it directly identifies the relationship between prospective candidates to professorial jobs (MCFs or RUs) and professors (PRs or POs). Candidate i 's *Credit* is measured as:

$$Credit_i = \sum_{j \in PR, PO} \left[\frac{co_Articles_{i,j}}{Articles_{j,t}} \right] \quad (4)$$

²⁰ For a definition of geodesic distance and a complete description of closeness, and its relationship to other centrality measures, see Wasserman and Faust (1994).

where $co_Article_{i,j}$ is the number of publications signed in by candidate i and professor j together, while $Article_j$ is the total number of publications of professor j . Professors whose recent scientific production owes much to a junior colleague's co-authorship may be expected to act as mentors of the latter. In France and especially in Italy, this may mean making an effort to be elected as a member of the selection committees for PR or PA positions, in order to support the junior colleague's application; or else exerting one's own influence in order to obtain the election of trusted colleagues, who will then act in the same direction. MCFs and RUs who manage to make themselves useful to PRs and POs hold an asset ("credit") which may be repaid by mentoring and political influence on the composition and operation of selection committees.²¹

$Weighted_Credit$ explicitly takes into account the amount of influence a professor (PR or PO) may exert within the discipline, by weighting each candidate's credit towards a given professor by that professor's closeness score, to be intended as a proxy for the professor's centrality in the social (disciplinary)

$$\text{network: } Weighted_Credit_{i,t} = \sum_{j \in PR, PO_i} \left[\frac{co_Articles_{i,j}}{Articles_{j,t}} C_j \right]$$

(5)

where i is the prospective candidate (MCF or PA) and C_j is professor j 's *Closeness*, as from equation (3).

Table 5 reports the descriptive statistics for all four measures of network position.

[TABLE 5 NEAR HERE]

3.1.4 Other controls

Both in Italy and in France, disciplines compete for resources, which allow for cross-disciplinary differences in the availability of new jobs and promotion opportunities. In most regressions we control for this effect by taking into account the average probability of being promoted in a given discipline (*Field probability*).

3.2 Models

²¹ This description of an agent's social capital as "credit" to be collected, was first expressed by Coleman (1988, p.S106): «If A does something for B and trusts B to reciprocate in the future, this establishes an expectation in A and an obligation on the part of B. This obligation can be conceived as a credit slip held by A for performance by B. If A holds a large number of these credit slips, for a number of persons with whom A has relations, then the analogy to financial capital is direct.» Notice that Coleman's theory of social capital also requires, for credit to be collectable, that agents involved in the exchange belong to tightly knitted ("dense") social networks, so that failure to repay debts can be monitored and sanctioned effectively. Scientific disciplines, such as those considered here, may be described as "dense", one proof of it being our own data on the density of co-authorship ties, and the weight of the principal component. Professors who fail to repay their debt will be quickly spotted by the entire disciplinary community..

In order to explore the determinants of the academic rank advancement we proceed in steps. First, we run a regression of the probability of promotion as a function of the individuals' characteristics and departmental stratification (*Model1*). We place special emphasis on the robustness of our results to different specification of the productivity variable.

A second model also takes into account the social network measures presented in Section 3.1.2 (*Model2*). Results for *Models 1* and *2* are presented jointly for French and Italian data. In addition, we test for the overall influence of individual, department, and social network covariates on rank advancements from PA to PO positions in Italy (*Model3*).

Promotion is a binary realization of the dependent variable y_i , where i is the individual. The reported estimations refer to Logit regressions, although we also applied Probit models, with no appreciable differences in the results. Logit coefficients cannot be readily interpreted as partial derivatives, so we examine what they suggest in terms of marginal effect with the help of several graphs, with special emphasis on comparisons between our two countries.²² Tables in the Appendix report the correlation matrixes for all the covariates. No variables show problems of high correlation, except for the various measures of productivity (which never enter the regressions jointly).

4 Results

4.1 Individual determinants

Regression results in Table 6 confirm many of the results already available from the US-centric literature we reviewed in Section 2, but also some interesting differences between France (odd-numbered columns) and Italy (even-numbered columns).

Columns from (1) to (10) differ only for the productivity measure. Columns (11) and (12) report also the coefficients for the stratification dummies. Unless stated otherwise, our comments refer to coefficients from columns (1) and (2) for individual variables, and columns (11) and (12) for the stratification ones.

[TABLE 6 NEAR HERE]

Age and Gender

The age variable (considered here as a proxy of career length) has a significant and non-monotonic impact on the scientists' promotion chances in both countries. The effect of age on the probability of

²² We have also run a number of linear probability (OLS) regressions, and checked that the resulting estimating coefficients do not differ much from the marginal effects as calculated from the Logit coefficients.

promotion has a concave shape, with an initial increment and a gradual decline as scientists' seniority increases. This result is close to what was found by Long et al. (1993). Figure 2 is a conditional effects plot, which represents the probability of promotion conditional to the age of an average French or Italian candidate. We notice immediately that age has a stronger impact on Italian scientists' promotion chances than on the French. The position of the promotion probability curves for Italian male and female scientists is persistently higher; at the same time, the rise (and then decline) of the Italian probability curves along with increases in seniority is steeper. While the position of the curves may be explained by the higher chances of promotion for Italian scientists *ceteris paribus*,²³ their inclination is the sole effect of seniority.

[FIGURE 2 NEAR HERE]

Considering only the linear component of age, we can also calculate (on the basis of the estimated coefficients) that an additional year of career in the same position generates for Italian scientist an odds ratio double that for a French colleague., which suggests that an Italian physicist's chances of promotion (relative to non-promotion) on the mere basis of seniority are double those of a French colleague.

Gender has a negative impact on promotion chances both in France and in Italy, but such an effect appears to be statistically significant only in France. Being a woman physicist in France means having half the chances of promotion of a man, other things being equal. These results are also evident from Figure 2.

A note of caution is due here. Our data cannot tell whether a scientist does not get promoted because he/she fails a *concorso* or *concours*, or because she does not even try it. So it may either be that French examination committees discriminate somehow against woman scientists, or also that the latter self-select themselves out of the competition for top jobs (for example, by not even trying to obtain the HDR²⁴). It remains to be seen whether the two explanations are complementary (when women scientists do not even try to enter a competition, they are bound to lose) or alternatively, as when women scientists decide that, for many possible reasons, they do not want to get a professorial job.

Productivity

²³ This is due both to the longer time interval during which promotion may occur for scientists in our sample (5 years in Italy vs. 3 in France) and to the existence of an intermediate career step (PA, associate professor) in the Italian academic ladder, which may facilitate progress off the bottom rung of the ladder.

²⁴ See footnote 9 above

All the measures of productivity have a positive, but diminishing impact on the probability of promotion, including *RelativeProductivity* (i.e. the individual productivity over the average productivity in the discipline). Not all measures, however, exhibit a significant quadratic component in the Italian case (where the component is significant, it suggests that diminishing returns to productivity kick in much sooner than in France). Estimates in columns (1) and (2) of Table 6 suggest that one extra single-authored publication on a journal with an impact factor equal to one may increase the average French scientist's promotion probability of 0.005 (0.002 for an Italian one); an increase of productivity equal to one standard deviation would increase the same scientist's promotion probability of around 0.2 (0.2 for an Italian one).

