

The internal economics of a university – evidence from personnel data

Catherine Haeck and Frank Verboven*

January 2011

Abstract

Based on a rich personnel data set of a large European university we find strong evidence for the existence of an internal labor market. First, the lowest academic rank is a strong port of entry and internal careers are very long. Second, wages do not follow external wage developments. We subsequently look at internal promotion dynamics to assess the relevance of alternative internal labor market theories. Consistent with promotion-based incentive theories, research and teaching performance are crucial determinants of promotions. Learning about ability mainly relates to our observed performance measures. Finally, administrative rigidities play an important role in explaining promotion dynamics.

* *Catherine Haeck*: Catholic University of Leuven. Email: Catherine.Haeck@econ.kuleuven.be. *Frank Verboven*: Catholic University of Leuven and C.E.P.R. (London). Email: Frank.Verboven@econ.kuleuven.be. We are especially grateful to Paul Oyer and two anonymous referees for useful comments. We also thank Robert Gibbons, Joep Konings, Georg Kirchsteiger, Frederic Warzynski and participants at several seminars for helpful comments. We also thank several members of the personnel department for support in collecting and interpreting the data. We gratefully acknowledge financial support from the Belgian Federal Science Policy Office (Interuniversity Attraction Poles P5/26).

1 Introduction

During the last decades great progress has been realized in understanding how firms organize their employment relationships. Several theories of internal labor markets have been developed taking a variety of different perspectives: incentives under imperfect monitoring of effort, learning about ability, human capital accumulation, administrative rigidities, etc. To establish the existence of internal labor markets, Doeringer and Piore (1971) identify two essential conditions: ports of entry at low job levels resulting in long internal careers, and wage paths that move independently from external wages. Having established the existence of internal labor markets, one can test alternative theories of internal labor markets. One approach is to look for direct evidence on incentives by assessing the role of performance in promotions and/or other monetary rewards. Alternatively, one may search for indirect evidence by characterizing promotion dynamics within the firm. For example, various theories make predictions on fast tracks, whereas learning theories also predict the late-beginner property (late beginners who catch up promote more quickly in the future).

Recent empirical evidence from personnel data has found somewhat mixed support for the existence of internal labor markets and instead focused on assessing the relevance of several alternative theories. In an important paper, Baker, Gibbs and Holmstrom (1994), henceforth BGH, collected a rich personnel data set of a single firm and documented several facts consistent with internal labor market theories, such as the presence of long careers with frequent one-step promotions. But they do not find a strong port of entry, i.e. entry appears to be common at all job levels. Subsequent work confirmed these findings, e.g. Treble et al. (2001) and Lazear and Oyer (2004). Other work introduced richer internal labor market theories to explain additional facts, e.g. Gibbons and Waldman (1999), DeVaro and Waldman (2009) and many others. A general conclusion that can be drawn from the recent empirical evidence is that (1) internal labor markets exist but typically not in the purest form of Doeringer and Piore (1971), and (2) no single theory can explain all facts relating to internal promotion dynamics.

In this paper we provide new evidence on the working of an internal labor market based on a unique and very rich new personnel data set. We observe the personnel records of all professors employed at a large European university since 1991. This analysis is of interest for several reasons. First, the university we study (a variant of the French promotion-based system) has a set of administrative rules that is much simpler than the personnel policies in many other companies: professors can have only four possible ranks; they can be promoted to higher ranks in an annual “tournament”; and wages conditional on rank follow deterministic seniority rules. Current wage is therefore entirely driven by the starting rank and starting

negotiated wage seniority level, and by the speed of future promotions. The simplicity and clarity of the rules provide an ideal setting to both establish the existence of an internal labor market and assess the relevance of alternative theories.

Second, in contrast with most other empirical work, we have good and objective information on performance (research and teaching). This does not only enable us to provide direct evidence on the role of incentives through promotions or other monetary rewards. It also allows us to assess to which extent theories of promotion dynamics, as documented in previous work, remain empirically relevant conditional on observed performance.

A third reason for studying this data set is to investigate the extent to which internal labor market theories also apply to universities. It is often believed that internal labor market theories have little relevance to universities as human capital is assumed to be general.¹ But several studies have recognized the role of mobility costs at universities, so that human capital may also be firm-specific.² Yet others would argue that (European) universities have rigid administrative rules with little leeway to follow personnel policies that are consistent with economic theories. Using our personnel data set, we can document whether internal labor markets exist at universities, and the extent to which economic theories of internal labor markets are relevant or administrative rigidities play a role.

Our main results can be summarized in two steps. First, we find strong evidence for the presence of an internal labor market at this university. The lowest academic rank is a strong port of entry, and in fact entry even occurs at the earlier level of Ph.D. student or postdoc. Internal careers are correspondingly very long. Furthermore, wages have been shielded from external labor market evolutions: real wages did not change over a long time period, in contrast with wages for high-skilled and high-occupation employees in the region, who experienced large real wage increases (consistent with international evidence). These facts are consistent with the classification of Doeringer and Piore (1971) and Lazear and Oyer (2004), and imply the presence of a strong internal labor market, in fact much stronger than documented in most earlier empirical work.

Second, having established the presence of a strong internal labor market, we assess the relevance of alternative theories. Consistent with incentive theories, we find that observable performance plays an important role. Both research and teaching performance significantly

¹For example, Lazear and Oyer (2004) write that “human capital in academics, particularly at the research end, is general, so movement into jobs even at high levels seems natural.”

²For example, Ransom (1993) develops a model to explain that employees with high mobility costs will have high seniority yet low pay if monopsonistic employers can discriminate. He finds evidence that university professors are indeed paid less when they have higher seniority. However, Hallock (1995) obtains opposite empirical evidence based on data for one university (UMASS). In a related sector (stock analysts), Groysberg et al. (2004) show the importance of various sources of mobility costs leading to firm-specific human capital (such as internal networks, teams, leadership), which can also be relevant to universities.

increase the speed of promotions, but they do not increase wages through other channels. Hence, incentives are purely promotion-based, in contrast with Kwon's (2006) empirical finding for an insurance company where promotions and other monetary rewards provide approximately equal incentives. Furthermore, if we do not control for performance, we find evidence of both fast tracks and Chiappori et al. (1999)'s late-beginner property. In contrast, conditional on observed performance, the late-beginner property only has weak empirical support, whereas fast tracks remain very important. These findings indicate that learning about ability mainly relates to our observed research and teaching measures and not to other dimensions of performance.³

In sum, we find much stronger evidence for the presence of an internal labor market in the university we have analyzed than in the private companies of other studies using personnel data. The evidence on career dynamics is consistent with promotion-based incentive theories. Other theories (learning, human capital accumulation) also matter to some extent. However, given that the university has followed its administrative rules quite rigidly for a long time, it is not possible to rule out inefficiencies in personnel policy. Since the university landscape is changing rapidly, several rules may be in need of change, not only at this university but also at many other European universities with similar administrative rules and policies.

More concrete policy recommendations for university reform are, however, beyond the scope of this paper. Further comparative analysis on other European and U.S. universities would first be required. In this respect, it is useful to point out the results of two interesting recent papers on university career dynamics (based on less detailed data sets for multiple universities instead of the richer data set on a single university we use). Using a sample of top 1000 economists, Coupé et al. (2006) find support for both incentive and learning theories, but no evidence of internal labor markets. Oyer (2008) shows how updated expectations about economists' ability during the first career period may affect second period placement, consistent with the learning model.

The outline of the paper is as follows: Section 2 provides literature background and Section 3 presents the data set. After introducing the university's personnel policies, Section 4 documents the existence of a strong internal labor market. Section 5 then looks at the dynamics of careers to assess the relevance of specific internal labor market theories. We summarize our main empirical findings in various Observations.

³Our finding that the evidence for the learning model becomes weaker once we incorporate performance measures is also in the same spirit as Kahn and Lange (2010), although they use a different approach. They find that wage dynamics are predominantly explained by time-varying productivity rather than by learning.

2 Literature background

We provide a short review of the theoretical and empirical literature that is most relevant for our own empirical analysis. For more detailed overviews of recent work in personnel economics we refer to Waldman (Forthcoming) and Lazear and Oyer (2007).

Following Doeringer and Piore (1971), Lazear and Oyer (2004) and others one may distinguish between two conditions to identify the presence of internal labor markets (ILMs). First, there tend to be strong ports of entry at low job levels and long internal careers. Second, wages tend to move independently from external wages. The previous empirical literature has found only mixed support for these conditions.⁴ In contrast, in our study the conditions turn out to be satisfied to quite a strong degree.

Instead of attempting to conclusively identify the presence of ILMs, much of the empirical literature has focused on the career dynamics within firms to assess specific theories. Gibbons and Waldman (1999) summarized the available evidence by the following five main stylized facts on promotion and/or wage dynamics. (i) Real wage decreases are not rare, but demotions are rare. (ii) There is significant serial correlation in both wage increases and promotions, i.e. fast tracks. (iii) Promotions are associated with large wage increases, but (iv) wage increases at promotion are small relative to the difference between average wages across levels. (v) Employees who receive large wage increases early on are promoted more quickly to the next level. Others made similar classifications, and several more recent papers found further evidence relating to these stylized facts.⁵ As we will see, the university we study has no direct wage autonomy, so the facts relating to wage dynamics have mixed support. For our purposes, the facts and theories relating to promotion dynamics will be most relevant. We distinguish between models of learning, incentives and human capital accumulation.

The first class of models focuses on learning about workers' ability. Harris and Holstrom (1982) develop a model of symmetric learning, where both firms and workers have little information about workers' ability at the start and gradually learn by observing output over time. Firms are risk neutral and workers are risk averse about how beliefs regarding their ability will evolve. The model predicts a downward rigid real wage path to partially insure workers. It also predicts fast tracks: a fast first promotion is a signal of high ability and will

⁴For example, Lazear (1992), BGH, Ariga et al. (1999), Treble et al. (2001), Lazear and Oyer (2004), Lin (2005) document a significant amount of external entry at each level in the hierarchy. Only Seltzer and Merrett (2000) and Howlett (2004) find a strong port of entry for two 19th century companies. There is also mixed evidence that wages move independently from the external market. Lazear and Oyer (2004) finds that firm-effects are only important in the short run, but not in the long run.

