Departure and Promotion of U.S. Patent Examiners: Do Patent Characteristics Matter?

Corinne Langinier* and Stéphanie Lluis†

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Abstract

Using data from patent examiners at the U.S. Patent and Trademark Office, we ask whether, and if so how, examiners' career outcomes relate to aspects of the patent review process. Exploiting longitudinal information about all the patents granted by a group of examiners between 1976 and 2006 and their yearly mobility outcomes (departure and promotion) between 1992 and 2006, we find consistent evidence from static, dynamic and duration models of the importance of patent characteristics, granting experience in specific technological fields, repeated interactions with the same inventor and self-citations in predicting an examiner's departure or promotion.

Keywords: Patents, Examiners, Promotion, Turnover

JEL classification: J60, O34

*University of Alberta, Edmonton, Canada. Corinne.Langinier@ualberta.ca

†University of Waterloo, Waterloo, Canada. slluis@uwaterloo.ca

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1 Introduction

Over the last 10 years, the U.S. Patent and Trademark Office (USPTO) has witnessed a dramatic increase in the turnover rate of examiners (U.S. Government Accountability Office reports, 2005, 2007, 2008). The attrition rate and the quota system for reviewing patents have been the subject of changes proposed in the latest USPTO strategic plan.[1] However, criticisms of the internal functioning of the patent office keep surfacing and the USPTO business model is currently the subject of internal investigations regarding cases of examiners shirking on the job.[2]

Examiners grant patents to innovators and, therefore, allow firms temporary monopoly power. Poor examination quality lowers competition (imposes costs on society) and leads to high legal costs in cases of litigation which may reduce innovation. Hence, patent examiners have a key role to play in society and it is important to understand how their work incentives and career progression at the USPTO interact with the patent review system.

In this paper, we present an empirical analysis of examiner mobility outcomes such as leaving the USPTO or receiving a promotion, and the extent to which these career events may be linked to examiner granting outcomes like the number and characteristics of granted patents and granting related behavior. To do so, we have collected information from a random sample of 623 examiners who worked at the USPTO in 1995 and retrieved information about all the utility patents they have granted. We follow these examiners over time (until 2006) considering different measures of their productivity in terms of granting experience and accumulated years of tenure at the USPTO.

Our goal is to analyze whether, and if so how, the average profile of the patents these examiners have granted every year relates to their mobility outcomes, controlling for typical measures of productivity and experience. We consider the following types of question: is an examiner in biotechnology more likely to leave (or be promoted at) the USPTO than an examiner who grants patents in mechanics? Can promotion or leaving be linked to an examiner's average number of claims (scope of patent protection) or backward citations?

We also construct two measures of examiner granting related behavior not exploited in the literature: examiner self-citations – proportion of citations (made) of the patents he/she has

[1] USPTO strategic plan 2010-2015 (www.uspto.gov/sites/.../stratplan/USPTO_2010-2015_Strategic_Plan.pdf).

[2] In 2013, an internal report revealed telework fraud allegations which led the patent office to admit the lack of control that supervisors have over time and attendance fraud among patent examiners (Washington Post articles in August 2014 and August 2015).

granted in the past over the total citations made over his/her career – and repeated interactions with the same inventor – maximum number of repeated interactions with the same inventor over the total number of granted patents. The percentage of examiner self-citations has direct implications on his/her productivity within the USPTO,[3] and repeated interactions with an inventor likely reflect inventor-specific knowledge. Through their implications on examiner productivity and knowledge specificity, these two measures are expected to correlate with mobility outcomes. Our analysis uses fixed- and random-effect logistics estimations as well as parametric survival estimation models to document the importance of various granting related variables in relation to examiner mobility outcomes.

There is an abundant literature on patents and patenting behavior, and failures in the functioning of the patent system have been widely acknowledged (Lemley, 2001; Jaffe and Lerner, 2004; Lemley, et al., 2005; Farrell and Shapiro, 2008; Bessen and Meurer, 2008). Much less is known about the inner functioning of patent offices which is probably due to the lack of available data at the examiner level. To have a more accurate description of the patent examination process, surveys have been conducted in patent offices, both in the U.S. (Cockburn et al., 2003; King, 2003; Popp and Juhl, 2004) and in Europe (Friebel et al., 2006).

Cockburn et al. (2003) provide the earliest empirical evidence that there exists heterogeneity among examiners in the examination process. Since then, a growing number of empirical contributions have studied the behavior of patent examiners.[4] In particular, the finding of an examiner-specific effect in granting related decisions has now been well-documented in the empirical literature. Studies have confirmed the presence of examiner heterogeneity in granting rates (Lemley and Sampat, 2010; Tu, 2012) and in citations made (Alcacer et al., 2009; Lemley and Sampat, 2012). Furthermore, Lemley and Sampat (2012) find that more experienced examiners are more likely to issue patents on the first office action.

In these studies, it is made clear through informal discussions with examiners and/or other USPTO staff that the assignment of patent applications to examiners is random, within a technological center or Art Unit and within the technological category of the patent. Our approach also

[3] Citations are made by both the inventor and the examiner. Until 2000, it was not possible to distinguish the two. Since the time period in our data covers mostly the years prior to 2001, we cannot use this information. Studies that have compared inventor and examiner citations find that a large share of citations is added by the examiner, and these citations are those used to decide whether to grant the patent (Alcacer et al., 2009; Lemley and Sampat, 2010; Cotropia et al., 2010).

[4] See for instance Cockburn et al., 2003; Sampat, 2005; Alcacer and Gittelman, 2006; and Alcacer, et al., 2009; Mann, 2013; Frakes and Wasserman, 2014.

assumes random allocations of patent applications to examiners within a technological center. Our analysis emphasizes the importance of a different channel by which examiner heterogeneity impacts the patent review system: examiners' departure and promotion opportunities.

We consider whether the non-random attrition of examiners at the USPTO that we observe in our data is correlated with the non-random variations in the characteristics of the patents they have granted, controlling for their accumulated years of tenure and their granting experience as well as for Art Unit fixed-effects. In other words, can two examiners with similar tenure and granting experience and working in the same Art Unit be experiencing different mobility outcomes (one is predicted to leave and the other one to be promoted) based on the difference in the characteristics of the patents they have granted (e.g., more citations or more patents with a U.S. inventor)? We also exploit the longitudinal format of our mobility measures to estimate any lagged relationships and to further control for examiner specific-effects.

We find that controlling for examiner granting experience and tenure at the USPTO, examiners who leave and those who receive a promotion are significantly different in terms of their pattern of self-citations, repeated interactions with inventors and in terms of some of the characteristics of the patents they grant. The presence of a systematic link between the characteristics of the patents granted by an examiner and his/her career outcome calls for a better alignment between the functioning of the patent review system and the incentive structure implemented by human resource policies at the USPTO.

In the mobility literature, a few recent studies have analyzed the labor market of scientists and researchers in academia, workers with similar training as examiners and in jobs with related characteristics (Zucker et al., 2002; Coupé et al., 2006; Giuri et al., 2007). The common finding is that promotion and mobility within academia or to a job in the industry strongly depend on measures of the worker quality and productivity. For economists, the sensitivity of promotion and mobility to past production diminishes with experience indicating the presence of learning about worker quality (Coupé et al., 2006). More particularly, among scientists, evidence of fast-tracking, with "star" scientists being more likely to move out of a research institution to a private sector firm, depends on the worker's field of expertise as well as on measures of market competition in the worker's industry and city (Zucker et al., 2002). Our paper complements this literature by offering additional evidence of the importance of worker productivity (past and current) in driving current mobility outcomes for the group of USPTO examiners. Moreover, our results also emphasizes the importance of work-related behavior in predicting mobility outcomes after controlling for productivity-related factors. While tenure and granting experience significantly relate to departure and promotion decisions, examiners' self-citations as well as the intensity of their interactions with inventors (or their lawyers), and the resulting networking opportunities created, are also strong and robust predictors of examiners' mobility outcomes.

In the innovation literature, recent contributions have established a clear link between work incentives, career outcomes and innovation activity for different groups of workers: corporate R&D managers (Lerner and Wulf, 2007), investigators of the Howard Hugues Medical Institutes (Azoulay et al., 2011), CEOs of publicly-traded firms (Galasso and Simcoe, 2011) and MIT college graduates (Shu, 2012), where innovation is measured in terms of research creativity, patent counts or patent citations. Our paper contributes to this literature by providing additional evidence of the implications of workplace policies and career opportunities on innovation outcomes through an analysis of the particular behavior of patent examiners.