Figure 2 shows the promotion probability for men and women scientists in Italy and France. The declining section of the curves is determined by the existence of a few outliers with maximum productivity value. As a matter of fact, most scientists have a productivity value well below the mean (which is around 20 for France and 54 for Italy). This suggests that for almost all scientists the probability for achieving promotion always increases (never decreases) with productivity, although with diminishing returns; and that most scientists have higher promotion chances in Italy than in France.

[FIGURE 3 NEAR HERE]

Stratification and Inbreeding

Our *Inbreeding* variable is never significant in France, while it is so in most regressions for Italy (although never at 99 per cent, and with an estimated coefficient whose value is sensitive to the choice of productivity proxy). This result, albeit not strong, is in keeping with the descriptive statistics which demonstrated that Italian scientists are less mobile than French ones.

As for stratification, French scientists with a high percentage of CNRS-affiliated papers have higher promotion chances. Calculations of the marginal effect suggest that an extra standard deviation of CNRS would add 0.05 to the promotion probability of the average French scientist. The CNR variable does not bear a similar effect in the case of Italy, possibly due to the limited importance of CNR outside nuclear physics (which does not represent the core field of physics considered in this paper). On the contrary, INFN has a positive and significant impact on Italian scientists' promotion chances, due to its importance for all material physicists (who constitute the bulk of our physicists); in particular, an extra standard deviation would add 0.02 to the probability of promotion.

Finally, we note that while promotion chances in France do not depend on the specific discipline to which a physicist belongs, the same does not apply in Italy. Due to the high variability of average promotion chances across Italian disciplines (see descriptive statistics), disciplinary affiliation matters a great deal for a scientist's career.

4.2 The effect of social capital, and the promotion to full professor

Table 7 shows the effects of social capital on promotion from MCF to PR (for France) and from RU to PA (for Italy), together with the individual and stratification variables we have already examined. We note that the latter's estimated coefficients are not sensitive to the introduction of new explanatory variables. The only exception is the quadratic effect of productivity for Italy, which becomes not significant.

[TABLE 7 NEAR HERE]

Whatever social capital measures we consider, they show a strikingly different impact in the two countries: they are never significant for France and always significant for Italy. At the same time, for Italy, we note that the estimated coefficients of more generic measures of social capital (such as *Principal Component* and *Closeness*) appear to be less significant (90 per cent) than the coefficient for more specific measures (such as *Credit* and *Weighted_Credit*).

Being part of the principal component of the national scientific network does not affect the promotion chances of French scientists, while it considerably increases those of Italian ones [see *PrincipalComponent* in columns (1) and (2) of Table 7]. More strikingly, non-connected scientists in Italy stand almost half a chance of getting promoted compared to those with maximum observed closeness (which is equal to 0.2). Moreover, among connected scientists, those who occupy a more central position in the network have even higher promotion chances, as indicated by the positive and significant value of the *Closeness* variable, in columns (3) and (4) of Table 7.

However, *PrincipalComponent* and *Closeness* provide a generic measure of position of the individual candidate in the network. They do not capture the candidate's ties with the most influential, highest ranked members of the network. This task is better fulfilled by *Credit* and *Weighted_Credit*, which are found in columns (5) to (8) in Figure 6.

The positive sign of *Credit* suggests that the more valuable a junior scientist proved to be towards full professors the more the chances he/she has of being promoted in Italy, even after controlling for the scientist's productivity and seniority (this is not true in France, where *Credit* bears no relevance on promotion chances). The same result is obtained when considering *Weighted_Credit*, which is the higher the more central the full professors are (to whom the junior scientists can claim *Credit*). *Credit* and *Weighted_Credit* are not only more significant than *PrincipalComponent* and *Closeness*, but considerably improve the goodness of fit of our regression, as measured by McFadden adjusted pseudo-R² (different pseudo-R² measures give the same result). The latter increase around 20 per cent (for Italy) when moving from columns (2) and (4) to columns (6) and (8).

Figure 4 plots the promotion probability in terms of *Weighted_Credit* for two scientists, one Italian and one French, with average values of age, productivity and other regressors. The probability of being promoted for the Italian scientist increases with *Weighted_Credit* reaching a maximum at *Weighted_Credit*=1.8, and declines for higher values. Note that such an inverted U-shape is determined by the existence of a few scientists with exceptionally high *Weighted_Credit* values. The mean and median values for *Weighted_Credit* are respectively 0.5 and 0.1, so most scientists have only to gain by increasing the contribution they make to a full professor's publication record. In the case of the French scientist, no increase in the probability of promotion is associated with an increase in *Weighted_Credit*.

Figure 5 examines the probability of promotion for three Italian scientists with different productivity levels (respectively pointing at the 25th, 50th, and 75th percentiles), as a function of *Weighted_Credit*. The figure suggests that an Italian scientist with low productivity, but a mean value of *Weighted_Credit* (that is *Weighted_Credit*=0.5) has roughly the same promotion probability as a highly productive scientist with a *Weighted_Credit* equal to 0; the latter, in turn, has less probability of being promoted than a mediumly productive scientist with a *Weighted_Credit*=0.5. Note that this comparison makes sense, due to the fact that *Weighted_Credit* and *Productivity* reflect two different characteristics of Italian scientists, as confirmed by the low correlation between the two (see Appendix 3b).

[FIGURE 4 NEAR HERE]

[FIGURE 5 NEAR HERE]

The role of social capital measures in Italy is also confirmed by the analysis of promotion from the rank of associate professor (PA) to the top rank of full professor (PO), which we examine in Table 8. We first note that the estimated coefficients for Age and Productivity are respectively higher and lower than those concerning promotion from RU to PA; apparently, when it comes to reaching the top of the academic ranking (in Italy), seniority matters more, and productivity less than at earlier career stages. No stratification variable is significant, possibly because all PAs are similarly connected to INFM. As for social capital, *Principal Component* remains highly significant, while *Closeness* does not differ significantly from zero. The coefficients for *Credit* and *Weighted_Credit* remain positive and significant (albeit smaller than in the case of promotion at lower ranks), and the quadratic effects are confirmed.

[TABLE 8 NEAR HERE]

5. Discussion and conclusions

Our analysis confirms the importance of seniority and scientific productivity for academic careers, as found in the literature. The older the scientist the higher his/her chances of promotion, but only up to an age between 40 and 45 (for promotion from the bottom to the top/intermediate ranks in France and Italy) or well over 50 (for promotion to the top rank in Italy), after which promotion chances decline. As for productivity, our estimates suggest the existence of positive but diminishing returns, which are considerably higher for French scientists as opposed to Italian ones. Overall, the balance between seniority and productivity, as promotion determinants, seems to be relatively more shifted in favour of the former in Italy, and of the latter in France. Within Italy, such a balance shifts even more in favour of seniority when it comes to moving to the top tier of the academic hierarchy.