⁵For studies with personnel records on individual firms relating to these facts, see for example Baker et al. (1994) and Gibbs and Hendricks (2004) on (i)-(v); Seltzer and Merrett (2000), Treble et al. (2001) and Dohmen (2004) on (ii)-(iv); Dohmen et al. (2004) on (i)-(iv); Lin (2005), Kwon (2006) on (iii)-(iv), Rosenbaum (1984), Ariga et al. (1999), Podolny and Baron (1997), Chiappori et al. (1999) on (ii).

therefore predict a fast next promotion.⁶ Chiappori et al. (1999) derive another interesting prediction on promotion dynamics from this learning model: the late-beginner property. Suppose workers A and B were promoted equally quickly from level 1 to level 3, but A was promoted more quickly to level 2 than B. Hence, A was an early starter and B was a late beginner who was able to catch up. The learning model predicts that the late beginner B is more likely to be promoted to level 4. Intuitively, the late beginner had bad luck at the start. From the fact that she was able to catch up one can infer that her average performance between level 1 and level 3 was higher, so that her perceived future ability is higher. In our empirical analysis below, we will show that the fast track and late-beginner property can be combined to give the following equivalent predictions: the speed of previous promotions (to levels 2 and 3) has a positive impact on the speed of the current promotion (to level 4), and this impact is stronger for more recent promotions (to level 3) than for the older promotions (to level 2).

A second class of relevant models focuses on the provision of optimal incentives under imperfect observability of effort, which involves the basic trade-off between insurance and incentives [Holmstrom (1979)]. Lazear and Rosen (1981) propose a tournament theory of promotions. Workers are promoted if they perform better than other workers at the same level. The spread between wages at two different levels is the prize of winning the tournament and serves to induce an optimal effort level. Tournaments have an informational advantage over other incentive contracts, since it is only necessary to provide an ordinal ranking of the employees. One relevant extension for our purposes is Meyer (1992). She considers multiple tournaments and shows that it is optimal to reward success in the first tournament by raising the success probability in the second tournament (i.e. favoring early winners). While this gives reduced incentives in the second tournament, it gives more than sufficient increased incentives to risk-averse employees in the first tournament. Her model is therefore an incentive theory for fast tracks.⁷

A third class of ILM models considers the role of human capital acquisition [Becker (1962)]. Gibbons and Waldman (1999) develop a rich model with human capital acquisition, job-assignment and learning to reconcile the above stylized facts. Workers are heterogeneous in their innate ability and this interacts positively with their labor market experience to

⁶Farber and Gibbons (1996) develop a symmetric or public learning model to obtain different testable predictions, for example unobserved ability should increasingly be correlated with wages as experience increases. Pinkston (2009) extends this model and develops a test to show, using the same dataset, that asymmetric employer learning may be at least as important.

⁷In another paper, Meyer (1991) develops an alternative multiple tournament model with learning about ability (in the spirit of Harris and Holstrom (1982)). This model also has the fast track prediction. See also Rosen (1986) for a model of multiple elimination tournaments, showing the importance of concentrating prizes among few participants at each round.

yield heterogeneity in effective ability. This heterogeneity implies the presence of fast tracks: workers who promoted most quickly to level 2 will also promote most quickly to level 3, as they are more efficient in accumulating human capital.⁸ However, without heterogeneity in the ability to accumulate human capital, the fast track property may not hold. Chiappori et al. (1999) argue that employees who were promoted quickly (because of luck) have accumulated little human capital, so they are less likely to promote quickly to the next level than employees who promoted more slowly.

To summarize, learning, incentive and human capital acquisition models may all be consistent with the fast-track prediction. But only the incentive model does not rely on some form of worker heterogeneity, and the human capital model may even predict reverse fast tracks in the absence of heterogeneity. Furthermore, the learning model is consistent with the late-beginner prediction. We will assess these predictions on promotion dynamics in section 5 (after establishing the conditions for an ILM in section 4). We will stress the role of incorporating observed performance. This does not only serve as direct evidence on promotion-based incentives, but also shows how the fast-track and late-beginner predictions may be affected.

3 The data set

We study a large European university, located in Belgium and currently ranked in the top 100 of the QS World University Rankings. Our data set consists of the personnel records of all professors employed during 1972–2007. We will focus our analysis on the subperiod 1991–2007, since the university reformed its ranking system in 1991 and most performance variables were only available since then. In the Appendix we provide more detail on the evolution before 1991.

3.1 Overview

The main data set is the personnel data set, which records the employment information of all professors at the start of each academic year: anonymous identification code, age, sex, nationality, current academic year, affiliation within the organization (university group, faculty, department), four academic ranks (ranging from assistant professor to full professor), tenure status (permanent appointment or not), part-time appointment status, wage seniority

⁸The fast track prediction already holds for their benchmark full information model of human capital acquisition and job assignment. To also incorporate the other stylized facts (e.g. real wage decreases), Gibbons and Waldman (1999) subsequently extend their model to include learning.

and employment history (previous academic ranks, pre-doctoral and post-doctoral positions, year and location of Ph.D., age at entry).

We matched the personnel data set with two rich additional data sets on performance, maintained by the university. The first additional data set includes teaching load and selected management duties (dean, department head), available since 1980. Note that there is no information on teaching evaluations (as they have only been introduced in recent times and are not centrally maintained), nor on lower-level administrative duties (e.g. program director). The second additional data set contains the number of publications and average impact factor from three sources. First, the Science Citation Index Expanded (SCIE) primarily accounts for publications in exact sciences and medical sciences, and is available since 1991. Second, the Social Sciences Citation Index (SSCI) and the Arts and Humanities Citation Index (AHCI) account for publications in social sciences and humanities, and is available since 1997. For simplicity, we will refer to it as SSCI, since it is more representative for fields such as psychology and economics, and less so for other fields such as literature and philosophy, where professors more often publish in books.⁹ Third, we have the Proceedings measure since 1996. Proceedings counts the number of publications related to conferences (ISI Proceedings) and mainly accounts for publications in engineering (exact sciences) with a bias towards American conferences. For all research measures, we use the average cumulative performance of the past five years, since the university focuses on this period in its evaluation policy.¹⁰ We nevertheless performed an extensive sensitivity analysis with respect to other measures (e.g. performance in current year), as discussed in our empirical analysis below.

3.2 Summary statistics

Table 1 shows the definitions and summary statistics of our main variables during the period 1991-2007. There were 2,282 different professors, yielding a total number of 22,197 employee-year records during this period. The average number of professors per year is therefore 1,306 and the average observed (and censored) employment duration is 9.7 years. The recorded information per professor is complete for most variables, except for the research performance variables SSCI and Proceedings which are only recorded since 1997 and 1996. In our main analysis we include a dummy variable to account for missing information. We also perform a

⁹SSCI has been corrected to ensure that publications counted in SCIE are not also counted in SSCI. The impact factor in both SSCI and SCIE is based on the number of citations within SSCI and SCIE. If a publication is cited elsewhere it is not counted.

¹⁰For the years 1991-1994, we take the cumulative average since 1991, since we only observe performance since 1991.

sensitivity analysis by focusing on the period since 1997 or by limiting attention to professors from the exact and medical sciences groups (since SSCI is not relevant for these two groups). Wage information (computed from seniority step and current rank) is available since 1999.

The top part of Table 1 summarizes the individual and contract characteristics. Professors were on average 49 years old. There were only 13% women and 4% foreigners. Only 15% had a Ph.D. from another university, and 15% were external hires (no prior employment history at the university). Similarly, the vast majority entered in the lowest rank 1 (86%) and only 3% entered in rank 3 or 4.

Professors are employed more or less evenly across the three university groups (34% in humanities, 35% in medical sciences and 30% in exact sciences). Up to 33% of the professor-years are in the highest of the four possible academic ranks. The large majority of professor-years are tenured (85%). A particular feature of the university is the number of part-time appointments (33%). This is often because of a position at an affiliated institution such as the university hospital.

The bottom part of Table 1 summarizes performance information. The average teaching load is 4.6 week-hours, where one week-hour roughly corresponds to 26–30 hours of teaching. The number of management duties is about 0.3 per professor. The average number of publications (cumulative annual average over 5 years) is 2.5 in SCIE, 0.1 in SSCI and 0.3 in Proceedings. However, these averages hide important performance differences between the three main university groups. Teaching load has been considerably lower in medical sciences (3.4 week-hours) than in exact sciences and humanities (approximately 5.3 week-hours). The annual number of SCIE publications is highest in medical sciences (4.5) and exact sciences (3.1), while it is small in humanities. Conversely, the number of publications in SSCI is highest in humanities (0.3). We will account for these differences in our empirical analysis by interacting performance with group dummy variables.

4 The university as an internal labor market

In this section we show that Doeringer and Piore's (1971) two conditions for an ILM are satisfied to a much stronger degree for this university than for firms in other empirical studies. First, there are strong ports of entry at the lowest level, implying very long internal careers, already starting from graduate student. Second, the university has no wage autonomy, implying wages are shielded from external wages. Our description of the Belgian university includes a comparison with practices at universities in other countries.

4.1 Hiring and promotion policy

While European countries have recently attempted to harmonize their educational systems (the so-called Bachelor-Master reforms), there have been only very limited attempts to coordinate reforms of the internal governance of universities. As a result, there is currently a large diversity in hiring, promotion and tenure rules across European and North-American countries. As discussed in Musselin (2004) and Ferlie et al. (2008), one may distinguish between three different models. The first is the “tenure model”, with the U.S. as the most prominent example. After obtaining their Ph.D., candidates for an academic position start with time-limited contracts (often two three-year contracts) and at the end of the period an “up-or-out” tenure decision is made. The second is the “survivor model”, with Germany (before its 2001 reforms) and Austria as well-known examples. In this model candidates must first overcome a long period of selections. Only a few survive to obtain a permanent position as a university chair, usually at a relatively old age (average age of 42 in Germany in 2000). The third model is what Enders and Musselin refer to as the “protective pyramid model”. It is common in public systems of higher education such as France, Italy, and Spain. Access to a permanent position occurs quite early after a highly selective tournament. Careers subsequently develop through an internal system of promotions to higher categories, and there is no assurance that one can rise to the top of the pyramid.

In sum, Europe currently has two main systems: the German survival model with late access to tenure and a predominant external labor market, and the French pyramid or promotion-based model with early access to tenure and a predominant internal labor market with a promotion system (Musselin (2004)). In practice, the differences between the two models are not always clear-cut. Furthermore, several European countries started incorporating elements from the U.S. tenure model. For example, Germany introduced a system of Juniorprofessoren in 2001. These positions consist of two three-year contracts similar to U.S. tenure-track positions, except that at the end of the six year term, Juniorprofessoren must still apply for open permanent positions under the traditional process.