Despite the data limitations we face which restrict our analysis in some ways, we believe our results are important in further informing both academic and practitioners interested in the links between worker mobility and innovation. On the one hand, our approach is descriptive. On the other hand, our examiner-granted patent dataset allows us to document whether and how examiner mobility correlates with examiner- and patent-related characteristics and our results provide the first evidence of significant interactions between outcomes of the patent review process and examiners' departure and promotion outcomes.

Furthermore, while our analysis is partial because our examiner-granted patent dataset does not allow us to link examiner granting rates with promotion and/or departure outcomes, the interactions we find using post-granting information likely reflect examiners' pre-granting heterogeneity in granting rates generated by differences in career expectations and outcomes. Our results suggest that the evidence of differential granting rates by technological fields found in the literature (Lemley and Sampat, 2012) is partly driven by examiners' mobility.

Overall, the results help shed light on examiner behavior in relation to the patent review system providing insights to the USPTO human resource policies about the importance and implications of the non-random sorting of examiners across the different technological fields, citation behavior and the matching of examiners to inventors, all of which are significantly linked to departure and promotion outcomes within the USPTO. Our results also offer empirical evidence motivating the need to incorporate career related decisions in the design and modelling of an efficient patent review system.

The paper is organized as follows. In section 2 we present an overview of the USPTO: the examination process, the career path of patent examiners and we compare characteristics of patent examiners with other engineers and scientists. Section 3 is devoted to the description of the data collection, and the construction of the dataset and variables. In section 4 we present the empirical analysis and we describe the results. Section 5 concludes.

2 USPTO: Overview of the Institution

The functioning of patent institutions and the patenting process have been well-documented. Surveys have been conducted in patent offices, both in the U.S. (Cockburn et al., 2003; Popp et al., 2004) and in Europe (Friebel et al., 2006).[5] Most of the overview presented in this section is based on these contributions as well as on information gathered from the USPTO website.

The USPTO, first established in 1836, is the Federal agency for granting patents and registered trademarks in the U.S. located in Alexendria, Virginia. In 2014, 300 678 utility patents[6] have been approved, and the USPTO received 578 802 new patent applications that same year which, in combination with pending patent applications from previous years, creates an important backlog.

In response to the growing backlog, the USPTO has been launching an important hiring program over the last decade. However, the rate of attrition is relatively high. For instance, between 2002 and 2006, even though 3,672 patent examiners have been hired, the patent examination workforce has only increased by 1,644.[7] The attrition rate seems particularly high among new patent examiners. This early attrition has a significant impact on the patenting process as it takes three to five years to attain proficiency (NAPA, 2005).

Patent examiners, who are technological specialists employed by the USPTO, review patent

[5] In Cockburn et al. (2003) 20 current and former examiners and patent attorneys have been interviewed whereas Popp et al. (2004) is based on the interview of five experienced officers at different levels of authority. Friebel et al. (2006) is based on a computer-based staff survey done at the European Patent Office (EPO).

[6] There are three types of patents: utility patents ("may be granted to anyone who invents or discovers any new and useful process, machine, article of manufacture, or composition of matter, or any new and useful improvement thereof," USPTO definition), design patents ("may be granted to anyone who invents a new, original, and ornamental design for an article of manufacture") and plant patents ("may be granted to anyone who invents or discovers and asexually reproduces any distinct and new variety of plant"). We are mainly interested in utility patents that, in fact, represent the majority of patents.

[7] During the same period, 1,643 examiners left the USPTO and the remaining 385 examiners were either transferred or promoted out of the position of patent examiner.

applications for compliance with the Patent Act that has been established by the Congress. They are organized into one of the eight broad "technological centers,"[8] each technological center is subdivided into "Art Units." An Art Unit is a group of 10 to 20 examiners with technology expertise in closely related areas.[9] In order to assign a patent application to the relevant Art Unit, the USPTO has established an elaborate classification system for all U.S. patents with classes and subclasses.

For each patent case, the examiner and the applicant (or his attorneys) are engaged in an *ex parte* proceeding by mail, and the examiner ultimately decides whether the invention meets the "stringent" standards. If it meets the requirements, the examiner allows the patent to issue.

We now detail the examination process and the career progression and expectations of patent examiners. We end the institutional background discussion by presenting our own evidence of the extent of examiner turnover by comparing examiner characteristics with characteristics of workers with similar education who chose to become engineers and scientists.

2.1 The Patent Examination Process

Patent applications arrive at a central receiving office called the Office of Initial Patent Examination (OIPE) and must pass basic checks to qualify for a filing date. When the application is complete (fees have been paid, all documents comply with the USPTO rules), an application wrapper is assembled. A patent application contains the claims, a description of the innovation and prior art information that has been provided by the patent applicant or his attorneys.

An examiner at OIPE assigns the patent application to one of the main U.S. patent classification. Based on that classification, the patent application is sent to one of the eight technology centers, where it is then directed to one of the Art Units. Within each Art Unit a supervisory patent examiner (SPE), who is a senior examiner with administrative responsibilities (he might be the director of the Art Unit) assigns the application to a specific examiner.

The examiner who has been assigned the case is responsible for the application until it is

[8] Before 1998, instead of 8 technology centers there were 17 examiner groups. Nowadays, these 8 centers are: Technology Center 1600 (Biotechnology and Organic Chemistry), Technology Center 1700 (Chemical & Materials Engineering), Technology Center 2100 (Computer Architecture and Software), Technology Center 2400 (Networking, Mulitplexing, Cable, and Security), Technology Center 2600 (Communications), Technology Center 2800 (Semiconductors, Electrical and Optical Systems and Components), Technology Center 3600 (Transportation, Construction, Electronic Commerce, Agriculture, National Security, and License & Review), Technology Center 3700 (Mechanical Engineering, Manufacturing, and Products & Designs).

[9] In 2015, examiners are spread over 307 different Art Units.

disposed of (rejected, allowed or discontinued). He then interacts with the applicant or his attorneys. Even though the process is fairly standard and is well-documented in the Manual of Patent Examining and Procedure,[10] it is highly dependent on the examiner's skills (Cockburn et al., 2003). At any given time, an examiner has to deal with current patent applications (that are at different stages in the patenting process) and new applications.

The examination of an application begins with a review of legal formalities and an analysis of the claims. The examiner must judge the application against the relevant technical, legal and commercial information. Therefore, he searches for prior art information to determine whether the innovation is novel enough to be granted a patent. It is probably in the prior art search procedure that there is the most heterogeneity among patent examiners (Cockburn et al., 2003). Different Art Units have different approaches to search for prior art too: some are more team-oriented whether others are more individual-oriented (Popp et al., 2006). In general, the prior art procedure begins with a review of existing U.S. patents in relevant technology classes either through computerized tools or by hand examination.

The examiner then reviews the material provided by the applicant. After reviewing the prior art information, he/she decides to grant a patent or not. He/she writes a first office action letter to the applicant in which he accepts or rejects the claims. Most of the time some of the claims are rejected. The applicant must respond during a certain time frame and must narrow the claims or explain changes made to the original application. The examiner then analyzes the answer and writes a second action letter. Most applications are allowed on the second or third action letter.[11]

To complete each patent examination, examiners are allocated fixed amount of time. However, they can average these time allotments over their caseload and, thus, can spend more time on some more difficult applications and less time on easier ones. We further discuss production quotas and examiners progression along the institution-specific pay scale in the next subsection.

[10] See website http://www.uspto.gov/web/offices/pac/mpep/

[11] According to NAPA (2005), patent prosecution process is divided into four tasks: i) search (read application, prior art search, claims); ii) examination (compare prior art with the innovation, prepare and submit first action letter); iii) amendment review (if it exists, additional search, second action letter); iv) post examination (depending on whether the patent is issued or not).

2.2 Production Quotas and Career Path of Patent Examiners

The quality of patent examination, and therefore the quality of a patent examiner, is very difficult to assess. One measure used by the USPTO to evaluate patent examiners is to rely on production quotas. Patent applications are assigned to technological centers and, therefore, each technology center is expected to review a certain number of applications.

Examiners have a bi-weekly production quota, and they receive "counts" for the completion of an office action. An office action corresponds to either the disposal of an application (issued or rejected) or the examination of a new application (first action letter). In order for the examiner to get credit for the action, it must be approved by a SPE. Overall, an examiner receives two counts per application: 1.25 count for the first action and 0.75 for its final disposal.[12]

At the very beginning of their career, examiners have to examine only a few patent cases, and the caseload increases as examiners become more experienced. Production goals depend both on the technological field and the experience as measured by the examiner's position in the general schedule (GS) pay scale.[13] For instance, in most technology centers the production goal is about 17 hours per disposal (adjusted for experience), while it is 31.6 hours in computers as it is recognized that applications require more examination time in this area (as is also the case in biotechnology). Also, for the same application, an examiner at the level $GS-7$ will spend 37.3 hours, whereas an examiner at the level $GS-12$ will spend 27.5 hours, and one at the level $GS-14$ will spend 20.4 hours (NAPA, 2005).