We also find that both in Italy and France stratification matters. Such stratification derives from interaction between the universities and the national systems of public research organization (CNRS in France, INFN in Italy). As such, our findings reflect the institutional peculiarity of the two national science systems, and differ from similar findings in the US-based literature (where stratification refers to an internal hierarchy of universities).

A distinctive result of our analysis is the evidence of the importance of a specific type of social capital for Italian scientists. The particular institutional arrangements of the Italian academic recruitment system are such that senior colleagues of those seeking promotion have considerable (and largely unchecked) power on the latter's careers, and are at the same time involved in a web of job commissions, local in nature, but elected by peers on a national basis. As a consequence, proximity to influential decision-makers, as measured by *Credit*, (or the combination of two, *Weighted_Credit*) may be decisive for a scientist's career, at any level of productivity. In this light, even the significance to more generic measures of social capital, such as *PrincipalComponent* and *Closeness*, may be interpreted more as a signal of access to mentoring within the discipline, than as an indicator of scientific potential (access to the scientific community at large).

In France, where job commissions are not entirely elective and stand for several years, this effect does not appear. We are aware that the network effect for Italy could be explained by the recruitment norms as much as by the social norms of the community, with their emphasis on inbreeding and mentoring (which could also be responsible for the existence of such a baroque and easily rigged recruitment system). However, at this stage of our research, we cannot distinguish between social and legal norms. It is also possible that they reinforce each other, to the extent that the latter are a result of the professors' pressure on the legislature.

Besides being of immediate policy interest, our findings on social capital suggest that it is possible to analyse networks of scientists not only in terms of knowledge diffusion (as typical of the recent literature on the economics of science, and of the literature on small worlds), but also in terms of power and brokerage of career opportunities and rewards for exchanges at the dyadic level.

An unexpected result of our study is the differential impact of *gender* on career in the two countries, negative in France and non-significant in Italy. At this stage of our research we can only observe that the French system host more women than the Italian one, and that it is more selective (fewer French *maitres a conference* become professors, as opposed to Italian *ricercatori*). It may well be that while Italy exhibits its gender effect at the entry level (the number of women who manage to enter the academic system at the bottom rank) France sees the gender effect kicking in only at the promotion level.

Going back to the literature on the new economics of science, our results confirm the role of scientific productivity as a determinant of academic career, but they also suggest that such a role is very much tempered by other determinants, such as seniority, gender, and social connections. While evidence on the importance of seniority and age has also been produced for the US case, we are not aware of studies that have highlighted the role of social connections (of the type we found relevant for Italy).

In the near future, we plan to develop both a more sophisticated theory of the recruitment process in the two countries and a more accurate analysis of network effects on promotion. In France, such an analysis will require taking into consideration the role of CNRS, the National Research Centre, whose influence on the academic system is much greater than the influence exercised by its Italian counterpart, the CNR.

At a later date, we expect that a better understanding of the career process will be instrumental in framing the ongoing debate on the changing economics of universities within a more general model of individual scientists' incentives and constraints.

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TABLES AND FIGURES

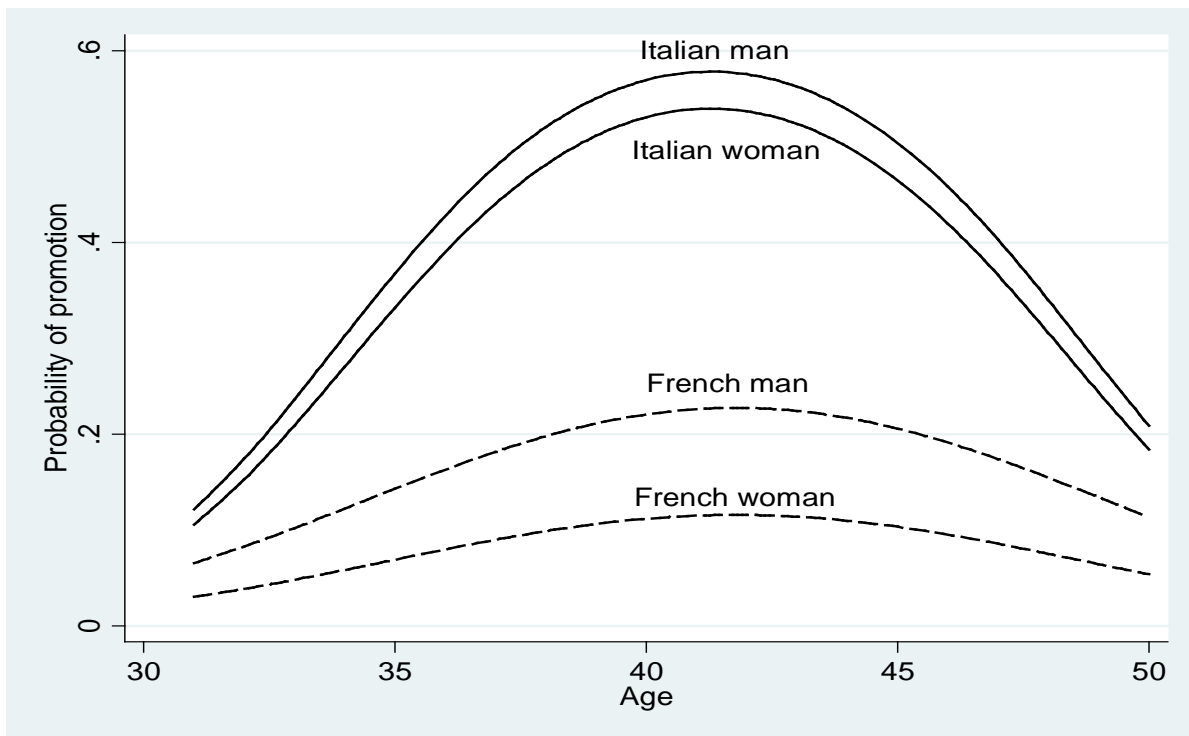


Figure 1. Promotion probability as a function of age and gender*, France and Italy
Notes: Marginal effects calculated on the basis of regressions (1) and (2) in Table 6. All other regressors besides gender and age are set at avg. values

Figure 2.