4.1.1 Administrative rules

The Belgian university we study is a close variant of the French system with early tenure and a promotion system, although it also shares features of the German system. Other universities in Belgium have very similar administrative rules, implying universities within the country have limited leeway to compete for academic personnel within the country.¹¹

¹¹Competition is further limited to the regional level, since Belgium consists of a Dutch-speaking and French-speaking region and there are usually language requirements for teaching. Within its own region, the

According to a Decree of the regional government, professors may be in one of four possible academic ranks, ranging from rank 1 (assistant professor), ranks 2 and 3 (associate professor) to rank 4 (full professor). These ranks have very similar job requirements (except somewhat more administrative duties at higher ranks). Every year the university decides on the number of new academic openings, with a description of the field for each opening.¹² There is typically strong competition for these openings, though in practice this is largely limited to Ph.D.’s or postdocs from the same or nearby universities. This is partly due to language requirements for teaching and partly because of the detailed field description in each vacancy. Appointments are often preceded by a postdoc position and usually start in the lowest rank (75%). There is clearly no up-or-out system as in the U.S. Contracts are often tenured from the start (42%) or contractually granted after a short period of three years (73%). After 6 years over 85% already have tenure. Hence, new entry in any rank is “quasi-tenured”, implying most hires have a history of post-doctoral experience (though not as long as in the German system). Professors may have a part-time or a full-time appointment. Full-timers are entitled to leave or become part-time on a temporary basis for a total of eight years during their career. In practice, 84% of the full-time appointed professors never go part-time, and 95% do not go part-time for more than 5 years.

Every year the university makes available a maximum number of promotion slots per academic rank and per university group (humanities, exact and medical sciences). The number of promotion slots is largely determined by the government, which specifies certain bounds on the number of professors per rank relative to the number of other employees (technical staff). The promotions are granted through an annual “tournament”, based on three main performance criteria: research, teaching and management duties. Evaluation of research performance is largely based on the past five years, with an emphasis on both publications and impact (without a rigid formula). Teaching performance is mainly evaluated on load (number of hours) rather than quality. Recently introduced student evaluations are currently purely informative or serve to remedy unusually bad performance. Management duties consist of a variety of tasks, such as program director or department chair. Each faculty has its own evaluation committee (of elected rank 4 professors), which makes an initial ranking of the candidates. The faculty rankings are subsequently aggregated to the level of the university group. Not everyone is eligible to apply for promotion: university

university we study has a reputation of a lower teaching load, which has made it particularly attractive for researchers to build an academic career.

¹²The university has only limited leeway to determine the number of openings. The government has most control as it decides on the budget and regulates the number of professor positions. The limited budget autonomy is a common phenomenon in Europe. According to Aghion et al. (2010)’s European survey, budget autonomy is low in Germany (index=0.0), Switzerland (0.1), Belgium (0.375), Ireland, Spain (0.5), whereas it is high in the Netherlands, Sweden (0.8), Italy, the U.K. (0.9) and Denmark (1.0).

rules stipulate that professors can typically only be promoted one rank higher, and should stay at least two/three full years within a rank.

4.1.2 Structure and stability of the hierarchy

With only four ranks, the hierarchy is considerably simpler than in the private corporations of BGH, Treble et al. (2001) and others. Figure 1 shows the university’s hierarchy at several points in time since 1991, following BGH’s Figure III. The number of professors per rank is more or less uniform, so it does not have the pyramid structure of BGH or of the pure French system as suggested by Musselin (2004) (although she does not provide actual evidence of the pyramid structure in France). The hierarchy has remained relatively stable since 1991, with the exception of the lower ranks during the first few years. This is because rank 2 was only introduced during the 1991 ranking reform.

We can summarize these findings as follows:

Observation 1 *The university’s hierarchy is simple, uniform and has been relatively stable during 1991-2007.*

4.1.3 Ports of entry and exit, and long-term careers

Insights into the hiring and promotion policies are obtained by looking at the number of annual job transitions. Extending BGH’s Table I, we present a job transition matrix for the period 1991–2007 in Table 2. Row 4 of the transition matrix (Total Entry) confirms that most entry occurs in the lowest professor rank: there were 948 entrants in rank 1. Entry in rank 2 was considerably less important and entry in rank 3 and 4 was very rare. Rows 1 to 3 of the transition matrix provide more detail on how entry occurs by distinguishing between three types of entry. “Internal entry” refers to professors who were previously employed as a Ph.D. student or post-doctoral researcher at the same university. “Delayed internal entry” is similar, except that the individual was employed elsewhere for an intermediate period. “External entry” refers to professors who were never employed at the university before. Table 2 shows that 80% of entry is internal: there are 767 internal and 238 delayed internal entrants, compared with only 260 external entrants. Note that external entry is comparatively more important in the highest ranks 3 and 4, but is rare in absolute terms. Since an internal entrant is typically also a Ph.D. from the same university, it is interesting to put this in a broader European perspective. Based on a European survey, Aghion et al. (2010) find that many other European universities tend to hire their own Ph.D.’s, with the

exception of Germany and the U.K. This “endogamy” tends to be strongest in the smaller countries, such as Belgium where the university we study is located.

In sum, we have:

Observation 2 *The lowest rank 1 is a strong port of entry into professorship. In fact, the port of entry is already prior to professorship (as Ph.D. or postdoc).*

It is interesting to relate this to the findings of Coupé et al. (2006). They focus on a sample of top economists and find evidence of upward mobility (to higher ranked universities) in response to past performance. To shed light on this, we constructed a new transition matrix, limited to only the top 10% researchers (using various alternative measures, as discussed in Appendix). Consistent with Coupé et al. (2006), this matrix shows that the port of entry is somewhat less clearly defined for top researchers: they enter relatively more in the higher ranks.¹³

Columns 5 and 6 of Table 2 shows exits from the various ranks. A small group temporarily exits (Temp Out column) to come back later, usually in the same rank. Permanent exit (Total Exit column) most frequently occurs from the highest rank 4 (386 out of 827 cases). In contrast with earlier work, we can distinguish between two sources of exit: early exit and retirement (mandatory at age of 65 and voluntary from age of 60). In fact, most exit from ranks 2, 3 and 4 is due to retirement (up to 84% of the cases), whereas exit from the lowest rank 1 is mostly early exit, related to non-tenure decisions (69% of the cases).

In sum, we can conclude:

Observation 3 *The highest rank 4 is an important port of exit. Exits at ranks 2, 3 and 4 are mainly due to retirement, whereas exit at rank 1 is mainly early exit.*

Observations 2 and 3 are in stark contrast with most other personnel studies, such as Lazear (1992), BGH, Treble et al. (2001) and others. They observe considerably more entry in higher levels, and more exit at lower levels. To our knowledge, there are only two other studies documenting a strong port of entry at low job levels, both for a 19th century firm: Seltzer and Merrett (2000) for the Union Bank of Australia and Howlett (2004) for the Great Eastern Railway company in the U.K..

Finally, the intersection of rows 5–8 and columns 1–4 in Table 2 shows the career transitions among the four academic ranks. Non-promotions or stays (on the “diagonal”) are most

¹³From the top researchers, 28.8% enter in rank 2 and 10.6% enter in rank 3 or 4, compared with only 17.5% rank 2 and 7.5% rank 3 or 4 entrants for the whole sample of researchers. We also find that top researchers show more early exit, but the difference here is only small.

commonly observed. Promotions (to the right of this diagonal) are almost always one-rank promotions. Demotions are essentially non-existent. These findings are consistent with the administrative promotion rules described earlier.

Having established the patterns of ports of entry and exit, Table 3 provides insights into the length of careers, broken down by the rank at which professors entered. This follows a structure similar to BGH's Table II on career characteristics by entry in rank. As in BGH, the table limits attention to professors hired between 1991-1999: this reduces censoring problems when describing the career length and the number of obtained ranks over a career.

Table 3 shows that professors hired between 1991–1999 have very long careers. Only a small minority leaves within the first eight years of professorship. Rank 1 and 2 entrants had an average career length of about 12 years. This is very long, given that our sample ends in 2007. Furthermore, most entrants into professorship have a long prior employment history at the university (e.g. Ph.D. student or postdoctoral researcher), approximately 8 years for rank 1 and 2 entrants. This evidently makes their average career length within the university up to 2007 even longer. In sum, careers tend to be substantially longer than documented in BGH's comparable Table II or Treble et al. (2001).

Careers are not only very long, they also show steady progress. Of the professors with long careers (more than 8 years), only 18% of the rank 1 hires did not promote to a higher rank; 28% promoted one rank, 26% two ranks and the remaining 29% even three ranks up to the highest rank. The majority of rank 2 or 3 professors also promoted to the highest rank. We can summarize these findings as follows.

Observation 4 *Careers within the university are very long, and they show steady progress to higher ranks.*

4.2 Wage policy

In many European countries, universities have only limited wage autonomy. According to a survey by Aghion et al. (2007) and Aghion et al. (2010), wage autonomy is especially low in Belgium, together with Germany, Ireland, Italy, Spain and Switzerland (index=0.0). There is some small wage autonomy in the Netherlands (0.2) and Denmark (0.5) and large wage autonomy in the U.K. (0.8) and Sweden (1.0).

In the Belgian university we study, wage autonomy is indeed very low. A government decree determines the compensation system for all universities, and this has not been modified since 1991. The compensation system includes automatic wage indexation to compensate for inflation, and fixed seniority schemes for each academic rank. More specifically, every year

of employment results in an additional seniority step. If a cycle of three steps is completed, the salary increases to a new level and a new three-step cycle begins. When a professor is promoted to a higher academic rank, she receives a wage according to the seniority scheme of the new rank. The number of seniority steps in this new rank is adjusted downward to the lowest number such that (1) the wage is not lower than without the promotion and (2) the position within the three-step cycle is maintained. For example, a professor who is currently in the second year of a three-step cycle will upon promotion move to the third year of the cycle in the new rank that gives at least the same wage.

The seniority rules imply that the university can only influence wages at the start of entry (by negotiating a rank and a number of seniority steps) and through the timing of subsequent promotions. There is no flexibility to directly influence wages within a rank. Figure 2 shows the salary scales for the four ranks (in real terms). We normalize a professor's wage in rank 1 with zero years of seniority to 100. One can clearly see how wages increase after each three-year cycle. To illustrate how promotion affects wages, the bold line shows the salary path of the average professor with an average duration in each rank (and zero seniority steps at entry). It would take the average professor 27 years for the (real) wage to increase from 100 to 230.