The current count system has been severely criticized, especially because it seems relatively out of date as it has been drafted in 1976 (NAPA, 2005). In response to these critics, in 2009, the USPTO provided a series of proposals to make significant changes to the count system. In the 2010 report, quotas are still used to measure examiner productivity and they still differ by technological fields and years of experience of the examiner.[14]

When an examiner meets all the deadlines on time with a few errors, he advances to the next GS level based on the recommendation of the SPE.[15] The highest level on the GS chart

[12] Until February 2010 it was one count for the first action and one for its final disposal.

[13] New hires are in general at level $GS-7$ or inferior, whereas experienced examiners are $GS-9$ or above.

[14] In the empirical analysis, we therefore consider separately the number of patents granted by technological field in addition to the years worked at the USPTO.

[15] Junior examiners need to get the authorization of senior examiners before sending the first action letter. Hence, their work is closely monitored. Furthermore, the USPTO randomly reviews about two to three percent of granted patents. In 2004 the error rate was 5.3% (NAPA, 2005), and about 300 applications have been reopened. This is another way to monitor examiners errors.

corresponds to the level of a SPE who manages an Art Unit and is the direct supervisor to approximately 15 patent examiners (assistant or primary examiners). This is the first and main promotion opportunity for examiners.[16] Further promotions can take place afterwards to positions involved in the administration of the patent review system and other legal matters applying to the management of the institution.

2.3 USPTO Examiners and Other Engineers/Scientists

The basic qualifications for the job of patent examiner (as defined on the USPTO web site or on job advertisement web sites) are a bachelor's degree in engineering or science.[17] Examiners are educated individuals in highly technical fields with valuable alternative options in the private sector as engineers or scientists.[18] To get a sense of how examiners compare to workers in jobs with similar educational requirements, we looked at the 5% census public use file for the year 2000 and the 2004, 2006 and 2008 Current Population Survey (CPS) data (choosing years that cover our study period) which provide occupation information precise enough to proxy for the job of examiner.

The census data and the CPS data starting in January 2003 have a 4-digit level occupation variable with enough precision to locate the occupation of examiners.[19] We also selected workers who report being engineers and scientists. Along with the occupation, we pulled out information on gender, education, age, percentage U.S. born, hours worked and individual yearly earnings. The table below provides summary statistics based on the large 2000 census sample of full-time

[16]Our promotion measure is purely job-based and we consider a promotion a change from examiner to SPE or any higher administrative positions (more details on the definition of our promotion measure will be presented in the data section). This is because we do not observe when the change from the status of assistant to primary examiner is taking place. However, we are able to measure and distinguish the number of years and patents granted as assistant examiner from the years and patent granted as primary examiner.

[17]In the USPTO strategic plan for 2010-2015, the qualification requirements have changed to include the possibility to have a lower degree than a BA if it is combined with technical experience.

[18]Going back in time, the most famous case of alternative and more attractive opportunities taken by a former patent examiner is Albert Einstein who worked at the Swiss Patent Office for 7 years, produced and published his most famous work (outside of his 8 hour work day at the office) before leaving for a job of Professor at the University of Zurich.

[19]Examiner is provided as an illustrative example for the category numbered 23-2099 for jobs related to providing legal support. We further narrow down examiners by selecting individuals who report holding a BA or a higher degree, are U.S. citizens, and who live in the D.C. area and neighboring states (Washington, Virginia, Maryland, district of Columbia, New-Jersey and Pennsylvania).

workers with yearly earnings of at least $20,000.[20]

Table 1: 2000 Census Data Comparisons for Examiners-Other Engineers-Scientists[a]

	Engineers/Scientists[b]	Examiners[c]
% Female	0.22 (0.41)	0.47 (0.49)
Age	40.2 (10.1)	38.3 (10.6)
% US Born	0.80 (0.39)	0.90 (0.29)
Hours Worked in 1999	44.5 (7.15)	45.3 (8.3)
Ind[a] Earnings in 1999	64581.1 (40920.7)	60660.4 (50508.1)
N	148486	630

Note a: Weighted averages using the 5% Public Use Microdata Area Code Census data. Standard deviation in parenthesis. Sample selected based full-time employment and earnings > $20000.
b: Engineers/Scientists are defined using all occupation codes spanning the categories 11 though 19.
c: Examiners are defined using 4-digit occupation code of "Other legal support workers" (23-2099) and further selected as U.S. citizens who live in states in the neighborhood of Virginia and hold at least a bachelor's degree.

Female representation among our constructed sample of examiners is larger than among engineers and scientists. Our proxied examiners are on average younger, more likely to be born in the U.S., work relatively more hours and earn relatively less on average than engineers and scientists workers in 1999.

To obtain additional evidence of the high turnover of examiners often mentioned in the media and internal government reports during the mid-2000 period, we compared the (kernel estimated) age density of our sample of proxied examiners with the age distribution of workers reporting their occupation as engineers and scientists obtained from the 2000 census data. We repeated the exercise using the CPS data for 2004, 2006 and 2008 to get a sense of the trends in the age distribution. We also used the 2006 CPS supplement on job tenure to further illustrate differences in turnover profiles between examiners and engineers/scientists using job tenure information. Appendix A Figures 1a-1c show the results.

The age and tenure distributions of our proxied examiners sample exhibit an earlier peak (age less than thirty and tenure less than 10 years) and greater variance than for engineers and scientists. All the graphs point to the same evidence that our proxied job of examiners is more likely occupied by younger workers who accumulate less years of tenure compared to engineers and scientists. The present graphical analysis further confirms the relatively larger turnover of USPTO examiners based on publicly available survey data.

Our objective in this paper is to investigate possible determinants of the mobility of examiners and, more particularly, to see whether and how examiners mobility outcomes can be linked to their granting experience as well as potentially, to the characteristics of the patents they granted.

[20] We exclude observations with missing information on earnings and further selected individuals who report working full-time with at least $20,000 of yearly earnings.

3 Data and Variables

3.1 Data Collection

We present the procedure used to collect and build the data before describing the variables of interest. The data comes from three sources: the USPTO website, the NBER Patent Database of patent characteristics (Hall et al., 2001) updated to include patent information up to 2006, and the PTO employee directories over the period 1992-2006 used in Lemley and Sampat (2012). We constructed two dataset exploiting different measures of mobility outcomes.

The first dataset considers the yearly variations in patent characteristics for our sample of examiners over the period 1976-2006 and exploits a static measure of examiner mobility where mobility is defined as an outcome which took place some time between 1992 and 2006 and remains fixed for the entire time period. Examiners are categorized as either having experienced no job changes, a promotion or as having left some time between 1995 and 2006.

The second dataset exploits the longitudinal information of yearly mobility outcomes and therefore restricts the sample to the period 1992-2006 over which yearly mobility (no change, promotion or leave) can be observed.

The data collection process was done in four main steps: *a*) creation of a random sample of examiners, *b*) collection of all the patents granted by each sampled examiner to build an examiner-patents link, *c*) merge of information on patent characteristics from the NBER Patent Database to the sample of patents granted by our sampled examiners, and *d*) merge of career related information from the PTO directories to the sampled examiners.

Steps *a*) to *c*) resulted in a dataset of examiner-patents with patents sorted by granting years over the period 1976-2006. Step *d*) helped to create a panel dataset of examiner-patents for the 1992-2006 period over which year-to-year mobility outcomes can be observed and a dynamic analysis of mobility can be performed.

To create a random sample of examiners (step *a*)), we chose the date of December 19th, 1995 and retrieved all the patents granted on that random day from the web search engine of the USPTO. We then extracted the information on the examiner's name on each granted patent. On that day, a total of 1,663 utility patents were granted by 660 different primary examiners and the names of the examiners were cross-checked with the names from the USPTO website to insure that all examiners were indeed working as examiners at the USPTO at the time.

While this method creates randomness in the process for gathering information, it is not a perfect sampling method. Indeed, there may be seasonality effects in the organization's hiring or retirement policy which may increase or reduce the population of examiners around that particular date and, more importantly for our collection method, influence the granting rate more than at other times of the year.[21]

Gathering information based on examiners' name is problematic (Cockburn et al., 2003; Sampat, 2005; Lemley and Sampat, 2012). The same examiner may appear under several combinations of last, middle and first names. For instance, the middle name, or Jr. or Sr. terms, may sometimes be omitted, the last name may be misspelled and women may also change names as they get married.[22]

We adopted the following rule: for non-common names we omitted the middle and first names and searched for patents that correspond to the last name. We compared the number of patents obtained under that search to the number of patents granted by the examiner if we searched for patents with the complete name (first, middle and last names). Whenever the difference between the two numbers was small, we assumed it was the same individual and counted all the patents. Otherwise, we would refine our search by including the first name.