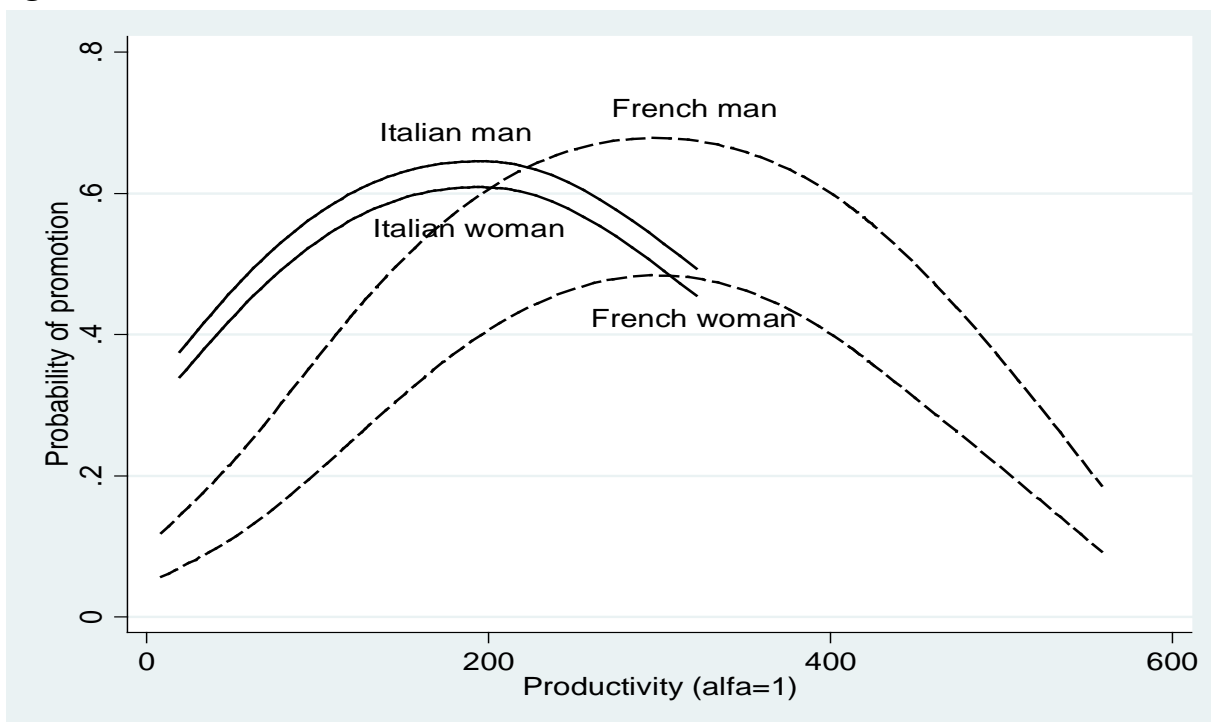


Figure 2. Promotion probability as a function of productivity and gender*, France and Italy
Notes: Marginal effects calculated on the basis of regressions (1) and (2) in Table 6. All other regressors besides gender and productivity are set at avg. values

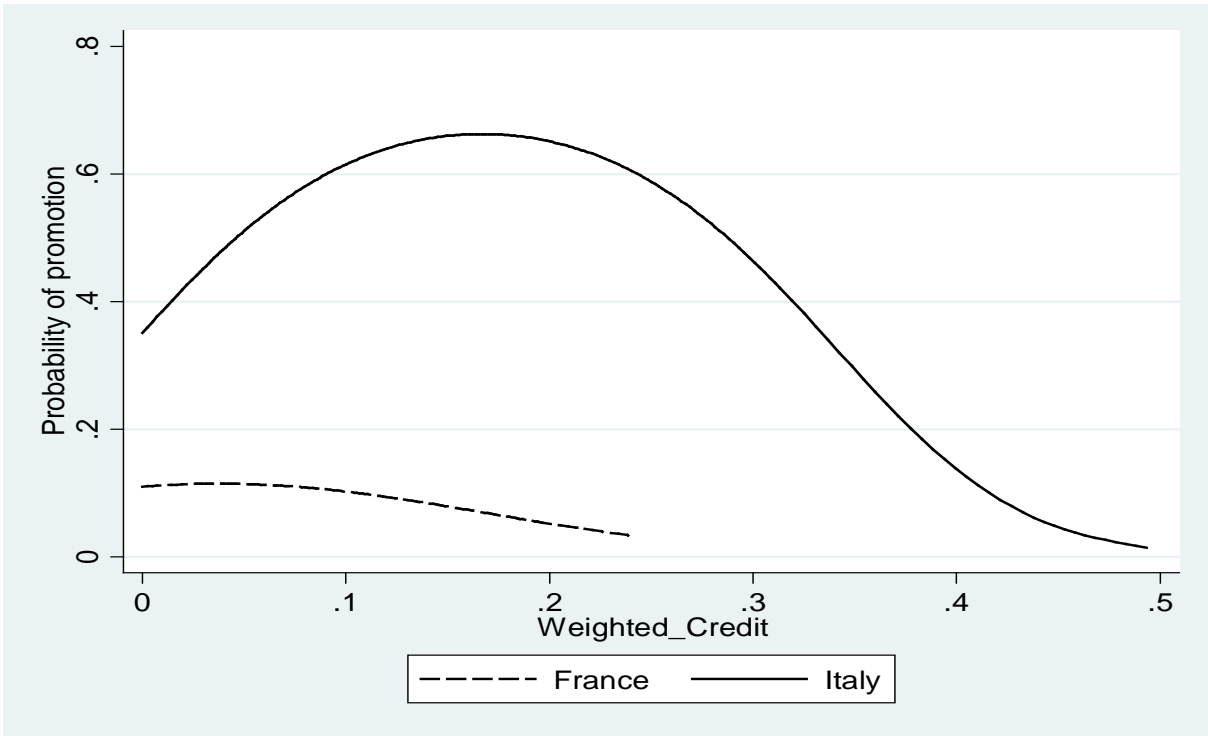


Figure 3. Promotion probability as function of *Weighted_Credit*, France and Italy

** Marginal effects calculated on the basis of regressions (7) and (8) in Table 7. All other regressors besides gender and productivity are set at avg. values*