Since the university has no wage autonomy and the wage rules have not changed since 1991, one may conjecture that internal wages are shielded from the external wage evolution, Doeringer and Piore's second condition for an ILM. Indeed, if the ranking system of the hierarchy and the age structure remained stable over time, we would expect that average wages at the university simply follow inflation (because of automatic wage indexation). The question then becomes whether external market wages for comparable employees also followed inflation or followed a different pattern.

To address this question we compared the evolution of real (gross) wages at the university with the evolution on the external labor market, in the spirit of Lazear and Oyer (2004).¹⁴ We made use of a rich annual survey of gross wages from the Belgian Ministry of Economic Affairs, which distinguishes between wages by education level and occupation level. Figure 3 shows the results of this comparison. The top panel (Figure 3a) shows that average real wages have essentially remained constant at the university, and effectively followed a similar pattern as real wages for employees with only secondary education levels. In contrast, real wages for employees with a post-secondary education (college or university) increased significantly, by 11% over 1999-2007. The bottom panel (Figure 3b) confirms this conclusion for employees

¹⁴Lazear and Oyer (2004) are able to follow a more systematic approach since they have panel data on multiple firms. This enables them to assess whether firm effects are important in the long run relative to time and occupations effects. Our approach is in a similar spirit, though we can only compare a single firm (our university) with market averages, broken down by skills and occupations.

with different occupation levels. Just like the professors at the university, employees in low occupation levels (technical and semi-skilled) did not experience real wage increases, whereas employees in high occupation levels saw real wage increases from 11% (intellectual professions) to 18% (management). Note that other work has also extensively documented increases in the returns to education and a resulting rising inequality between low and high skilled jobs, see e.g. Katz and Murphy (1992) and Autor et al. (2006) for the U.S. or Goos and Manning (2007) for the U.K. From this perspective our finding that university wages did not increase is even more striking. It is however consistent with a limited number of studies on public firms. Gibbs (2006) found that the returns to skills for engineers and scientists in the U.S. Department of Defense laboratories remained flat or even decreased during 1982-1996, in contrast with the evolution in the private sector. Finally, note that university wages do not only diverge from comparable external wages in the long run. They also show considerably more short-term stability than average external wages.

To further explore the wages at the university, we use our data set on professors/years to estimate a wage regression in the spirit of Medoff and Abraham (1980) and Kwon (2006). We regress the log(wage) on calendar year effects, years of experience, rank dummies and performance variables.¹⁵ The results are shown in Table 4. The year effects are even more stable than in Figure 3 (as they now control for time-varying effects). Interestingly, the performance variables have a significant effect on wages in the regression unconditional on professor rank, but most are no longer significant once we condition on rank. Hence, performance is only rewarded through promotions and not directly because of the lack of wage autonomy. This contrasts with Kwon (2006)'s study of an insurance company, where incentives are 50% promotion-based and 50% based on direct monetary payments.

We can summarize the above findings as follows.

Observation 5 *The university has no direct wage autonomy; it can only influence wages through incentive-based promotions. As a result, average real wages at the university have hardly changed since 1999. This contrasts with large external wage increases for high education or high occupation employees, showing that wages are shielded from the external wage evolution.*

Finally, note that because of the lack of wage autonomy some of the stylized facts relating to wage dynamics (as summarized in section 2 based on Gibbons and Waldman (1999)) may

¹⁵Our focus here is most closely related to Kwon (2006). Other studies since Medoff and Abraham, e.g. Flabbi and Ichino (2001) and Dohmen (2004), used somewhat more subjective performance measures. They focused on how performance affects the experience-wage relationship. Similar to these studies, we find that increased performance cannot explain the experience-wage relationship.

no longer hold. For example, real wage decreases never occur (because of wage indexation and the wage seniority rules). There is, however, more support for Gibbons and Waldman (1999)’s third and fourth stylized facts. Wage increases at promotion are relatively large (despite the above described downward seniority adjustment), on average +8.4% for promotion to rank 2, +8.1% for promotion to rank 3 and +8.6% for promotion to rank 4 (compared with 5-9% wage increases upon promotion in BGH’s firm, their Table VI). Furthermore, these wage increases at promotion are relatively small compared with average wage differences between ranks: an average wage premium of +13.6% for rank 2 over rank 1, +17.7% for rank 3 over rank 2, +22.0% for rank 4 over rank 3.¹⁶

5 Internal promotion dynamics

The evidence in the previous section indicates strong evidence for Doeringer and Piore’s two main conditions for an ILM. There is a strong port of entry at the lowest rank and even prior to that, and as a result long internal careers. Furthermore, the university has no wage autonomy, resulting in constant real wages independent of external market developments. Since promotions are the only channel through which the university can influence its employees during their careers, we now investigate the promotion dynamics in more detail. In section 5.1 we outline a semi-parametric hazard rate model of promotion, to test the predictions of ILM models and assess the role of performance incentives.¹⁷ In section 5.2 we present the empirical results.

5.1 A discrete-time hazard rate model for promotions

The promotion hazard rate is the probability of promotion conditional on not being promoted before. Since the promotion process is truly discrete in our application, we consider a discrete-time semi-parametric hazard rate model. The model allows the hazard rate to depend in a fully flexible way on time in current rank, durations in previous rank, performance variables and individual and contract characteristics. More specifically, define the hazard rate h_{jt}^r as the probability that professor j , currently in rank $r = 1, 2, 3$, promotes to the next rank $r + 1$ at time $T_j^r = t$, given that j has not yet been promoted. Specify this hazard

¹⁶However, BGH find much larger wage differences between ranks, especially for their higher ranks 4 to 8 (40% or higher). A possible explanation is that these ranks are more exclusive in their firm.

¹⁷This extends BGH’s descriptive non-parametric promotion hazard rate analysis. Their hazard rate tables (which we present for our university in the Appendix) only condition on years in current rank and years in previous rank. In contrast, our model also considers dependence on earlier ranks to assess predictions from learning models, in particular Chiappori et al. (1999)’s late-beginner property.

rate as the logistic function

$$\begin{aligned} h_{jt}^r &= \Pr[T_j^r = t | T_j^r \geq t, x_{jt}] \\ &= \frac{1}{1 + \exp(-\alpha^r(t) - v_{jt}^r)}. \end{aligned} \quad (1)$$

The logistic specification ensures that the hazard rate lies between 0 and 1. If one would want to specify a proportional hazard rate, the log-log model would be more appropriate [Holford (1976) and Prentice and Gloeckler (1978)]. Nevertheless, the logistic model converges to a proportional hazard model as the time interval becomes small [Thompson (1977)]. The hazard rate depends on time and on other variables.

First, the hazard rate depends on time through the function $\alpha^r(t)$. One may specify functions that are increasing or decreasing in time.¹⁸ We follow a more flexible approach and specify time-dependence semi-parametrically by including a full set of time in rank effects α_t^r ($t = 1, 2, \dots$). This flexibility is appropriate since institutional constraints on promotion may affect the promotion probabilities rather differently in the first years.

Second, the hazard rate depends on other variables through v_{jt}^r . We consider three sets of variables: durations in previous ranks, teaching and research performance, and individual and contract characteristics. Consider the following specification for professors in rank $r = 3$ being promoted to rank 4:

$$v_{jt}^3 = \beta_1^3 DUR_j^1 + \beta_2^3 DUR_j^2 + \gamma^3 PERF_{jt} + \delta^3 OTHER_{jt}. \quad (2)$$

$PERF_{jt}$ is a vector of teaching and research performance variables, interacted with the university groups (humanities, exact and medical sciences) to account for possible differences in culture and standards towards teaching and research. $OTHER_{jt}$ refers to individual characteristics such as sex, age at entry, nationality and Ph.D. origin, and contract characteristics such as tenure and full-time status. It also includes rank cohort effects, which refer to the academic year at which previous promotion took place. The rank cohort effects capture the possibility that the number of promotion slots was lower during certain years because of government restrictions or budget cuts.

Finally, DUR_j^1 and DUR_j^2 are state variables referring to the duration in previous ranks 1 and 2, respectively. The signs and magnitudes of β_1^3 and β_2^3 enable us to assess specific patterns of promotion dynamics predicted by the ILM models discussed in section 2. First, several models predict the presence of fast tracks: professors with a short duration in previous

¹⁸For example, in the proportional log-log hazard rate model, one could specify $\alpha^r(t) = \alpha_0 + \alpha_1 \log t$, to have the well-known Weibull model.

ranks have a short duration in the next rank, or equivalently they have a higher promotion probability to the next rank. The fast track property means that $\beta_1^3 < 0$ and $\beta_2^3 < 0$. Second, the symmetric learning model of Harris and Holstrom (1982) and Chiappori et al. (1999) predicts the late beginner property: a rank 3 professor who stayed long in rank 1 (high DUR_j^1) but subsequently caught up (to achieve same total duration in ranks 1 and 2, $DUR_j^1 + DUR_j^2$) has a higher promotion probability to rank 4. To see what the late beginner property implies for the parameters, it is convenient to rewrite the specification (2) as

$$v_{jt}^3 = (\beta_1^3 - \beta_2^3) DUR_j^1 + \beta_2^3 (DUR_j^1 + DUR_j^2) + \gamma^3 PERF_{jt} + \delta^3 OTHER_{jt}.$$

According to the late beginner property, DUR_j^1 has a positive impact on rank 3 professor's promotion probability to rank 4, holding constant $DUR_j^1 + DUR_j^2$. This means that $\beta_1^3 - \beta_2^3 > 0$. Combining the fast track and late beginner properties, we therefore have the testable prediction $\beta_2^3 < \beta_1^3 < 0$. Intuitively, the duration in the most recent rank 2 has the strongest negative effect on the probability of promotion. The duration in the earlier rank 1 has a weaker but still negative effect.¹⁹

More generally, for professors currently in rank $r = 1, 2, 3$ we specify v_{jt}^r as a function of all durations in previous ranks DUR_j^s , $s = 0, \dots, r - 1$:

$$v_{jt}^r = \sum_{s=0}^{r-1} \beta_s^r DUR_j^s + \gamma^r PERF_{jt} + \delta^r OTHER_{jt},$$

where DUR_j^0 refers to the duration at the university prior to entering professorship (i.e. as a Ph.D. or postdoc).²⁰ If there are fast tracks, then $\beta_{r-1}^r < 0, \beta_{r-2}^r < 0, \dots, \beta_0^r < 0$. If in addition the late beginner property holds, we have $\beta_{r-1}^r < \beta_{r-2}^r < \dots < \beta_0^r < 0$: professors with long durations in previous ranks have a lower promotion probability, and the effects are strongest for the most recent durations. For the fast track property we will therefore test the null that the β_s^r 's are equal to zero; for the late beginner property we test the null that the β_s^r 's are equal to each other.