To define whether a last name is common or not, we looked at how many examiners with a particular name are currently working at the USPTO. This gives an idea of the scarcity of a name. For instance, Smith is a very common name whereas Bartuska is not. Every time there was a discrepancy between numbers of patents for apparently the same examiner, we checked carefully by hand whether different examiners had identical names. After ruling out name problems, we obtain a sample of 652 examiners.

For each examiner of our sample, we used the USPTO web search engine again to find all the patents he/she granted as primary and assistant examiners (step *b*)). We obtained an examiner-patents link describing the set of all patents granted for each examiner. This could be as early as patents granted in 1976, the earliest year patent information was electronically recorded. We completed the dataset by adding patent characteristics from the updated version of 2006 of the

[21] Another issue affecting the randomness of the sample is the fact that there may be greater absenteeism during that particular time of the year. While this affects the number of examiners present at the USPTO, this concerns us less since we are using the information about the examiners who granted patents on that day. Signing on a patent does not imply the examiner is physically present in the office on that day. Our collection method, however, creates a dataset of examiners which oversamples examiners who are more likely to grant relative to those more likely to reject applications.

[22] The name problem is actually an important one that is carefully treated in Trajtenberg et al. (2006) concerning inventors' names.

NBER Patent Database (merging the information by patent number) in step c).

We therefore have a dataset exploiting variations at two levels: the examiner level with a sample of 652 examiners who were granting patent on a random day in 1995, and the patent level with a sample of patents which corresponds to all the patents each examiner granted during the 1976-2006 period.[23]

At the patent level, we consider the typical patent characteristics found in the NBER Patent Database: year of application, granted year, number of claims, pendency time, citation,[24] etc... We also exploit a timing dimension by sorting patents by year of patent granted. This gives us a three dimensional link defined as examiner-id/ patent-id/year-patent-granted. After dropping patent or examiner observations with missing information, we obtain a random sample of 623 examiners who have granted about 1,300,000 patents.

Our sample of patents is by definition a subsample of the population of patents provided in the 1976-2006 NBER Patent Database. During the year 1995, our sample of 623 examiners granted 74,665 patents which corresponds to 73% of the granted patents during the year according to the NBER Patent Database (101,413 patents granted in 1995). We view this large percentage as indicative of the large representativity of our sample of examiners in the total population of examiners hired in 1995.

We now provide the details of the patent characteristics, examiner characteristics, mobility measures (step d) of our data collection process) and the dataset used to perform our analyses.

3.2 Descriptive Statistics

3.2.1 Patent Characteristics

Summary statistics of the main patent characteristics for our subsample of patents and comparison with the NBER Patent Database is presented in Appendix A Table A1. The patent characteristics used are: pendency time (defined as the difference between the year of the patent application and the year the patent was granted), number of claims, whether the country's inventor is U.S., backward citations, indices of originality and generality (Trajtenberg et al., 1997) and the 6 technological fields (Chemical, Computers and Communications, Drugs and Medical,

[23] The lack of patent information prior to 1976 for examiners who already had several years of experience back implies that the dataset if left-censored.

[24] We cannot consider the 2001 change in the reporting of citations (by examiners or inventors) as we use the citations measures provided in the NBER patent database which do not make the distinction after 2001.

Electrical and Electronics, Mechanical, and Others).

Over the period of 1976 to 2006, average patent characteristics from the NBER Patent Database and from our examiner-patent dataset show notable differences. Our sample of patents exhibits smaller average pendency time, smaller average number of claims and average percentage of U.S. patents, and a relatively greater proportion of patents in the mechanical field (category 5) but smaller proportion in the field of computers and communication (category 2).

These observed differences are in fact not surprising. While our sample of examiner-patent is random on the day of December 19th, 1995, the sample becomes less representative of the entire population of examiners and patents granted the years following 1995. This is because our sample follows examiners who stay at the USPTO (either remaining examiners or changing job levels through an administrative promotion), therefore it loses examiners who leave and excludes newly hired examiners. As a result, for any other year than the collection year of 1995, our sample of examiner-patents is not random.

We are interested in exploiting the non-randomness of that sample and in particular, in analyzing whether and how the endogeneity created in who stays, who leaves and who gets promoted is correlated with examiner granting and patent characteristics. Our objective is to exploit the endogenous variations in the characteristics of our sample of examiners (tenure accumulated, number of patents granted by technological field, gender, etc.) and in the average characteristics of the patents they granted over the years to provide empirical evidence about who stays, who leaves and who gets promoted and demonstrate empirically how this information interacts with patent granting outcomes.

3.2.2 Examiner Characteristics

Appendix A Table A2 presents more details about examiners; 204 of our 623 examiners granted patents as early as 1976, implying that a third of our sample are examiners who in our collection year of 1995, had been granting patents for at least 20 years. Also 595 out of 623, or 95% of our sample of examiners, were working at the USPTO in 1992, the year we match our data with the PTO roster to obtain yearly information on turnover and promotions at the USPTO.

Regarding examiner attrition after 1995, the rate is relatively constant at about 4% per year with an exception in 2001 where 7.7% of the sample left that year and gradually going back to 4% after. By 2006, 382 examiners were still working at the USPTO, which corresponds to 61% of our original 1995 sample of examiners. Conversely, 39% of the 1995 sample examiners have left the USPTO by 2006 as a result of retirement or job separation.

We constructed gender from the examiner name information extracted from the patents. In the majority of cases, the name was clearly indicative of a female or male. In the initial examiner sample of 1995, 15% of the examiners are female. This number is in line with evidence described in the existing literature discussing the small but fast growing presence of women in the patent industry (Ding et al., 2006; Whittington and Smith-Doerr, 2008; Adams, 2008). However, given measurement errors in the name based approach for identifying gender, the derived female dummy variable is affected by measurement errors implying an attenuation bias in the female dummy estimates from the regression estimations which will be performed.

We constructed two tenure variables: tenure as assistant examiner and tenure as primary examiner. We obtained the assistant information while collecting the examiner names on the patents which indicate the name of the primary examiner and the assistant examiner (if there was one). We therefore have for each examiner, all the patents he/she granted as primary and as assistant examiner. From this information, we were able to count the number of patents granted as assistant and primary examiner. We also calculated years of tenure as assistant and primary examiner by calculating the difference in the year of the last patent granted and the year of application of the first patent granted, for patents granted as assistant and as primary examiner.

3.2.3 Additional Examiner-Patent Measures

We exploited two sources of information to further analyze examiner granting behavior: examiner self-citations (the percentage of citations of an examiner's own granted patents), and the frequency of interactions between the assignee and the examiner.

For self-citations, we used the NBER citing-cited dataset and matched it by citing patents to the patents of our sample of examiners. For each examiner, we counted the number of times an examiner citations refer to a patent previously granted by that same examiner.[25] Our measure of self-citations corresponds to the ratio of own examiner granted patent citations out of all the

[25] We do not distinguish citations provided by the inventor versus by the examiner on the application. Doing so would have substantially reduced the size of the sample since the extra information is only available starting in 2001 (this would make us drop 80% of our sample). Our measure remains a reasonable approximation of examiners' self-citations given previous evidence that a large share of citations are added by examiners (Alcacer et al., 2009; Sampat, 2010) and that examiner-provided citations are the ones that are most likely used in deciding whether to grant a patent (Cotropia et al., 2010).

examiners citations and is calculated over the examiner's career.

This measure can be interpreted in two ways. On the one hand, it can measure the extent of the knowledge specificity or knowledge depth of the examiner. On the other hand, it may also reflect a lack of effort in searching for prior art outside of the examiner's own field of expertise. Both interpretations have very different (and in fact opposite) implications for the evolution of an examiner's job performance and how it relates to leaving and promotion outcomes.

One way to distinguish between the two interpretations is to check whether self-citations significantly differ by technological fields. If self-citations represent the extent of an examiner's knowledge specificity, they will likely be larger in the narrow technological categories (e.g., chemical products) relative to broader ones (e.g., computers and communication) which borrow knowledge from various technologies. If instead self-citations reflect lack of effort, it is more likely to be independent of the technological field of the patent.