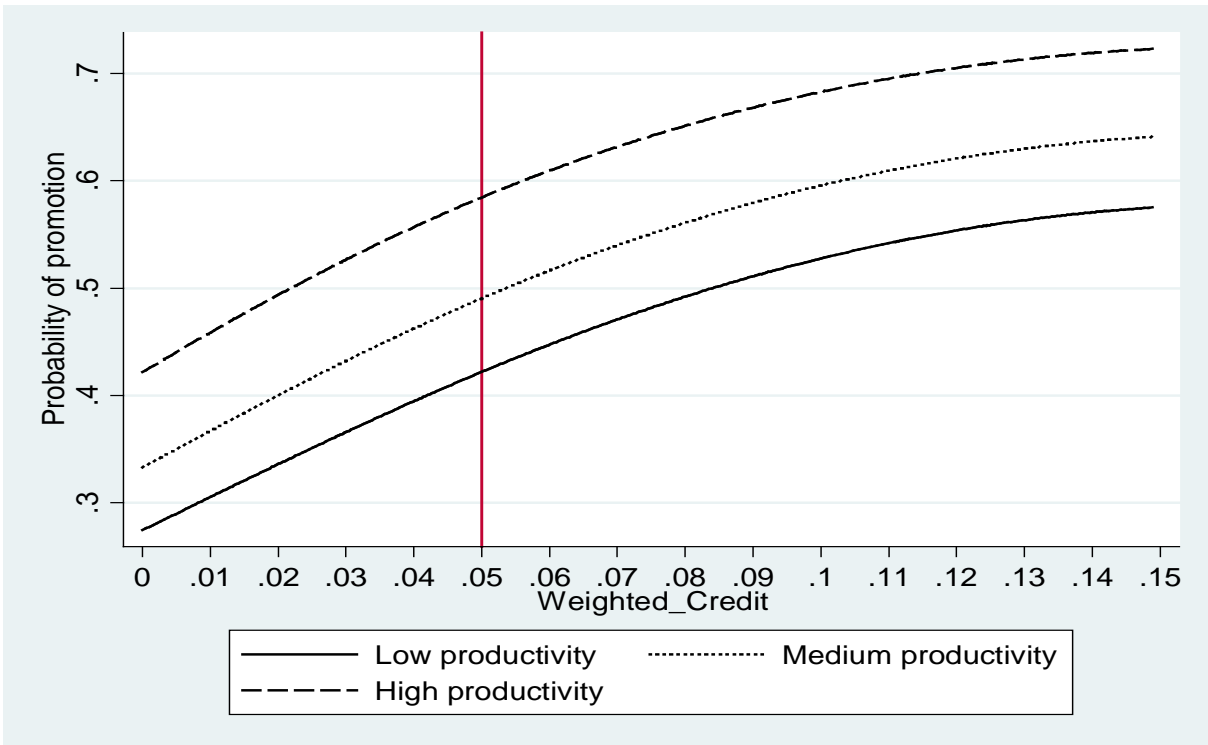


Figure 4. Promotion probability as function of *WeightedCredit* in Italy

Marginal effects calculated on the basis of regressions (8) in Table 7. All other regressors besides gender and productivity are set at avg. values; productivities are calculated at the following percentiles: 25th (LOW), 50th (MEDIUM,) and 75th (HIGH).

Table 1. Promotion and mobility

	FRANCE			ITALY		
	Total	Men	Women	Total	Men	Women
<i>No. of scientists [MCFs-France; RUs-Italy]</i>	816	601	215	469	365	104
<i>Promoted, no. and % over no. of scientists</i>	110 (13.5%)	95 (15.8%)	15 (7%)	211 (45%)	172 (47%)	39 (39%)
<i>Mobile*, no. and % over promoted</i>	22 (20%)	19 (20%)	3 (20%)	12 (5.7%)	11 (6.4%)	1 (2.5%)

* MCFs and RUs promoted to professorial positions (aged between 30 and 50)

** MCFs and RUs who changed university affiliation when promoted

Table 2. Career determinants (explanatory variables for promotion)

2a. Productivity and individual characteristics	
Gender	Gender dummy (=1 for women scientists)
Age	Scientist's age in year 2000
Productivity (α)	Cumulative sum of impact factors of the journals where articles are published, weighted by the number of co-authors (see Equation 1)
Articles	Gross number of publications
Relative productivity	Ratio between individual Productivity (α) and average Productivity (α) for each discipline individual i belongs to
Inbreeding	No. of co-authors from same university / No. of co-authors
Field probability	Average probability of being promoted for each field and rank, i.e. % of researchers promoted in each field and rank
2b. Stratification	
CNRS	Percentage of articles published between 1995 and 1999 which list at least one CNRS or UMR affiliation, for each scientist i
CNR	Percentage of articles published between 1995 and 1999 which list at least one CNR affiliation, for each scientist i
INFM	Percentage of articles published between 1995 and 1999 which list at least one INFM affiliation, for each scientist i
2c. Network variables	
Principal Component	Connection dummy (=1 if scientist belongs to principal component of co-authorship network, 1995-1999)
Closeness	Inverse of avg shortest path between the scientist and other scientists in the principal component (co-authorship network, 1995-1999; =0 for scientists outside the principal component)
Credit	Weighted sum of ties with PO or PR, where the ties are a co-publication and the weight is 1 over the total number of PO/PR's articles.
Right Credit	Weighted sum of ties with PO or PR, where the ties are a co-publication and the weight is 1 over the total number of PO/PR's articles times the PO/PR's closeness.

Table 3a. Descriptive statistics (MCF, France)

	Obs.	Mean	Standard Deviation	Min	Max	Median	90° percentile
<i><u>Individual covariates</u></i>							
Gender	816	0.26	0.44	0.00	1.00	0.00	1.00
Age	816	36.37	4.77	30.00	50.00	35.00	43.00
Productivity($\alpha=1$)	816	19.90	46.20	0.00	563.40	10.31	39.45
Productivity($\alpha=0.25$)	816	35.21	76.49	0.00	987.97	19.54	70.09
Productivity($\alpha=0.10$)	816	54.14	110.91	0.00	1417.94	30.40	104.27
Articles	816	13.70	30.73	0.00	373.00	8.00	24.00
Prob_field	816	0.13	0.01	0.13	0.14	0.13	0.14
Relative Productivity($\alpha=1$)	816	1.00	2.16	0.00	34.06	0.53	2.08
Inbreeding	816	0.30	0.41	0.00	1.00	0.00	1.00
Productivity($\alpha=1$)_field <i>Milieux denses et matériaux</i>	559	16.40	33.77	0.00	558.66	8.82	36.31
Articles_field <i>Milieux denses et matériaux</i>	559	11.90	25.19	0.00	340.00	7.00	22.00
Productivity($\alpha=1$)_field <i>Milieux dilués et optique</i>	257	27.52	64.99	0.00	563.40	13.50	49.04
Articles_field <i>Milieux dilués et optique</i>	257	17.60	40.00	0.00	373.00	10.00	28.00
<i><u>Stratification covariates</u></i>							
CNRS	816	3.05	4.84	0.00	71.00	1.00	8.00
<i><u>Network variables</u></i>							
PrincipalComponent	816	0.38	0.49	0.00	1.00	0.00	1.00
Closeness	816	0.04	0.05	0.00	0.16	0.00	0.12
Credit	816	0.20	0.34	0.00	1.96	0.00	0.73
Weighted_Credit	816	0.02	0.03	0.00	0.24	0.00	0.05

Table 3b. Descriptive statistics (RU, Italy)