We estimate the model using maximum likelihood. We take into account censoring issues because the data set ends in 2007: for individuals that have not yet achieved the highest rank we do not observe their complete duration in ranks history. This is a situation of independent

¹⁹Our empirical approach to test the late-beginner property differs from Chiappori et al. (1999). We test it directly using duration in previous ranks, whereas they first classify individuals into categories of early starters and late beginners prior to estimation.

²⁰As shown in section 4, there is a small group of professors who entered externally in rank 1, and an even smaller group who entered immediately in rank 2 or 3. For this group, the durations in previous ranks are not defined. To account for this, we set these past durations equal to zero and include three dummy variables for these types of entrants: external, rank 2 and rank 3 entrants.

censoring, since all individuals stopped being observed in 2007, regardless of their promotion probability. As first noted by Brown (1975) and further developed by Allison (1982), it is possible to simplify the likelihood function so that it can be estimated as a binary dependent variable model after suitably organizing the data set. With the hazard specification (1), the model can be estimated as a binary logit model.

5.2 Empirical results

Table 5 presents the empirical results of the hazard rate model (1), which includes the time in current rank effects (α_t^r), the individual and contract characteristics (*OTHER*), the duration in previous rank effects (*DUR*), and the teaching and research performance measures (*PERF*). In the Appendix we also report the results from a model without controlling for performance measures, and an extensive sensitivity analysis: a model based on post-1997 data or excluding humanities (for which performance is not observed prior to 1997), alternative measures of cumulative research performance, and alternative hazard rate models (a logistic model with random effects, and a discrete-time version of the Box-Cox model). These results broadly confirm the conclusions obtained below.

Time in current rank effects The time in current rank effects α_t^r (not shown in Table 5) follow an inverse U-shaped pattern. For all ranks 1, 2 and 3, the promotion probability to the next rank is extremely small during the first two years in a rank (0% after the first year and 4% after the second year). The promotion probability sharply increases after the third and fourth year (to about 25%), and then gradually declines in the subsequent years (to about 10% after the tenth year). This pattern shows the administrative restrictions on promotion during the first two years in a new rank are effectively binding. In the third and fourth year there appears to be a catching up with higher promotion rates, which subsequently decline to more “normal” rates.

Individual and contract characteristics Several of the individual and contract characteristics play a significant role, but there are no strong patterns across all ranks. For example, the promotion probability is significantly lower for women in rank 2 or foreigners in rank 3 but not when they are in other ranks. Part-time professors have a significantly lower promotion probability to ranks 2 and 4, and professors with tenure have a significantly higher promotion probability to all three ranks. Compared with internal Ph.D.s, external Ph.D.s from a foreign university have a significantly higher promotion probability to rank 2, but not to higher ranks, suggesting that general human capital acquired abroad only plays a short-term role at this university. External entrants (i.e. professors who were not employed at the

university before entering professorship) have a significantly higher promotion probability when they are in rank 2, but not when they are in other ranks. Perhaps surprisingly, professors who immediately entered in rank 2 or 3 (and thus skipped the port of entry at rank 1) have a significantly lower probability of being promoted than professors who entered in rank 1. One interpretation is that these professors need to build firm-specific human capital.

Performance We now turn to the estimated effects of the performance variables. The number of administrative duties do not appear to play a significant role, except for promotion to the highest rank. However, this variable does not capture several lower-level tasks such as program director. Teaching performance, measured by teaching load in week-hours, has a positive and highly significant impact on the promotion probabilities in almost all ranks and groups (except for humanities professors being promoted to rank 4). The positive effect of one extra week-hour is quantitatively the highest in medical sciences, because this group has the lowest average teaching load. Teaching load has a smaller effect on the promotion probability to rank 4, at least for professors in humanities and medical sciences.

Research performance also has a significant impact on the promotion probabilities. Professors in humanities promote faster to any rank if they have published a lot in their own field, SSCI. Publication impact does not appear to speed up their promotions. As expected, the number of publications in other fields (SCIE and Proceedings) play a less important role for professors in humanities. Professors in exact and medical sciences also promote significantly faster if they publish a lot in their own field, SCIE and Proceedings. Furthermore, the publication impact now also speeds up promotions. This may be because publication impact has a stronger recognition in exact and medical sciences, or because it is better measured here than in humanities. Finally, professors in exact and medical sciences do not see better promotion prospects when they publish in SSCI, which is outside their field.

It is interesting to note that an extra publication has a much larger effect on the promotion probability in humanities than in medical or exact sciences.²¹ This is because the average number of publications of exact and medical sciences professors in SCIE is about 10 times larger than that of humanities professors in SSCI (as discussed earlier in section 3). Hence, performance evaluation tends to be relative to the other individuals in the same group. One interpretation could be that articles have more coauthors in medical and exact sciences than in humanities, such that one additional publication receives less weight in medical and exact sciences than in humanities.²²

²¹For example, the effect of a SSCI publication on the promotion probability of a humanities professor varies between 0.83 and 1.11, whereas the effect of a SCIE publication on the promotion probability of an exact sciences professor is only between 0.06 and 0.20.

²²We had partial information on the number of co-authors for professors in exact and medical sciences.

It is also of interest to compare the magnitudes at which teaching and research are rewarded (bearing in mind the differences in publications across groups mentioned before). To illustrate, consider the promotion probabilities to rank 2. In humanities, a group-average of 0.3 publications per year in SSCI gives the same promotion probability as a teaching load of 2.4 week-hours (or about half of the average teaching load in humanities of 5.3 hours).²³ In exact sciences, an average of 3 publications per year in SCIE is equivalent with a teaching load of 1.6 week-hours (or less than 1/3 of the average teaching load of 5.4 hours). In medical sciences, an average of 4.5 publications per year gives the same promotion probability as a teaching load of 3.4 week-hours (which is the average teaching load in medical sciences). These calculations indicate that medical sciences reward research performance most (in terms of “teaching compensation”), followed by humanities and exact sciences.

We finally extended the model to allow the performance variables to have different effects on promotion probabilities in the second half of the sample period (after 2001). These results (not shown) indicate that the university did not change its policy over the period, for example by rewarding research more in recent years.

We summarize the role of the performance measures as follows:

Observation 6 *Both teaching and research performance play an important role in explaining promotion probabilities. There are important differences between the three main groups.*

Fast tracks and late-beginner property We finally assess the presence of fast tracks and the late-beginner property, by considering the duration in previous ranks effects. First, all duration effects are negative and highly significant (at the 1% significance level or lower). This shows the presence of fast tracks: short durations in previous ranks imply short durations in the next rank (i.e. high subsequent promotion probabilities). Second, the negative duration effects are larger for the most recent ranks (in absolute value). For example, a rank 2 professor’s promotion probability to rank 3 is especially high if she had a short duration in rank 1 and less so if she had a short duration in rank 0 (Ph.D. or postdoc). This is consistent with the late-beginner property: professors who had a late first promotion but caught up have a higher probability of being promoted in the future. However, while the differences between consecutive ranks show a clear pattern, they are usually not statistically significant.

What do these findings imply about the relevance of alternative learning models? First, the weak evidence for the late-beginner property seems to suggest that there is only limited

However, when we included that variable it did not turn out to be significant.

²³We find the equivalence in teaching load using the following calculation: $\frac{0.3(1.11)}{0.14} = 2.4$.

support for the learning model. However, Chiappori et al. (1999) developed the test as a prediction when performance is not directly observed by the researcher. When we estimate the hazard rate model excluding our performance variables, we find strong support for the late-beginner property (P-value $< 5\%$). One can interpret this as evidence that most of the learning about ability relates to our observed research and teaching variables. Learning about other determinants of ability appears to be less important, at least in this university. It would be interesting to explore this further for other universities or private companies.

Second, the strong support for the fast track property (even after we include the performance variables) is consistent with models of learning, incentives and human capital accumulation. If we assume our performance measures capture most of the heterogeneity between professors, we can be more conclusive. Indeed, learning and human capital accumulation models predict the fast-track property because of unobserved heterogeneity by the researchers.²⁴ Hence, in these models, fast tracks would no longer apply conditional on performance. Meyer's (1992) incentive model of consecutive tournaments (with identical workers) may therefore fit our findings more closely. She shows that it is optimal to reward winners of the first promotion tournament not only by a higher salary but also by favoring them in the next tournament. There may be other explanations for a direct link between the early promotions and subsequent ones (not depending on employee heterogeneity). Or, it is possible that our performance measures, while an improvement over previous work, leave an important amount of unobserved heterogeneity. It would be interesting to explore these possibilities in future research.

We can summarize these findings as follows.

Observation 7 *There is strong support for the fast track prediction, even conditional on observed performance. The late beginner property only has significant support in the model without performance variables. This suggests most learning about ability relates to our observed research and teaching variables.*

6 Conclusion

We collected a rich personnel data set of a large European university. A unique feature of our data is the relatively simple personnel policy rules compared to other studies. Furthermore,

²⁴As noted in section 2, Chiappori et al. (1999) even argue that reverse fast tracks would hold in human capital accumulation models (with homogeneous workers): a short duration in the first level (because of luck) means little human capital has been accumulated, and hence a long expected duration in the next level.

we have good measures of performance as compared with previous studies. These features make the data set particularly well-suited to study the relevance of internal labor market theories.

We find strong evidence for Doeringer and Piore's two conditions for the existence of an internal labor market, considerably stronger than the evidence found in other work. First, the lowest academic rank is a strong port of entry (and the highest rank is a port of exit). In fact, entry mainly occurs already prior to entering the professorship ranks (at the Ph.D. or post-doctoral stage). Second, wages have been shielded from external wage developments: they remained constant in real terms for a long time, in contrast with high-skilled and high-occupation employees in the region who saw large real wage increases during the same period.

Having established the presence of an internal labor market, we subsequently look at internal career dynamics to assess the relevance of alternative internal labor market theories. Consistent with incentive theories, observable performance plays an important role, but only by increasing the speed of promotion and not by raising wages through other channels. Furthermore, conditional on observed performance, fast tracks remain important but the late-beginner property only has weak empirical support, suggesting most learning about ability relates to our observed performance measures.

Finally, we stress that administrative rigidities play an important role in explaining promotion dynamics. For example, the university does not have direct wage autonomy, so it cannot give temporary monetary rewards, only permanent rewards through promotions. As another example, the university has a rule of not promoting individuals within the first two years of a previous promotion. This constitutes an effective constraint on promotion probabilities, since there is a disproportionate increase in the promotion hazard in the third and fourth year. These examples suggest that administrative rules constrain personnel policies and may entail inefficiencies.