We tested this idea by regressing examiner self-citations on dummies indicating the technological category of the last patent granted (of the last year the examiner was in the sample) further controlling for years tenure and Art Units. The estimated coefficients associated with the technological field dummies reflect a measure of average self-citations by technological category for examiners with equal years of tenure as primary examiners and within an Art Unit. We then performed an F-test of equality in the estimated coefficients. The results are shown in Appendix A Table A5.

While the null hypothesis of equality of examiner self-citations is rejected at the Art Unit level, it is not rejected at the technological category level. Together these results imply that there are statistically significant variations in average examiner self-citations across the different Art Units but within Art Units, examiner self-citations are similar across technological categories. The result is similar when the tests are performed over the subsample of leavers (last two columns of Table A5).

In light of these analyses, we are more inclined to interpret the examiner self-citation measure as a proxy for low effort rather than knowledge specificity. The significant variations in examiner self-citations across Art Units can be explained by the non-random sorting of examiners across Art Units.

For building our measure of assignee interactions, we used the assignee database and considered all patents granted by our sample of examiners between 1976 and 2006 and for which assignee information is available (assigned patents). We then selected patents assigned to non-government organizations (U.S. or not) and government ones (we excluded patents assigned to individuals). Next, we calculated the number of repeated interactions with the same assignee for each examiner over an examiner's career.

While it is quite common for an examiner to grant patents to the same assignee, we measure the intensity of these repeated interactions using the maximum number of repeated interactions with the same assignee in a given year as well as over an examiner's career. Because examiners vary in their granting experience, we divided this number by the total number of patents granted in a given year as well as calculated over the examiner's career (respectively). This measure therefore describes the ratio of an examiner's maximum number of repeated interactions which came out of all the examiner's granted patents. A graphical illustration of how we calculated our two measures is presented in Appendix A Figures 2a and 2b.

Because the maximum number of repeated interactions with a given assignee will depend on the extent of that assignee's innovative activity (assignees who regularly file patent applications in the same technological field are more likely to interact with the same examiner specialized in that field), we broke down our measure of repeated interactions by the level of an assignee's innovative activity (the number of patents granted to that assignee per year and per technological field). Doing so allows us to condition our measure of repeated interactions to the intensity of the assignee's innovative activity. Otherwise, unequal patent distribution among the various assignees mechanically generates unequal interactions with assignees.

An additional rationale for breaking down repeated interactions by intensity of innovative activity of assignees relates to its implication for an examiner's decision to leave the USPTO. Among non-individual assignees (private firms or governmental institutions), the extent of innovative activity may create incentives for the firm or the firm's attorney office to hire the examiner to take advantage of his/her highly specialized knowledge of what it takes for an innovation to be issued a patent. This may be even more relevant for assignees with relatively lower intensity of innovative activity and who would like to expand by increasing the activity of their research and development branch. We therefore expect to find different correlations between mobility outcomes and repeated interactions with assignees depending on the level of innovative activity.

To obtain a distribution of assignee innovative activity in terms of patents, we used the NBER patent-assignee database, excluding assignees who are individuals, selecting only firm or organization assignees (private or government organizations). For each assignee, we counted the number of patents in each technological field in a year (by the granting year of the patent). We thus obtained a year-specific and technological field-specific distribution of innovative activity by firm assignee. We used this information to create distributions of innovative activity by year and technological field. We define the 20^{th} and 80^{th} percentiles as the levels of low and high innovative activity (medium level being in between the two) in a year and technological field.

While these cutoff levels have been arbitrarily created,[26] they are defined for the whole population of firm assignees in the NBER Patent Database. After obtaining this information, we recalculated the maximum number of repeated interactions but, this time, separately by levels of the assignee's innovative activity. It is worth mentioning as well that the year- and field-specific levels of innovative activity of the assignees were defined over the whole population of patents-assignee to avoid endogeneity created by calculating the percentiles over the non-random subsample of patents-assignees of our sample of examiners.[27]

3.2.4 Mobility Measures

We now describe the last step *d*) of our data collection process. The mobility outcomes (leave or being promoted) of an examiner have been created using the USPTO employee yearly directory for 1992-2006, kindly provided to us by B. Sampat. The 1992-2006 roster data contains all the employees (full name and job title) who worked at the USPTO between 1992 and 2006. It also contains information about the four-digit Art Unit in which they were working each year.

The roster data gives us the exact year at which the individual left between 1996 and 2006 (since 1995 is the year we collected the examiner sample, none of the examiners could have left that year) allowing us to identify leavers as examiners who left the USPTO at some point during 1996 and 2006.[28] Using this information, we can further analyze turnover information in our data by looking at average tenure of examiners the year they left. Appendix A Table A3 calculates the yearly proportion of examiners who left the USPTO since 1995 by tenure level. We assume that departures with less than 15 years of tenure as primary examiner are more likely to represent a job separation while departures with more than 25 years of tenure as primary examiner are more likely to reflect retirement.

[26] We experimented with more or different cut-off levels and the results of the estimations (not shown but available upon request) were similar.

[27] When patents have several assignees, we split the patent count by the number of assignees on the patent.

[28] The end year of 2006 which corresponds to the last year of the employee directory data creates right censoring in the dataset regarding mobility information over time as examiners who stayed until 2006 and did not get promoted by then may well be after 2006. This issue is more problematic when using a sample which includes new hires every year which is not the case here.

In the first 5 years following 1995 (the year at which we start observing departures), none of the departures seem to be associated with a retirement and in the majority of them, examiners have less than 15 years of tenure as primary examiner. Retirements are observed later in the sample period. Overall, using tenure information at the time of departure, over the 1995-2006 period, 32% of the departures are likely job separations (tenure as primary examiner less than 15 years) and 31% are likely retirement (tenure as primary examiner of more than 25 years).

For identification of promotions within the USPTO, we use the job title information provided in the yearly roster data. The job titles include legal and quality related tasks as well as job titles implying management responsibilities such as director, chief of staff, chairman and supervisory examiner. Supervisory examiners (SPE) are responsible for supervising a group of examiners in specific Art Units and their patent examining load is reduced as a result. As not all examiners are promoted to SPE, we consider the promotion to SPE as being the first promotion opportunity for an examiner.[29]

We therefore identified an examiner's promotion based on the change in job titles from primary examiner to SPE as well as from SPE to any job titles which involve greater administrative responsibilities. An examiner is identified as a promotee if at some point during the period 1995-2006, his/she has moved out of his/her role of examiner to SPE or from SPE into one of the more administrative positions described earlier (director, chief of staff, chairman). We also identify promotions on a yearly basis as we have information about the year the job change occurred. Note that examiners could be identified as both leaver and promotee during the time period so we also categorize promotees-stayers as those who have received a promotion and have not left the organization by 2006.

We analyze leaving and promotion decisions separately although they may not be independent decisions, especially if leaving takes place after a promotion. Figure 1d presents the distribution of examiners (assistant and primary) tenure separately for examiners who left and those who received a promotion some time between 1992 and 2006. We see that whether it is for the smaller group of early leavers or for the rest of the examiners, the peak tenure year for leavers happens about a year before the one for promotees suggesting leaving happens before promotion opportunities. In the present paper, we analyze both mobility outcomes and associated dynamics separately.

[29] During their career, examiners are promoted to different GS levels, and most of them are also promoted from assistant to primary examiner. Therefore, we do not consider these "regular" promotions as being promotions.

3.3 The 1976-2006 Dataset and the 1992-2006 Panel Dataset

We added the leaver/promotee (static) identifier variable obtained from the roster data to our examiner-patent data and this completed our first 1976-2006 dataset which adds information about whom in our sample of examiners, left or obtained a promotion or experienced no change in job some time during the 1992–2006 time period, along with patent examination experience variables and average patent characteristics averaged by the granting year of the patents.

Over the 1976-2006 period, the sample contains 12,014 observations (examiner-year). Appendix A Tables A6 and A7 provide summary statistics for patent and examiner characteristics, respectively, for all examiners and by mobility outcomes (leavers and promotees). For tractability purpose, we reduced the within-year patent dimension of our 1976-2006 dataset by calculating yearly averages of patent characteristics and collapsing the within-year patent dimension, keeping the first and last patent information for each year (using granting year as the reference year).

The last data building step consists in exploiting the panel format of the mobility information from the roster over the 1992-2006 time period and merge it to the examiner-patents dataset. We merged the examiner-id/ (average) year-patent-grant data with the examiner-id/roster year 1992-2006 data merging by examiner-id and year.[30] The final panel dataset loses the yearly information pre-1992 but has the advantage of containing each examiner's Art Unit information and mobility outcomes on a yearly basis for the 1992-2006 time period. Appendix A Table A8 provides summary statistics by mobility status.