	Obs.	Mean	Standard Deviation	Min	Max	Median	90° percentile
<i>Individual covariates</i>							
Gender	469	0.22	0.42	0.00	1.00	0.00	1.00
Age	469	40.00	4.75	30.00	50.00	39.00	47.00
Productivity($\alpha = 1$)	469	53.47	50.14	0.00	326.67	39.28	125.25
Productivity($\alpha = 0.25$)	469	82.99	86.01	0.00	573.53	57.09	210.95
Productivity($\alpha = 0.10$)	469	120.31	110.14	0.00	745.27	90.78	268.43
Articles	469	43.06	49.80	0.00	290.00	29.00	87.00
Prob_field	469	0.45	0.07	0.33	0.53	0.44	0.53
Relative Productivity($\alpha = 1$)	469	1.00	0.85	0.00	6.70	0.80	2.06
Inbreeding	469	0.42	0.39	0.00	1.00	0.33	1.00
Productivity($\alpha = 1$)_field <i>Fisica sperimentale</i>	245	34.22	31.76	0.00	229.13	25.60	70.99
Articles_field <i>Fisica sperimentale</i>	245	56.23	63.96	0.00	290.00	33.00	196.00
Productivity($\alpha = 1$)_field <i>Fisica teorica, modelli e metodi matematici</i>	80	95.97	62.92	0.00	326.67	86.68	170.03
Articles_field <i>Fisica teorica, modelli e metodi matematici</i>	80	29.01	18.78	0.00	111.00	25.00	49.50
Productivity($\alpha = 1$)_field <i>Fisica della materia</i>	144	62.62	50.90	0.00	237.49	49.30	138.16
Articles_field <i>Fisica della materia</i>	144	28.44	17.80	0.00	81.00	26.00	53.00
<i>Stratification covariates</i>							
CNR	469	6.44	9.77	0.00	92.00	3.00	17.00
INFM	469	2.88	4.93	0.00	30.00	0.00	9.00
<i>Network variables</i>							
PrincipalComponent	469	0.70	0.46	0.00	1.00	1.00	1.00
Closeness	469	0.10	0.07	0.00	0.20	0.13	0.17
Credit	469	0.36	0.51	0.00	3.34	0.13	1.00
Weighted_Credit	469	0.05	0.08	0.00	0.49	0.01	0.15

Table 4. Co-authorship networks, 1975-1999 (only national scientists); selected statistics

	<i>ITALY</i>	<i>FRANCE</i>
% of scientists in the principal component (over non-isolates*)	83.2%	64.2%
Size ratio second largest / principal component	1.5%	1.8%
% of isolated scientists over total scientists *	26.7%	65.9%
Network density °	0.0090	0.0057

* isolates=scientists with no publications or no co-authors from the same country

° no. ties / no. of potential ties

Table 5. Co-authorship networks, mean by rank

	FRANCE		
	MCFU	PR	
Principal_Component	0.3848039	0.4076517	
Closeness	0.0399336	0.0453887	
Credit (to PR)	0.2029634	--	
Weighted_Credit (to PR)	0.0150574	--	
	ITALY		
	RU	PA	PO
Principal_Component	0.6993603	0.5657439	0.6419753
Closeness	0.1007591	0.0817522	0.0942427
Credit (to PO)	0.3550849	0.2758272	--
Weighted_Credit (to PO)	0.048869	0.0376584	--

MCFU and RU: ages between 30 and 50 are considered

Table 6. Logistic model for promotion, 2000-05 (Italy) and 2000-03 (France): individual and stratification determinants

VARIABLES	(1) France	(2) Italy	(3) France	(4) Italy	(5) France	(6) Italy	(7) France	(8) Italy	(9) France	(10) Italy	(11) France	(12) Italy
Gender	-0.81*** (0.30)	-0.20 (0.25)	-0.77** (0.31)	-0.23 (0.25)	-0.75** (0.31)	-0.21 (0.25)	-0.82*** (0.30)	-0.34 (0.25)	-0.85*** (0.30)	-0.19 (0.25)	-0.76** (0.30)	-0.18 (0.25)
Age	1.03*** (0.35)	1.76*** (0.37)	0.99*** (0.35)	1.74*** (0.37)	0.96*** (0.35)	1.71*** (0.37)	1.01*** (0.34)	1.76*** (0.37)	1.05*** (0.34)	1.74*** (0.37)	1.07*** (0.35)	1.81*** (0.38)
Age ²	-0.012*** (0.0044)	-0.021*** (0.0045)	-0.012*** (0.0044)	-0.021*** (0.0045)	-0.011** (0.0044)	-0.021*** (0.0046)	-0.012*** (0.0044)	-0.021*** (0.0045)	-0.013*** (0.0044)	-0.021*** (0.0046)	-0.013*** (0.0044)	-0.022*** (0.0046)
Inbreeding	0.085 (0.26)	0.43* (0.26)	0.035 (0.27)	0.36 (0.26)	0.0066 (0.27)	0.38 (0.26)	0.036 (0.27)	0.59** (0.26)	0.097 (0.26)	0.54** (0.26)	0.044 (0.27)	0.49* (0.26)
Productivity ($\alpha=1$)	0.020*** (0.0047)	0.016*** (0.0050)									0.015*** (0.0052)	0.012** (0.0052)
Productivity ² ($\alpha=1$)	-3.3e-05*** (1.0e-05)	-3.7e-05 (2.3e-05)									-2.4e-05** (1.1e-05)	-2.5e-05 (2.3e-05)
Productivity ($\alpha=0.25$)			0.015*** (0.0030)	0.0090*** (0.0027)								
Productivity ² ($\alpha=0.25$)			-1.7e-05*** (4.3e-06)	-1.2e-05 (7.5e-06)								
Productivity ($\alpha=0.1$)					0.011*** (0.0021)	0.0080*** (0.0022)						
Productivity ² ($\alpha=0.1$)					-9.4e-06*** (2.2e-06)	-8.0e-06* (4.5e-06)						
Articles							0.038*** (0.0082)	0.028*** (0.0073)				
Articles ²							-1.2e-04*** (3.2e-05)	-1.2e-04*** (3.2e-05)				
Relative Productivity									0.28*** (0.081)	1.15*** (0.26)		
Relative_productivity ²									-0.0076** (0.0034)	-0.17*** (0.058)		
CNRS (France); CNR (Italy)											0.052** (0.024)	0.0044 (0.011)
INFM												0.074*** (0.024)
Field probability	0.59 (17.4)	5.07*** (1.48)	-0.33 (17.5)	4.78*** (1.47)	-0.49 (17.5)	4.61*** (1.46)	3.59 (17.3)	4.23*** (1.45)	10.3 (17.1)	4.28*** (1.47)	3.48 (17.4)	4.01** (1.57)
Constant	-23.2*** (7.13)	-39.2*** (7.60)	-22.3*** (7.15)	-38.3*** (7.58)	-22.0*** (7.16)	-38.0*** (7.62)	-23.4*** (7.09)	-38.8*** (7.61)	-24.7*** (7.06)	-38.7*** (7.65)	-24.5*** (7.18)	-40.2*** (7.72)
Observations	816	469	816	469	816	469	816	469	816	469	816	469
Log-likelihood	-293.935	-289.022	-289.304	-287.746	-286.557	-285.108	-291.256	-290.266	-296.017	-285.817	-291.376	-283.525
LR	57.453***	67.411***	66.714***	69.962***	72.208***	75.239***	62.809***	64.922***	53.287***	73.820***	62.569***	78.404***
McFadden's Adj R ²	0.064	0.080	0.079	0.084	0.087	0.092	0.073	0.076	0.058	0.090	0.069	0.090

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 7. Logit model for promotion, 2000-05 (Italy) and 2000-03 (France); individual, stratification and social capital determinants