More generally, while we documented to which extent the French promotion-based system with early tenure may be consistent with incentives and other theories, it remains an open question under which conditions it is an efficient alternative to the U.S. up-or-out system. As analyzed by Ghosh and Waldman (2010), standard promotions create distortions because they signal the workers' ability to other firms. A promotion-based system may therefore only be optimal if firm-specific human capital is high; otherwise an up-or-out system is desirable to cope with the signalling distortions. Further comparative research on the organization of universities or other companies would be interesting to assess the relative efficiency of different systems and/or guide policy reforms.

7 References

- Aghion, Philippe, Mathias Dewatripont, Caroline Hoxby, Andreu Mas-Colell, and Andre Sapir**, “Why Reform Europe’s Universities?,” *Brugelpolicybrief*, 9 2007, 4, 1–8.
- , – , – , – , and **André Sapir**, “The governance and performance of universities: evidence from Europe and the US,” *Economic Policy*, 01 2010, 25, 7–59.
- Allison, Paul D.**, “Discrete-Time Methods for the Analysis of Event Histories,” *Sociological methodology*, 1982, 13, 61–98.
- Ariga, Kenn, Yasushi Ohkusa, and Giorgio Brunello**, “Fast track: is it in the genes? The promotion policy of a large Japanese firm,” *Journal of Economic Behavior & Organization*, 1999, 38 (4), 385 – 402.
- Autor, David H., Lawrence F. Katz, and Melissa S. Kearney**, “The Polarization of the U.S. Labor Market,” *The American Economic Review*, 2006, 96 (2), pp. 189–194.
- Baker, George, Michael Gibbs, and Bengt Holmstrom**, “The Internal Economics of the Firm: Evidence from Personnel Data,” *The Quarterly Journal of Economics*, November 1994, 109 (4), 881–919.
- Becker, Gary S.**, “Investment in Human Capital: A Theoretical Analysis,” *Journal of Political Economy*, 1962, 70, 9.
- Brown, Charles C.**, “On the Use of Indicator Variables for Studying the Time-Dependence of Parameters in a Response-Time Model,” *Biometrics*, 1975, 31 (4), 863–872.
- Chiappori, Pierre-Andre, Bernard Salanie, and Julie Valentin**, “Early Starters versus Late Beginners,” *Journal of Political Economy*, August 1999, 107 (4), 731–760.
- Coupé, Tom, Valérie Smeets, and Frédéric Warzynski**, “Incentives, Sorting and Productivity along the Career: Evidence from a Sample of Top Economists,” *Journal of Law, Economics and Organization*, April 2006, 22 (1), 137–167.
- DeVaro, Jed and Michael Waldman**, “The signaling role of promotions: Further theory and empirical evidence,” Technical Report, mimeo June 2009.

- Doeringer, Peter B. and Michael J. Piore**, *Internal Labor Markets and Manpower Analysis*, M E Sharpe Inc, 1971.
- Dohmen, Thomas J.**, “Performance, seniority, and wages: formal salary systems and individual earnings profiles,” *Labour Economics*, December 2004, 11 (6), 741–763.
- , **Ben Kriechel, and Gerard A. Pfann**, “Monkey bars and ladders: The importance of lateral and vertical job mobility in internal labor market careers,” *Journal of Population Economics*, 06 2004, 17 (2), 193–228.
- Farber, Henry S. and Robert Gibbons**, “Learning and Wage Dynamics,” *The Quarterly Journal of Economics*, November 1996, 111 (4), 1007–47.
- Ferlie, Ewan, Christine Musselin, and Gianluca Andresani**, “The Steering of Higher Education Systems: A Public Management Perspective,” *Higher Education*, 2008, 56 (3), pp. 325–348.
- Flabbi, Luca and Andrea Ichino**, “Productivity, seniority and wages: new evidence from personnel data,” *Labour Economics*, June 2001, 8 (3), 359–387.
- Ghosh, Suman and Michael Waldman**, “Standard promotion practices versus up-or-out contracts,” *RAND Journal of Economics*, 2010, 41 (2), 301–325.
- Gibbons, Robert and Michael Waldman**, “A Theory Of Wage And Promotion Dynamics Inside Firms,” *The Quarterly Journal of Economics*, November 1999, 114 (4), 1321–1358.
- Gibbs, Michael**, “Returns to Skills and Personnel Management: U.S. Department of Defense Scientists and Engineers,” *Economic Inquiry*, April 2006, 44 (2), 199–214.
- **and Wallace Hendricks**, “Do formal salary systems really matter?,” *Industrial and Labor Relations Review*, October 2004, 58 (1), 71–93.
- Goos, Maarten and Alan Manning**, “Lousy and Lovely Jobs: The Rising Polarization of Work in Britain,” *The Review of Economics and Statistics*, 01 2007, 89 (1), 118–133.
- Groysberg, Boris, Ashish Nanda, and Nitin Nohria**, “The Risky Business of Hiring Stars,” *Harvard Business Review*, 2004.
- Hallock, Kevin F.**, “Seniority and Monopsony in the Academic Labor Market: Comment,” *American Economic Review*, June 1995, 85 (3), 654–57.

- Harris, Milton and Bengt Holstrom**, “A Theory of Wage Dynamics,” *Review of Economic Studies*, July 1982, *49* (3), 315–33.
- Holford, Theodore R.**, “Life Tables with Concomitant Information,” *Biometrics*, 1976, *32* (3), 587–597.
- Holmstrom, Bengt**, “Moral Hazard and Observability,” *The Bell Journal of Economics*, 1979, *10* (1), 74–91.
- Howlett, Peter**, “The Internal Labour Dynamics of the Great Eastern Railway Company, 1870-1913,” *The Economic History Review*, 2004, *57* (2), pp. 396–422.
- Kahn, Lisa B. and Fabian Lange**, “Employer Learning, Productivity and the Earnings Distribution: Evidence from Performance Measures,” Technical Report Jul 2010.
- Katz, Lawrence F. and Kevin M. Murphy**, “Changes in Relative Wages, 1963-1987: Supply and Demand Factors,” *The Quarterly Journal of Economics*, 1992, *107* (1), pp. 35–78.
- Kwon, Illoong**, “Incentives, Wages, and Promotions: Theory and Evidence,” *The RAND Journal of Economics*, 2006, *37* (1), pp. 100–120.
- Lazear, Edward P.**, *Performance Measurement, Evaluation, and Incentives*, Boston: Harvard Business School Press,
- **and Paul Oyer**, “Internal and external labor markets: a personnel economics approach,” *Labour Economics*, October 2004, *11* (5), 527–554.
- **and –**, “Personnel Economics,” NBER Working Papers 13480, National Bureau of Economic Research, Inc Oct 2007.
- **and Sherwin Rosen**, “Rank-Order Tournaments as Optimum Labor Contracts,” *Journal of Political Economy*, October 1981, *89* (5), 841–64.
- Lin, Ming-Jen**, “Opening the Black Box The Internal Labor Markets of Company X,” *Industrial Relations*, 2005, *44*, 659–706.
- Medoff, James L. and Katharine G. Abraham**, “Experience, Performance, and Earnings,” *The Quarterly Journal of Economics*, 1980, *95* (4), pp. 703–736.
- Meyer, Margaret A.**, “Learning from Coarse Information: Biased Contests and Career Profiles,” *The Review of Economic Studies*, 1991, *58* (1), pp. 15–41.

- , “Biased Contests and Moral Hazard: Implications for Career Profiles,” *Annales d’Économie et de Statistique*, 1992, (25/26), pp. 165–187.
- Musselin, Christine**, “Towards a European Academic Labour Market? Some Lessons Drawn from Empirical Studies on Academic Mobility,” *Higher Education*, 2004, 48 (1), pp. 55–78.
- Oyer, Paul**, “Ability and employer learning: Evidence from the economist labor market,” *Journal of the Japanese and International Economies*, June 2008, 22 (2), 268–289.
- Pinkston, Joshua C.**, “A Model of Asymmetric Employer Learning with Testable Implications,” *Review of Economic Studies*, 01 2009, 76 (1), 367–394.
- Podolny, Joel M. and James N. Baron**, “Resources and Relationships: Social Networks and Mobility in the Workplace,” *American Sociological Review*, 1997, 62 (5), pp. 673–693.
- Prentice, R. L. and L. A. Gloeckler**, “Regression Analysis of Grouped Survival Data with Application to Breast Cancer Data,” *Biometrics*, 1978, 34 (1), 57–67.
- Ransom, Michael R.**, “Seniority and Monopsony in the Academic Labor Market,” *American Economic Review*, March 1993, 83 (1), 221–33.
- Rosen, Sherwin**, “Prizes and Incentives in Elimination Tournaments,” *American Economic Review*, September 1986, 76 (4), 701–15.
- Rosenbaum, James E.**, *Career mobility in a corporate hierarchy*, Academic Press, 1984.
- Seltzer, Andrew and David Merrett**, “Personnel Policies at the Union Bank of Australia: Evidence from the 1888-1900 Entry Cohorts,” *Journal of Labor Economics*, 2000, 18 (4), pp. 573–613.
- Thompson, W. A. Jr.**, “On the Treatment of Grouped Observations in Life Studies,” *Biometrics*, 1977, 33 (3), 463–470.
- Treble, John, Edwin van Gasteren, Sarah Bridges, and Tim Barmby**, “The internal economics of the firm: further evidence from personnel data,” *Labour Economics*, December 2001, 8 (5), 531–552.
- Waldman, Michael**, “Theory and Evidence in Internal Labor Markets,” *Handbook of Organizational Economics*, Forthcoming.