Because of the smaller window of time during which the information is collected (1992-2006), the sample size decreases from 12,014 to 6,497 observations. We use this data for the purpose of robustness checks by replicating the analysis performed with the larger 1976-2006 sample with additional controls for Art Unit dummies (which is equivalent to considering Art Unit fixed-effects).

Both datasets have censoring problems. The patent characteristics information is not available prior to 1976 which limits information on examiners' granting experience. This problem affects the 1976-2006 dataset more than the 1992-2006 one and a comparison of the results using each dataset gives us an indication of the importance of that left-censoring issue.

[30] Note that we could have merged by year of patent applied instead of year of patent granted. We chose to match the USPTO roster year information with the year the examiners' granted patents as we believe the year patents are granted is more likely to be the year the examiner is present and actively working at the USPTO.

A right-censoring issue in both datasets comes from the fact that the mobility information is not available after 2006. Examiners identified as stayers by 2006 could have left the year after. We addressed that issue in two ways. We replicated the analysis dropping the years 2004-2006 and defined leavers and promotees by the end year of 2004. We also used the year 2007 information from the original roster to redefine stayers, leavers and promotees by 2007 and replicated the analysis based on these alternative definitions of leavers, stayers and promotees. The conclusions are insensitive to the end year by which the mobility measures are defined.[31]

Concerning Art Unit information, we report in Appendix A Table A4 the percentage of examiners by Art Unit (at the 2 digit level) in column 1, and the proportions of the examiners within each Art Unit who left or got promoted during the 10 year period. Our sample of examiners is distributed somewhat evenly across the different technological centers with relatively more examiners in the centers related to biotechnology and designs. The percentage of those who left are also larger in these two centers which also have lower percentage of examiners who received a promotion.

We also use the (unbalanced) panel format[32] of the data with the time series aspect of the mobility measures and explanatory variables to look at potential lags in the relationships and consider or control for examiner-specific effects.

We also perform duration analysis by estimating whether patent and examiner characteristics affect the duration before leaving or before receiving a promotion. The next section describes in details the questions we are addressing and the methods used to address them.

4 Framework of Analysis

Our objective is to present a descriptive analysis of the mobility outcomes of examiners. The observational aspect of the data as well as the various interpretations of the variables we constructed both limit the possibility to exploit exogenous variations and/or test and discriminate between different theoretical predictions of worker mobility. Furthermore, models in the mobility literature are based on essentially two main theoretical arguments: human capital and effort-incentives, both of which tend to generate similar mobility predictions. It is therefore

[31] The results are available upon authors' request.

[32] We have to work with a panel dataset that is unbalanced as a direct implication of the examiners' attrition problem we are studying.

very difficult to identify each concept separately in the data.[33]

The human capital perspective analyzes the determinants of job mobility (promotion or turnover) based on the worker's job performance which is influenced by education, training and in general, the worker's skills and expertise on the job. The argument based on effort emphasizes the importance of designing appropriate incentives to generate and maintain optimal effort. This involves thinking about attraction and retention strategies such as promotions, an incentive device used to ensure effort, motivation and retention. Outside options and the market value of a worker's skills can also determine promotion and turnover outcomes (when skills are valuable to the market and information is symmetric).

Whatever the underlying mechanism at play which generates mobility predictions, we expect that variables positively correlated with a worker's job performance, such as human capital and high effort, increase promotion and reduce turnover opportunities (McCue, 1996; Pergamit and Veum, 1999; Oyer and Schaefer, 2011). However, additional considerations involving a worker's comparative advantage in a given job level may lead accumulated job-specific human capital or task-specific expertise to decrease the chances of a promotion to higher level responsibilities as the worker stays at the level at which he/she has a comparative advantage (Gibbons and Waldman, 1999; 2004). This could be the case in the context of patent examiners within some technological centers where the extensive field-specific knowledge gives them a comparative advantage in reviewing applications relative to supervising other examiners working more broadly across fields.

Another consideration which leads to different mobility predictions is the presence of asymmetric information. An examiner's performance on the job may be valued differently by the current employer and by the market and this may create outside options. This would then increase both the chance of leaving for a better job as well as the chance of receiving a promotion as a retention strategy for the current employer. Asymmetric learning about ability and strategic considerations regarding promotions as a signal of ability has also been linked to lower promotion rates and turnover (Waldman, 1984; Bernardt, 1995; Scoones and Bernardt, 1998; Oyer and Schaefer, 2011).

The previous interpretations and alternative explanations are the reasons our approach in this paper (and given the data) is at this point descriptive. We document the link between average granted patent characteristics (to the extent that they correlate with his/her job per-

[33] The ideal dataset would include information on worker's effort in addition to the worker's output.

formance) and the examiner mobility outcomes as a series of (as of now unanswered) empirical questions. The results of this analysis should help further inform theory about the role of examiners mobility in the optimal design of the patent review system and examiners career incentives. Our objective in the next section is therefore to analyze a set of questions highlighting potential links between average granted patent characteristics (later denoted AGPC) and examiner-patent characteristics (later denoted EPC) and mobility outcomes.

4.1 Average Granted Patent Characteristics (AGPC) and Examiner Tenure

We begin with an analysis of the correlation between an examiner's tenure and his/her AGPC. The idea is to see whether and how the type of patents an examiner grants every year is related to his/her accumulated tenure at the USPTO. A similar approach was done in Lemley and Sampat (2012) who analyzed the links between examiner years of experience and examiners' citations. We complement their analysis by considering whether accumulated tenure is related to additional examiner patent characteristics. We ask the following question: Do examiners granting outcomes change over time as they accumulate more work experience and if so, how?

We run separate ordinary least square regressions of each time-varying AGPC variables on a quadratic function of the examiner years of tenure as primary examiner.[34] The regressions also include year dummies to capture potential trends in the evolution of patent characteristics over time and include the technological field of the last granted patent in the year to control for technological differences affecting the time it takes between patent applications received and examination time, all of which are likely to create field-specific granting outcomes.

Tables 2a and 2b present the results based on the 1976-2006 pooled cross-section dataset and the 1992-2006 panel dataset, respectively. We notice from both Tables that most AGPC of an examiner in a year are significantly related to his/her tenure at the USPTO in the following way: an additional year of tenure is associated with an examiner's granted patent which has on average longer pendency time, more claims, a lower percentage of U.S. patents granted, patents with less citations (consistent with Lemley and Sampat, 2012) and granted patents which are less original (citing less across technological fields).

Based on Table 2b, except for the percentage of U.S. patents, the estimates which are statistically significant are similar in sign and magnitude suggesting the results are invariant to the

[34] We also tried a cubic function of tenure with no statistical significance of the cubic tenure terms so we only include the quadratic analysis in the paper.

time period used and format of the data.

Table 2c replicates the previous analysis controlling for the examiner's Art Unit (4-digit dummy variables). The results hold and in addition, the generality of the patent is now statistically significantly related to the examiner tenure such that as examiners accumulate additional years of tenure, their granted patents are, on average, less general. Also most squared terms are statistically significant reflecting non-linear U-shape (or inverted U-shape) relationships.

The relationships identified between an examiner's tenure and AGPC are likely the outcome of a selection process by which only a certain type of examiners stays at the USPTO continuing as examiner while other types get promoted (the tenure variable only measures years granting patents as primary examiner) to administrative jobs within the USPTO or leave. This non-random selection driven by unobserved individual heterogeneity in the error term, which is correlated with tenure can be corrected by using fixed-effect estimations removing the time-invariant examiner fixed-effect.[35] Moreover, given the unbalanced nature of the panel (not all examiners are observed over the same number of years), we further selected the first 5 years examiners spent at the USPTO (nearly all examiners stayed the first five years) excluding the (very small number of) examiners who left before 5 years of tenure.

To emphasize the effects associated with non-random selection of examiners into the different mobility outcomes, we interacted the tenure variables with indicators of whether the examiner eventually left the USPTO, stayed without promotion or stayed and received a promotion. Essentially this amounts to estimating different tenure profiles by mobility outcome of the examiners and perform F-test of equality (to 0) in the tenure estimates for movers and stayers and promotees. The results based on the 1992-2006 panel data which estimations with Art-Unit fixed-effects are shown in Table 2*e*.[36]

The results are stronger than those in Tables 2a-2c. Over the first 5 years of (primary) examiner tenure, the fixed-effect estimates and associated t-test show that there are statistically significant differences in the AGPC-tenure profile of stayers versus movers and promotees.