VARIABLES	(1) France	(2) Italy	(3) France	(4) Italy	(5) France	(6) Italy	(7) France	(8) Italy
Gender	-0.77** (0.30)	-0.14 (0.25)	-0.76** (0.30)	-0.15 (0.26)	-0.79*** (0.30)	-0.20 (0.26)	-0.76** (0.30)	-0.20 (0.26)
Age	1.07*** (0.35)	1.86*** (0.38)	1.07*** (0.35)	1.87*** (0.38)	1.11*** (0.35)	1.85*** (0.38)	1.09*** (0.35)	1.90*** (0.38)
Age ²	-0.013*** (0.0044)	-0.022*** (0.0046)	-0.013*** (0.0044)	-0.022*** (0.0046)	-0.013*** (0.0045)	-0.022*** (0.0047)	-0.013*** (0.0045)	-0.023*** (0.0047)
Productivity ($\alpha=1$)	0.015*** (0.0052)	0.013** (0.0051)	0.015*** (0.0052)	0.013** (0.0051)	0.016*** (0.0052)	0.014*** (0.0052)	0.016*** (0.0052)	0.015*** (0.0053)
Productivity ² ($\alpha=1$)	-0.000024** (0.000011)	-0.000027 (0.000023)	-0.000025** (0.000011)	-0.000028 (0.000023)	-0.000026** (0.000011)	-0.000030 (0.000024)	-0.000025** (0.000011)	-0.000035 (0.000024)
Field probability	3.80 (17.4)	3.68** (1.61)	1.53 (17.6)	3.37** (1.65)	2.02 (17.5)	3.88** (1.60)	1.66 (17.5)	3.33** (1.61)
CNRS	0.054** (0.025)		0.056** (0.026)		0.059** (0.024)		0.057** (0.025)	
INFM		0.068*** (0.024)		0.063*** (0.024)		0.045* (0.024)		0.048** (0.024)
Principal Component	-0.038 (0.24)	0.44* (0.24)						
Closeness			2.20 (3.42)	3.95* (2.34)				
Closeness ²			-2.82 (2.99)	-0.69 (2.14)				
Credit					0.090 (0.89)	2.17*** (0.54)		
Credit ⁻²					-0.44 (0.75)	-0.95*** (0.29)		
Weighted_Credit							2.44 (7.17)	15.5*** (3.85)
Weighted_Credit ²							-32.6 (46.3)	-46.4*** (13.8)
Constant	-24.5*** (7.18)	-41.2*** (7.70)	-24.3*** (7.20)	-41.3*** (7.73)	-25.1*** (7.23)	-41.4*** (7.82)	-24.7*** (7.20)	-42.1*** (7.84)
Observations	816	469	816	469	816	469	816	469
Log-likelihood	-291.377	-283.638	-290.947	-283.089	-290.485	-276.149	-290.920	-276.034
LR	62.567***	78.177***	63.427***	79.275***	64.352***	93.156***	63.483***	93.386***
McFadden's Adj R2	0.069	0.090	0.067	0.089	0.069	0.110	0.067	0.111

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 8. Logistic model for promotion from PA to PO (Italy); individual, stratification, and social capital determinants

	(1)	(2)	(3)	(4)
Gender	-0.42 (0.31)	-0.42 (0.31)	-0.40 (0.31)	-0.41 (0.31)
Age	1.96*** (0.28)	1.97*** (0.28)	1.93*** (0.28)	1.95*** (0.28)
Age ²	-0.020*** (0.0028)	-0.020*** (0.0028)	-0.020*** (0.0028)	-0.020*** (0.0028)
Productivity ($\alpha=1$)	0.0047* (0.0026)	0.0047* (0.0026)	0.0053** (0.0027)	0.0055** (0.0027)
Productivity ² ($\alpha=1$)	-3.4e-06 (5.4e-06)	-3.2e-06 (5.5e-06)	-4.2e-06 (5.7e-06)	-4.4e-06 (5.7e-06)
Field probability	3.11** (1.51)	3.30** (1.52)	3.61** (1.48)	3.61** (1.49)
CNR	0.000087 (0.011)	-0.00094 (0.011)	0.0045 (0.011)	0.0021 (0.011)
INFM	0.029 (0.019)	0.019 (0.019)	0.028 (0.019)	0.025 (0.019)
Principal Component	0.73*** (0.24)			
Closeness		2.73 (2.32)		
Closeness ²		2.93 (2.30)		
Credit			0.97** (0.40)	
Credit ²			-0.27** (0.14)	
Weighted_Credit				8.60*** (2.89)
Weighted_Credit ²				-17.3** (7.28)
Constant	-49.2*** (6.94)	-49.6*** (7.00)	-48.5*** (6.83)	-49.1*** (6.88)
Observations	578	578	578	578
Log-likelihood	-288.820	-288.317	-290.435	-288.814
LR	145.566***	146.573***	142.336***	145.579***
McFadden's Adj R2	0.174	0.172	0.166	0.171

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

APPENDIX

A1 – Rank and age distribution of physicists (in selected disciplines) on active duty in 2000

	Number (and % of total physicists) - (1)	Age in 2005	Age of nomination (avg)	Promoted to present rank after 2000 [% of (1)]
<i>France</i>				
MCFU	1397 (65%)	43.95702	33	0.2091691
PR	758 (35%)	54.2876	42	0.2242744
<i>Italy</i>				
RU	524 (30%)	43.55344	34	0.4045802
PA	640 (36%)	53.28594	41	0.384375
PO	606 (34%)	60.57426	47	0.3316832

A2 – Fields and probability of being promoted (MCFU, RU, PA); year of reference 2000

	Number (% of total physicists) - (1)	% of Promoted after 2000
<i>France: MCFU</i>		
Milieux denses et matériaux	559 (69)	13.05
Milieux dilués et optique	257 (31)	14.39
<i>Italy: RU</i>		
Fisica sperimentale	245 (52)	44.08
Fisica teorica, modelli e metodi matematici	80 (17)	32.50
Fisica della materia	144 (31)	53.47
<i>Italy: PA</i>		
Fisica sperimentale	369 (64)	29.53
Fisica teorica, modelli e metodi matematici	100 (17)	25.00
Fisica della materia	109 (19)	45.87

NB For MCFU and RU only age between 30 and 50 is considered

A3. ISI-Web of Science publications used to measure productivity, selected list (≥ 300 publications in the sample)

Title	Entry year in ISI-Web of Science	Exit year from ISI-Web of Science	No. of articles by Italians in our sample (1)	No. of articles by French in our sample (2)	(1) + (2)	(1)/[(1)+(2)]	(2)/[(1)+(2)]
Physics letters B	1975	1999	1283	536	1819	11.39%	5.27%
Physical review B	1975	1999	867	716	1583	7.69%	7.03%
Physical review letters	1975	1999	587	561	1148	5.21%	5.51%
Nuclear instruments & methods in physics research section A	1984	1999	667	183	850	5.92%	1.80%
Nuclear physics B	1975	1999	447	136	583	3.97%	1.34%
Journal of applied physics	1975	1999	236	326	562	2.09%	3.20%
Physical review B	1975	1999	296	206	502	2.63%	2.02%
Zeitschrift für physik C	1979	1997	336	129	465	2.98%	1.27%
Physical review D	1975	1999	312	133	445	2.77%	1.31%
Journal of chemical physics	1975	1999	161	278	439	1.43%	2.73%
Solid state communications	1976	1999	198	226	424	1.76%	2.22%
Applied physics letters	1975	1999	149	260	409	1.32%	2.55%
Europhysics letters	1986	1999	166	187	353	1.47%	1.84%
Physical review E	1993	1999	221	110	331	1.96%	1.08%
Journal of physics-condensed matter	1989	1999	145	175	320	1.29%	1.72%
Nuovo cimento della societa italiana di fisica D	1983	1998	298	17	315	2.64%	0.17%
Journal of magnetism and magnetic materials	1979	1999	64	242	306	0.57%	2.38%
Optics communications	1975	1999	136	164	300	1.21%	1.61%