8 Tables

Table 1: SUMMARY STATISTICS

Number of		
Observations	22197	
Professors	2282	
Variables	Mean	St Dev.
Individual and Contract		
Characteristics		
Age (in years)	48.89	8.78
Female	0.13	0.33
Foreign	0.04	0.21
Ph.D. own university	0.85	0.36
Ph.D. same country	0.06	0.24
Ph.D. world	0.09	0.29
External entrant (vs internal)	0.15	0.35
Rank 1 entrant	0.86	0.35
Rank 2 entrant	0.10	0.30
Rank 3 entrant	0.02	0.15
Rank 4 entrant	0.01	0.12
Rank 1	0.22	0.42
Rank 2	0.26	0.44
Rank 3	0.19	0.39
Rank 4	0.33	0.47
Part-time	0.33	0.47
Tenure (i.e. permanent)	0.85	0.35
Exact sciences grp.	0.30	0.46
Humanities grp.	0.34	0.47
Medical sciences grp.	0.35	0.48
Other grp.	0.01	0.12
Wage (monthly gross in 1,000 Euro)	5.83	1.22
Duration Variables		
Age at entry (in years)	29.21	6.93
Duration 0 (years prior to rank 1)	7.45	6.06
Duration 1 (years in rank 1)	4.12	3.47
Duration 2 (years in rank 2)	2.00	2.86
Duration 3 (years in rank 3)	1.83	3.21
Duration 4 (years in rank 4)	3.86	7.16
Performance Measures		
Highest duty (1 to 5 with 5 =lowest)	1.07	1.93
Number of duty	0.31	0.66
Teaching load (in week-hours)	4.61	4.00
SCIE Publication (count)	2.52	4.85
SCIE Impact factor (average)	2.02	2.95
SSCI Publication (count)	0.12	0.42
SSCI Impact factor (average)	0.11	0.41
Proceedings (count)	0.27	0.93

Note: This table shows the mean value and standard deviation of each variable of interest for the entire data set for the period 1991-2007. The research performance measures are averages over the past 5 years, for both publication count and impact factor.

Table 2: PROFESSORSHIP TRANSITION MATRIX

	Rank 1	Rank 2	Rank 3	Rank 4	Temp Out	Total Exit	<i>Early Exit</i>	<i>Retire</i>	Total
<i>Int. Entry</i>	<i>612</i>	<i>130</i>	<i>18</i>	<i>7</i>	-	-	-	-	<i>767</i>
<i>Delayed Int. Entry</i>	<i>181</i>	<i>38</i>	<i>13</i>	<i>6</i>	-	-	-	-	<i>238</i>
<i>Ext. Entry</i>	<i>155</i>	<i>54</i>	<i>32</i>	<i>19</i>	-	-	-	-	<i>260</i>
Total Entry	948	222	63	32	-	-	-	-	1,265
Rank 1	3,818	616	7	0	7	151	<i>103</i>	<i>48</i>	4,599
Rank 2	0	4,586	667	12	10	165	<i>57</i>	<i>108</i>	5,440
Rank 3	0	0	3,337	426	1	125	<i>20</i>	<i>105</i>	3,889
Rank 4	1	0	0	6,425	1	386	<i>29</i>	<i>357</i>	6,813
Temp Out	7	9	4	3	48	-	-	-	71
Total	4,774	5,433	4,078	6,898	67	827	<i>209</i>	<i>618</i>	22,077

Note: This table is obtained using observations during the period 1991 to 2006. The intersection of rows 5-8 and columns 1-4 shows the career transitions of professors employed in one of the four academic ranks. Non-promotions or stays are on the “diagonal” (starting from the fifth row onwards), promotions are to the right of this diagonal and demotions are to the left. Total Entry is the sum of internal, delayed internal and external entry (all rows displayed in italic). Total Exit is the sum of early exit, early retire and retire (all columns displayed in italic). Temp Out refers to professors who temporarily exit the university to return later in one of the four professorship ranks. A zero value truly means that this type of transition never took place, while “-” implies that this type of transition is not possible.

Table 3: BASIC CAREER CHARACTERISTICS STATISTICS

	Rank			
	1	2	3	4
Total number of all entrants into rank	549	143	26	13
Percent with 1-2 year career	3.6	2.7	11.5	15.4
Percent with 3-8 year career	12	15.5	30.8	15.4
of which: % Holding 1 title	89.4	76.5	87.5	100
% Holding 2 titles	6.1	17.6	12.5	-
% Holding 3 titles	4.5	5.9	-	-
Percent with 8+ year career	84.3	81.8	57.7	69.2
of which: % Holding 1 title	18.1	23.3	26.7	100
% Holding 2 titles	27.6	26.7	73.3	-
% Holding 3 titles	25.5	50	-	-
Avg. years in professorship	11.5	12.8	9.0	9.4
Std deviation	3.9	4.3	4.3	4.9
Avg. years in univ. prior to entry in professorship	8.4	7.2	4.2	1.9
Std deviation	7.4	7.5	8.8	3

Note: To avoid censoring problems, this table is obtained using observations of professors hired between 1991 to 1999. This follows a structure similar to BGH’s Table II on career characteristics by entry in rank. We do not include the bottom panel of BGH’s table, as this contains information similar to the transition matrix reported earlier.

Table 4: EFFECTS OF EXPERIENCE, RANK AND PERFORMANCE ON REAL WAGES

	(1)		(2)	
	Coef.	Std.Err.	Coef.	Std.Err.
Prior experience/10	0.132***	(0.005)	0.081***	(0.003)
Prior experience ² /100	2.126***	(0.302)	0.750***	(0.188)
Experience/10	0.225***	(0.009)	0.078***	(0.006)
Experience ² /100	-0.009***	(0.002)	0.009***	(0.001)
Rank 2			0.074***	(0.004)
Rank 3			0.194***	(0.004)
Rank 4			0.339***	(0.004)
<i>Academic year</i>				
2000	0.002	(0.006)	0.007*	(0.004)
2001	0.013**	(0.006)	0.009**	(0.004)
2002	0.013**	(0.006)	0.002	(0.004)
2003	0.015**	(0.006)	0.001	(0.004)
2004	0.015**	(0.006)	0.008**	(0.004)
2005	0.007	(0.006)	0.004	(0.004)
2006	0.014**	(0.006)	0.004	(0.004)
2007	0.000	(0.000)	0.000	(0.000)
<i>Performance</i>				
teaching load	0.007***	(0.000)	-0.000	(0.000)
SCIE Pub	0.004***	(0.000)	-0.000	(0.000)
SCIE Impact	0.005***	(0.001)	0.001**	(0.000)
SSCI Pub	0.017***	(0.005)	-0.002	(0.003)
SSCI Impact	0.001	(0.006)	-0.004	(0.003)
Proceedings	0.015***	(0.001)	0.002**	(0.001)
Constant	8.127***	(0.015)	8.308***	(0.010)
Gender dummy	yes		yes	
Foreign dummy	yes		yes	
Observations	6559		6559	
R ²	0.642		0.863	

Note: The dependent variable is the log of real wage (nominal wage divided by Health CPI) in October. Following Medoff and Abraham (1980), prior experience equals age minus experience in the institution minus schooling (21 years for Ph.D.) minus five. Rank 2, 3 and 4 are dummy variables (base = rank 1). Research performance measures are annual averages over 5 years. Standard errors are in parentheses. Coefficient significance is denoted using asterisks: *** is $p < 0.01$, ** is $p < 0.05$, and * is $p < 0.1$.

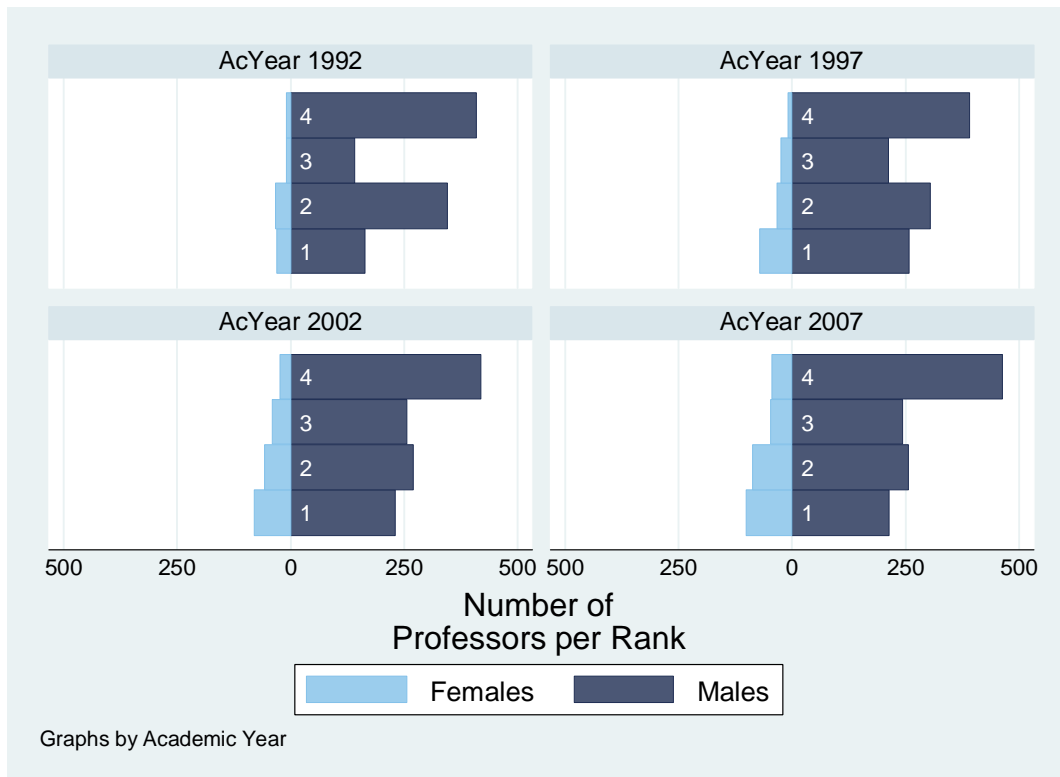
Table 5: DISCRETE-TIME PROMOTION HAZARD MODEL