In the first 5 years of tenure as primary examiner, the average pendency time per additional year of tenure increases and is significantly larger for promotees relative to stayers and leavers; the average number of claims per additional year of tenure increases and is significantly larger for leavers; the average number of citations per year of tenure significantly declines for leavers but

[35] Random-effects estimations of the same regressions and a Hausman test in each case confirmed that the fixed-effect estimates are appropriate in this case. Results are available upon request.

[36] Table 2*d* represents a similar analysis with the first 15 years.

increases for promotees; the average originality of the granted patents increases per additional year of tenure only for promotees and the average generality of the granted patent increases per year of tenure only for leavers.

In summary, the present analysis provides preliminary evidence that a) examiner heterogeneity in granting rates found in the literature also translates into heterogeneity in granted patent characteristics, and b) that this heterogeneity interacts with the non-random sorting of examiners into more administrative job within the USPTO (through promotions) and jobs outside of the USPTO (through leaving the institution). These first results shed light on the importance of the interactions between examiner mobility outcomes and examiner granted patent outcomes.

The remainder of our analysis concentrates more specifically on empirically examining whether, and if so how, average granted patent characteristics as well as examiner granting behavior help explain examiner mobility outcomes.

4.2 Who Leaves and/or Gets Promoted?

In this section we further concentrate on the link between an examiner mobility outcome (the fact that he/she left or got promoted some time between 1995 and 2006) and the average characteristics of his/her granted patents as well as our examiner-patents measures based on self-citations and repeated interactions with assignees. We are wondering who leaves and/or got promoted based on information on gender, tenure and patent characteristics of the examiner.

We use a latent variable model with the observable mobility outcome defined by whether the examiner left the USPTO or whether he/she received a promotion. We exploit the yearly variations in patent average characteristics of the 1976-2006 dataset to see whether and how they correlate with the static mobility outcomes of our sample of examiners who are classified as either leavers, or promotees versus non job changers.

We performed a series of hierarchical logistic estimations, starting initially with a specification (**S1**) which includes only the variables related to average patent characteristics. We then added examiner characteristics such as gender, tenure as assistant and as primary examiner, number of patents granted as assistant examiner, and number of patents as primary assistant per technological field (specification **S2**). We further augmented the previous specification by adding examiner-patent characteristics starting with self-citations (specification **S3**) and adding the variables on repeated assignee interactions (specification **S4**).

The last specification (specification **S5**) considers **S4** regressed over the sample of examiners which excludes examiners who left after 15 years or longer (more likely to reflect retirement) considering only those who stayed or left after staying less than 15 years at the USPTO. In the case of the promotion analysis, it excludes promoted examiners who left during the sample period. All the specifications include year dummies and dummies for the technological field of the last patent granted in the given year. Standard errors are clustered at the examiner level.

The results for the outcomes of leavers versus stayers are given in Table 3, and for the outcomes of promoted versus non-promoted examiners are presented in Table 4. From the column summarizing the results of specification **S1** in each table, we see that none of the AGPC variables are statistically significantly related to having left the USPTO. Average pendency time is positively related to having received a promotion. This is not surprising as examiners have less time for patent granting after taking on the greater supervisory responsibilities of the job of SPE. Average backward citations are weakly significant and positively associated with having received a promotion.

Adding number of patents granted per year by technological field (specification **S2**) and controls for examiner characteristics and examiner-patent variables (specifications **S3** and **S4**) does not change the previous results except for the correlation of promotions with backward citations which disappears and a negative correlation between having received a promotion and average originality of the examiner's patent (column **S4** of Table 4). Overall, between-examiners variations in AGPC are not significantly strong predictors of turnover and promotion likelihoods.

The strongest correlations are found when considering variables related to the EPC variables, that is granting experience (number of patents granted by field and tenure) and granting behavior (self-citation and repeated interactions with the same assignee). The estimates are presented in the lower panels of the specifications **S2-S4**.

Interestingly, while the number of patents granted per year helps explain (statistically significantly positive estimates) both leaving and promotion outcomes, the technological field in which the patents have been granted seems to make a difference for predicting turnover or promotion. That is, having more patents granted in the Chemical field is positively associated with examiners who have left, while it is the granting of patents in the Computer and Communication field and Electronic field which is positively associated with having received a promotion. The estimates of column **S4** in terms of odds ratio imply that with 10 additional patent granted per year in the Chemical field, an examiner is 6.6% more likely to leave and with 10 additional patent granted per year in Computers and Communications, an examiner is 6.6% more likely to receive a promotion.

Among the set of examiner characteristics, gender is unrelated to mobility outcomes. Examiners who have left have had spent fewer years as assistant examiner and have less patents granted as assistant and more years as primary examiners (a direct implication of retirement). Years of tenure as assistant and number of patents granted as assistant are unrelated to an examiner's promotion but examiners who have been promoted have on average less years of accumulated tenure as primary examiner. This suggests that there is a fixed window of promotion opportunities and pass the right time, promotion prospects decline.

Regarding examiner-patents characteristics, the percentage of self-citations is strongly related to mobility outcomes. Examiners who have left have a higher percentage of self-citations while those who have been promoted have a lower percentage of self-citations (each relative to examiners who stayed until 2006 and did not receive a promotion) (specifications **S3** and **S4** of both tables). For repeated interactions with the same assignee (specification **S4**), interactions with highly innovative firms are statistically significantly and positively related to leaving the USPTO and repeated interactions with assignees with low levels of innovative activity strongly negatively correlate with promotion probabilities.

The last column of Tables 3 and 4 further analyzes the particular group of examiners whom, if they have left before 2006, have done so after having spent less than 15 years at the USPTO (specification **S5** of Table 3) and the group of examiners whom, if they have received a promotion before 2006, have not left the USPTO by 2006 (specification **S5** of Table 4).

The results are slightly different when considering early movers, especially for early leavers (last column of Tables 3 and 4). Backward citations seem to be positively correlated with leaving early and it is now patents granted in the fields of Drugs and Medical products and Mechanical products that increase the probability of leaving, by about 94% and 96%, respectively. For the early promoted examiners who stayed, the results are similar to those in Table 4 (the statistically significant estimates are slightly different in magnitude).[37] Regarding examiner-patents characteristics, the previous estimates become stronger for both the odds of leaving and receiving a promotion. In appendix B table B1, we replicated the analysis of specifications (**S4**) and (**S5**) controlling for Art-Unit fixed-effects using the 1992-2006 dataset. The results hold and sometimes with larger estimates reflecting stronger correlations.

[37] Except for the number of granted patents in the field of Electronic products which does not correlate anymore with promotions.

Summarizing the results which are robust to Art Unit fixed-effects, we find that examiners who have left the USPTO some time between 1995 and 2006 have longer tenure as primary examiner but have spent less time as assistant examiners, and have granted more patents in the field of Chemical products. These examiners also tend to have more self-citations and more repeated interactions with high innovative assignees, after controlling for technological fields.

Early leavers' outcomes are different. The number of years of tenure as assistant examiner does not matter but early leavers grant patents with more backward citations, grant more patents in the field of Drugs and Medical products. They also have more self-citations, and have repeated interactions with both low and high innovative activity firms.

Examiners who have received a promotion some time between 1992 and 2006 have granted patents with on average greater pendency time, and lower average originality. Promoted examiners have granted more patents in the fields of Computers and Communication and Electronic products. They have less self-citations and less repeated interactions with assignees of medium and low levels of innovative activity.

Given the previous finding of the lack of evidence that self-citations reflect knowledge depth in a particular field, we instead interpret the positive correlation of self-citations with the likelihood of leaving and the negative correlation with the promotion probability as the outcome of the examiner's low effort. The positive correlation between leaving outcomes and repeated interactions with assignee firms of high level of innovative activity confirms our initial conjecture that not all interactions are the same and that highly innovative assignees may be more likely to offer job opportunities for examiners in their R&D office. The negative correlation with promotion prospect may reflect the fact that the time and information invested in maintaining assignee interactions prevent examiners from investing time in developing a career track within the USPTO.

For early leavers, the correlation between mobility outcomes and repeated interactions with both high and low levels of innovative activity seems odd at first. However, job opportunities for examiners teaming up with low innovative assignees may also take place, to the extent that these assignees would like to increase the size of their R&D activity level.

An alternative interpretation which has been brought to us is one based on the assumption that examiners are more likely to leave as a result of the inconvenience of repeatedly dealing with the 'persistent filers' (and the limited control examiners have of rejecting a patent application). The persistent filers are more likely to be low innovative activity firms which rely on the continuation process to eventually get their patents approved. These high volume applicants are more sophisticated applicants who know what is necessary to game the patent system. It is possible that examiners first enjoy the benefits of the job but may soon realize they cannot handle the disadvantages which come with handling the 'persistent filers' and leave the USPTO as a result.