A4a. Correlation Matrix, for French MCFs

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]
[1]	Gender	1													
[2]	Age	-0.03 [0.34]	1												
[3]	Productivity ($\alpha=1$)	-0.06 [0.09]	0.1 [0.00]	1											
[4]	Productivity ($\alpha=0.25$)	-0.07 [0.06]	0.1 [0.01]	0.99 [0.00]	1										
[5]	Productivity ($\alpha=0.1$)	-0.07 [0.04]	0.09 [0.01]	0.98 [0.00]	0.99 [0.00]	1									
[6]	Articles	-0.06 [0.11]	0.08 [0.02]	0.9 [0.00]	0.89 [0.00]	0.9 [0.00]	1								
[7]	Field probability	-0.06 [0.10]	-0.08 [0.03]	0.11 [0.00]	0.12 [0.00]	0.12 [0.00]	0.09 [0.01]	1							
[8]	Relative Productivity	-0.07 [0.06]	0.11 [0.00]	0.96 [0.00]	0.94 [0.00]	0.93 [0.00]	0.88 [0.00]	0 [1.00]	1						
[9]	Inbreeding	-0.17 [0.00]	-0.07 [0.05]	0.07 [0.06]	0.08 [0.02]	0.09 [0.01]	0.09 [0.01]	0.12 [0.00]	0.06 [0.11]	1					
[10]	Comp	-0.12 [0.00]	-0.13 [0.00]	0.16 [0.00]	0.18 [0.00]	0.2 [0.00]	0.19 [0.00]	0.08 [0.03]	0.16 [0.00]	0.35 [0.00]	1				
[11]	Closeness	-0.12 [0.00]	-0.13 [0.00]	0.16 [0.00]	0.18 [0.00]	0.22 [0.00]	0.2 [0.00]	0.02 [0.49]	0.17 [0.00]	0.32 [0.00]	0.97 [0.00]	1			
[12]	Credit	-0.16 [0.00]	-0.09 [0.01]	0.11 [0.00]	0.13 [0.00]	0.16 [0.00]	0.15 [0.00]	0.02 [0.54]	0.12 [0.00]	0.44 [0.00]	0.37 [0.00]	0.39 [0.00]	1		
[13]	Weighted_Credit	-0.11 [0.00]	-0.07 [0.05]	0.12 [0.00]	0.14 [0.00]	0.18 [0.00]	0.17 [0.00]	-0.02 [0.50]	0.15 [0.00]	0.28 [0.00]	0.56 [0.00]	0.61 [0.00]	0.79 [0.00]	1	
[14]	CNRS	-0.14 [0.00]	-0.09 [0.01]	0.26 [0.00]	0.3 [0.00]	0.34 [0.00]	0.28 [0.00]	0.01 [0.76]	0.33 [0.00]	0.13 [0.00]	0.39 [0.00]	0.46 [0.00]	0.27 [0.00]	0.34 [0.00]	1

(p values in square brackets)

A4b. Correlation Matrix, for Italian RUs

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]
[1] Gender	1														
[2] Age	0.1	1													
	[0.03]														
[3] Productivity ($\square=1$)	-0.21	-0.05	1												
	[0.00]	[0.30]													
[4] Productivity ($\square=0.25$)	-0.18	-0.03	0.95	1											
	[0.00]	[0.50]	[0.00]												
[5] Productivity ($\square=0.1$)	-0.18	-0.05	0.93	0.98	1										
	[0.00]	[0.28]	[0.00]	[0.00]											
[6] Articles	-0.09	-0.09	0.2	-0.03	0.03	1									
	[0.05]	[0.04]	[0.00]	[0.53]	[0.45]										
[7] Field probability	0.09	0.01	-0.16	-0.11	-0.06	-0.04	1								
	[0.07]	[0.84]	[0.00]	[0.02]	[0.18]	[0.37]									
[8] Relative Productivity	-0.19	-0.06	0.82	0.75	0.79	0.41	0	1							
	[0.00]	[0.17]	[0.00]	[0.00]	[0.00]	[0.00]	[1.00]								
[9] Inbreeding	0.03	-0.04	0.05	0.09	0.08	-0.11	0.1	0	1						
	[0.52]	[0.40]	[0.27]	[0.05]	[0.09]	[0.01]	[0.03]	[0.98]							
[10] Principal Component	-0.09	-0.25	0.08	0.12	0.18	0.01	0.16	0.15	0.22	1					
	[0.06]	[0.00]	[0.08]	[0.01]	[0.00]	[0.83]	[0.00]	[0.00]	[0.00]						
[11] Closeness	-0.06	-0.25	0.05	0.1	0.18	0.02	0.2	0.15	0.17	0.95	1				
	[0.18]	[0.00]	[0.25]	[0.03]	[0.00]	[0.68]	[0.00]	[0.00]	[0.00]	[0.00]					
[12] Credit	-0.04	-0.21	-0.05	-0.06	0.01	0.14	0.07	0.06	0.12	0.32	0.37	1			
	[0.41]	[0.00]	[0.32]	[0.21]	[0.89]	[0.00]	[0.15]	[0.17]	[0.01]	[0.00]	[0.00]				
[13] Weighted_Credit	-0.03	-0.2	-0.05	-0.06	0.01	0.16	0.11	0.07	0.07	0.41	0.49	0.94	1		
	[0.53]	[0.00]	[0.31]	[0.19]	[0.79]	[0.00]	[0.02]	[0.13]	[0.16]	[0.00]	[0.00]	[0.00]			
[14] CNR	-0.11	-0.12	0.14	0.12	0.17	0.12	-0.25	0.15	-0.11	0.27	0.28	0.29	0.3	1	
	[0.02]	[0.01]	[0.00]	[0.01]	[0.00]	[0.01]	[0.00]	[0.00]	[0.02]	[0.00]	[0.00]	[0.00]	[0.00]		
[15] INFM	-0.07	-0.22	0.15	0.23	0.29	-0.03	0.21	0.24	0.02	0.21	0.3	0.23	0.24	0.04	1
	[0.12]	[0.00]	[0.00]	[0.00]	[0.00]	[0.45]	[0.00]	[0.00]	[0.65]	[0.00]	[0.00]	[0.00]	[0.00]	[0.42]	

(p values in square brackets)