	Rank 1 Professors: Promotion to rank 2		Rank 2 Professors: Promotion to rank 3		Rank 3 Professors: Promotion to rank 4	
	Coef.	Std.Err.	Coef.	Std.Err.	Coef.	Std.Err.
Individual and Contract Characteristics						
Female	-0.232*	(0.126)	0.078	(0.171)	-0.428	(0.260)
Foreign	0.017	(0.276)	-0.670*	(0.352)	0.218	(0.530)
Ph.D. same country	0.092	(0.238)	-0.927***	(0.326)	-1.009*	(0.518)
Ph.D. world	0.485*	(0.255)	-0.330	(0.256)	-0.062	(0.407)
External entrant	0.067	(0.202)	0.817***	(0.270)	-0.269	(0.384)
Rank 2 entrant	na		-0.974***	(0.217)	-0.586*	(0.320)
Rank 3 entrant	na		na		-1.856***	(0.498)
Part-time	-0.259*	(0.146)	0.032	(0.187)	-0.529*	(0.273)
Tenure	0.467***	(0.139)	0.776***	(0.291)	2.032**	(0.861)
Exact sciences grp.	0.323	(0.235)	0.332	(0.381)	0.185	(0.733)
Humanities grp.	0.554**	(0.240)	0.706**	(0.355)	1.457**	(0.645)
Other grp.	0.251	(0.426)	1.231**	(0.509)	2.016**	(1.013)
Duration Variables						
Age at entry	-0.031***	(0.011)	-0.051***	(0.016)	-0.073***	(0.026)
Duration - rank 0	-0.037***	(0.011)	-0.062***	(0.014)	-0.114***	(0.025)
Duration - rank 1			-0.115***	(0.033)	-0.192***	(0.067)
Duration - rank 2					-0.224***	(0.060)
Performance Measures						
Highest duty	-0.107	(0.214)	0.088	(0.066)	-0.078	(0.087)
Number of duty	0.643	(0.967)	-0.066	(0.229)	0.683**	(0.315)
<i>Exact sciences grp.</i>						
Teaching load	0.115***	(0.035)	0.071***	(0.027)	0.126***	(0.041)
SCIE Publication	0.059	(0.043)	0.196***	(0.039)	0.147***	(0.042)
SCIE Impact factor	0.221***	(0.054)	0.115**	(0.056)	0.109	(0.086)
SSCI Publication	0.845	(0.940)	2.321	(1.653)	0.409	(2.638)
SSCI Impact factor	0.162	(1.610)	-0.073	(1.897)	-0.412	(2.209)
Proceedings	0.599***	(0.170)	0.264***	(0.090)	0.107	(0.083)
<i>Humanities grp.</i>						
Teaching load	0.144***	(0.036)	0.125***	(0.036)	0.042	(0.053)
SCIE Publication	0.880**	(0.443)	1.066**	(0.454)	0.506	(0.361)
SCIE Impact factor	0.119	(0.277)	-0.538*	(0.290)	0.176	(0.273)
SSCI Publication	1.114***	(0.396)	0.831***	(0.260)	0.998**	(0.427)
SSCI Impact factor	-0.550	(0.415)	-0.107	(0.247)	-0.792*	(0.437)
Proceedings	-1.731	(1.124)	1.017	(0.676)	2.321**	(0.923)
<i>Medical sciences grp.</i>						
Teaching load	0.199***	(0.039)	0.207***	(0.040)	0.111**	(0.052)
SCIE Publication	0.155***	(0.025)	0.164***	(0.027)	0.029	(0.021)
SCIE Impact factor	0.135***	(0.023)	0.105***	(0.029)	0.227***	(0.048)
SSCI Publication	0.530	(0.602)	1.853*	(0.958)	-0.119	(0.655)
SSCI Impact factor	0.235	(0.418)	-0.255	(0.540)	1.917**	(0.806)
Proceedings	0.286	(0.279)	-0.244	(0.328)	1.404***	(0.380)
Rank cohort dummies	yes		yes		yes	
Baseline dummies	yes		yes		yes	
Number of observations	4295		3364		1939	
df	58		58		61	
ll	-1387		-967.4		-468.7	
Late Beginner Property						
(1) without performance measures	na		0.029		0.030	
(2) with performance measures	na		0.155		0.223	
Fast Track						
(1) without performance measures	0.000		0.000		0.000	
(2) with performance measures	0.000		0.000		0.000	
Cohort Effects						
	0.001		0.143		0.071	

Note: The top panel of this table shows the empirical results of the logistic discrete time hazard rate model (1). Research performance measures are annual averages over 5 years. Standard errors are in parentheses. Coefficient significance is denoted using asterisks: *** is $p < 0.01$, ** is $p < 0.05$, and * is $p < 0.1$. The bottom panel of this table shows two types of test. First, the Late Beginner Property test is a Wald test where the null hypothesis is that all duration coefficients are equal. Second, the Fast Track test is a likelihood-ratio test where the null hypothesis is that the duration variables are jointly not significant.

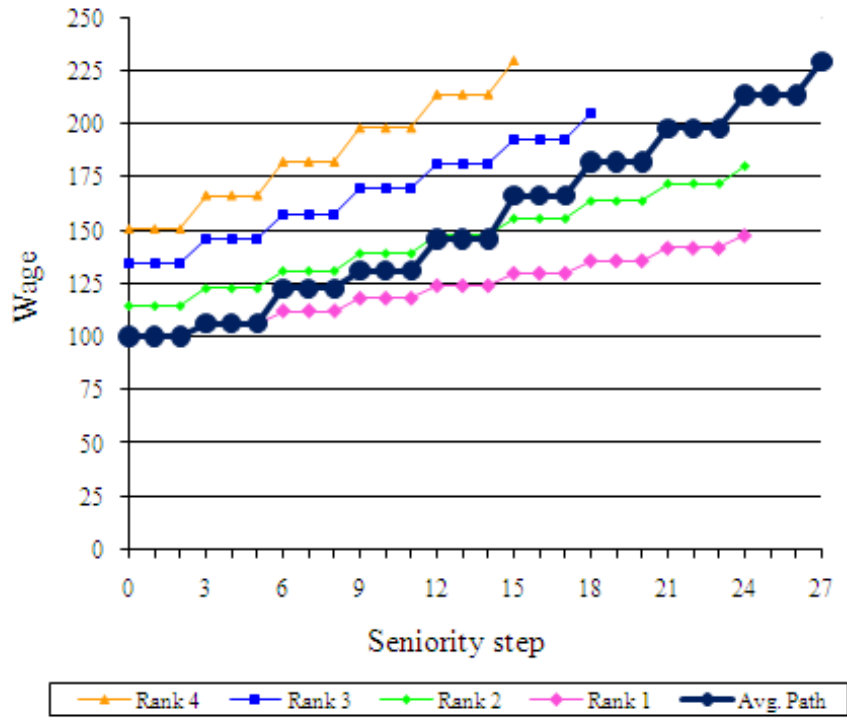
9 Figures

Figure 1: STRUCTURAL STABILITY



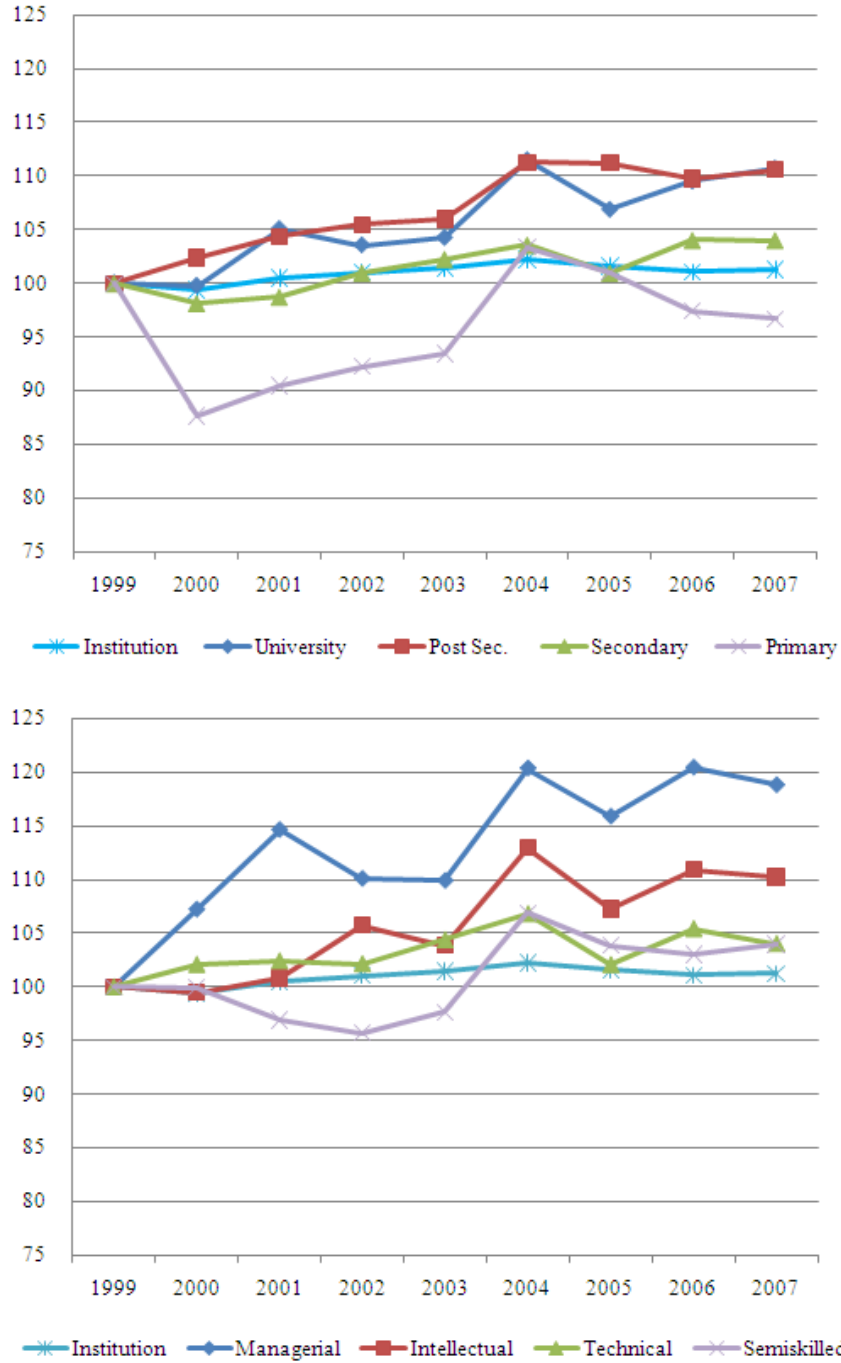
Note: This figure shows the structure of the hierarchy at different points in time by gender.

Figure 2: WAGE SCALES AND AVERAGE WAGE PATH



Note: This figure shows the four salary scales in the University for full-time professors (in real terms). Each non bold line is a different salary scale, one for each of the four professorship ranks. The salary of a professor in rank 1 with zero steps of seniority is normalized to 100. The bold line shows the average career progression of a professor entering the university in rank 1 (with zero steps of seniority at entry) in 1991.

Figure 3: REAL WAGE EVOLUTION - BY EDUCATION AND OCCUPATION



Note: These figures compare the real wage evolution of professors within the university with external wages by level of education (top panel) or by type of occupation (bottom panel). External wages are computed from the Structure of Earnings Survey collected by SPF Economie in Belgium. The data is restricted to full-time employees and wages are measured in October for both the institution and the different subgroups of the external market. All wages are normalised to 100 in 1999 and adjusted for inflation using the Health CPI.