Overall, controlling for years of tenure spent at the USPTO and Art Unit fixed-effects, leaving and promotion outcomes are significantly linked to examiners behavior regarding citations (backward and self), granting experience accumulated in particular technological fields, and repeated interactions with the same assignee firm. The next sections further investigate the potential dynamic aspect of the previous correlations.

4.3 Does Timing of AGPC Matter?

In this section, we perform two types of analyses exploiting the panel format of the 1992-2006 dataset. First, we model the likelihood of leaving and receiving a promotion at time t as a function of the lags of the time-varying AGPC and EPC using random-effect logistic estimations which control for years and Art-Unit fixed effects.[38] The use of random-effects instead of fixed-effects estimations in this dynamic context is motivated by the idea that in the dynamic mobility literature which models individual career choices (Gibbons and Waldman, 1999; 2004, Gibbons et al., 2005; Lluis, 2005), the yearly mobility outcome is driven by learning about an employee's own ability to perform on the job. The learning effects correspond to changes in individuals' and employers' beliefs about the employee's ability. These beliefs are part of an unobservable component in the error term which is a time-varying random variable, not a fixed-effect. Moreover, rational expectations imply that changes in beliefs between the previous and the current period which drive next period mobility outcomes follow a martingale and are therefore uncorrelated with current period employee characteristics, the covariates in the mobility equation. Under this type of mobility framework, the likelihood of current mobility is a function of the lags of an employee's characteristics or behavior and a random time-varying

[38] We consider random-effects instead of fixed-effect estimations as we assume that examiner ability which affects turnover and promotion prospects is unobserved and that the likelihood of mobility at time t is influenced by (examiner and employer) learning about it. Beliefs about ability follow a random process (martingale or random walk in the case of Bayesian learning) which affects the likelihood of leaving or receiving a promotion at t but is uncorrelated with the lags of the explanatory variables in the mobility equation such as the lags of the AGPC and EPC characteristics (as a result of the martingale process for the evolution of beliefs).

error term representing changes in beliefs about the employee's ability to perform on the job. Under the assumption of rational expectations, these variables are assumed to be uncorrelated and the random-effect logistic estimator is unbiased and efficient.

Second, we look at whether AGPC and EPC influence the conditional probability of leaving or receiving a promotion, conditional on the time already spent at the USPTO by estimating parametric hazard functions.

Given the dynamic aspect of this particular analysis, we also exploit the time-varying information we have on examiners Art Unit from the roster data. During the 1992-2006 time period, several examiners experienced multiple changes in Art Units both during and over the years. We created a variable reporting the number of Art Units an examiner was associated with (reflecting the scope of his/her knowledge) in a given year and a variable indicating whether he/she switched Art Units during the year where Art-Units are categorized at the 4 digit level. Tables 5a (leaving) and 5b (Promotion) and 6 (Duration) report the results of the random-effect logistic estimations and the hazard estimations, respectively.

Table 5a and 5b show the estimates of the first lag (first column) and second lag (second column of the panels for each mobility outcome) of the time varying variables.[39] Similar to the static analysis in Tables 3 and 4 we look at the estimates associated with patent and examiner characteristics (including the different variables related to granting experience) in specification **S1.** In specification **S2**, we add the variable indicating whether the examiner experienced a change in Art-Unit during the previous year (first lag) and two years prior (second lag).

Examining Table 5a for turnover outcomes, we see that both current and lagged pendency time strongly relate to current period leaving decision with opposite signs but similar magnitude. In fact, the estimated coefficients for the current and lagged variables are so similar that a hypothesis test cannot reject the null of equality of the coefficients suggesting it is the change in pendency time between $t-1$ and t which is correlated with leaving at t.[40] A re-estimation using the change in pendency time between t and $t-1$ confirms that an increase in pendency time has a statistically significant relationship with the likelihood of leaving.[41] This is not surprising as examiners who leave during a given year would have less time to finalize the last applications they have been working on. The second lag of pendency time is unrelated to departure suggesting that

[39] The regressions also include the first and second lags of the art unit dummies and year dummies.

[40] With the βs of similar magnitude for the two X variables X_t and X_{t-1}, factoring the beta leads to $\beta\ (X_t - X_{t-1})$ which reflects the change in X between two consecutive years.

[41] Results are available upon request.

pendency time is unlikely to be the source of the departure decision. Previous period average originality of an examiner's granted patents is statistically significantly related to next period departure. Interestingly, the second lag is also statistically significant but is negative and of the same magnitude (a test of equality of the two estimates cannot reject the null hypothesis). This suggest that it is the change in average originality of the patents granted between $t-2$ and $t-1$ which correlates with next period departure. A re-estimation using the change in originality between $t-2$ and $t-1$ confirms that finding.[42]

As with pendency time, another direct effect of an examiner's departure decision is the negative correlation with the current period number of patents granted in any of the technological fields. Examiners gone some time during a given year automatically grant less patents during that year. The more interesting results regarding granting experience are the strongly significant correlations of the number of patents granted in Drugs and Medical products and in Mechanical products two years prior to departure. The result is consistent with Table 3 conclusions about the statistically significant link between granting patent in the field of Drugs and Medical products and the likelihood of leaving the USPTO. Furthermore, the first lag of the number of granted patents in Drugs and Medical products is negatively correlated with departure next period. Together with the result on the second lag estimate (and similar to pendency time and originality), we see that it is the change in patents granted between t-2 and t-1 which correlates with next period departure. In this case, a decline in the number of patents granted in that field is associated with next period departure.

The second part of Table 5a shows that gender is not related to the dynamic decision of leaving in a given year but that tenure as assistant examiner reduces the likelihood of leaving the USPTO while tenure as primary examiner increases the likelihood of departure, similar to the static mobility results of Table 3.

In specification **S2**, we add information about examiners' number of Art-Units and previous period Art-Unit switches. The previous estimates do not change much. There is evidence that changing Art-Units significantly decreases the likelihood of leaving two years later.

Table 5b presents the promotion dynamics. While promotions are significantly negatively correlated with average generality of the promoted examiner's patents, average generality two years prior to the promotion increases the chances of an examiner's promotion. As with departure, a change in the number of patents granted between two periods is positively associated

[42] Results are available upon request.

with promotion. It is in the field of Electronic products, consistent with the results found in Table 4. The second part of Table 5b shows that gender does not relate to the dynamics of promotions and as in Table 4, that tenure accumulated as primary examiner reduces future promotions. There is also a negative correlation between the number of patents granted as assistant and future promotions. Regarding **S2** results which add Art-Unit information, the previous estimates do not change by much. The number of Art-Units in the year an examiner is promoted significantly increases but previous period number of Art-Units or Art-Unit switches do not seem to help predict future promotions.

In Table 6, we present the estimates for the Weibull distribution survival model.[43] While from the previous analysis we found that lagged values of AGPC are not correlated with the likelihood of current mobility outcomes, we now find that in the context of a duration model, AGPCs are correlated with the evolution of the hazards of leaving and receiving a promotion over time. Indeed, the average generality of examiner granted patents increases the hazard of leaving and the percentage of patents with U.S. inventors increases the hazard of receiving a promotion. Both estimates are statistically significant and the hazard ratios imply that a 1% increase in the generality index of examiner granted patents and in the proportion of his/her patents granted with U.S. inventors each increases the hazard of leaving by about 5 and the hazard of receiving a promotion by about 4.

Furthermore, while we found that examiners who grant patents in Drugs and Medical products are more likely to leave (Table 3) and that an increase in the number of patents granted in that technological field helps predict next period leaving decision (Table 5), we find that the number of patents granted in that same field does not significantly influence the risk of leaving over time. Instead, it is the number of granted patents in the other fields (those which have been found to positively relate to promotions in Table 4) which significantly reduces the hazard of leaving (patents granted in Computers and Communication, Electronic and Mechanical products). It is not surprising to find that leaving risks decline over time in the fields which are positively correlated with the likelihood of having received a promotion. Examiners would have lower incentives to leave in fields with greater promotion probabilities.

For the promotion hazard, we find that other than the percentage of U.S. patents granted, pendency time significantly reduces promotion hazards (Table 6, second column estimate which

[43] A comparison of the AIC across the different distributions (exponential, log normal and Weibull) is shown in Appendix B Table B2. Based on the AIC value, we conclude that the Weibull distribution is preferred over the others.

implies a hazard ratio of 0.596). A small decline in the promotion hazard is associated with an increase in the number of claims. The number of granted patents does not relate to the promotion hazard. This finding confirms our previous conclusion that there seems to be no link between the timing of a promotion (the likelihood of a promotion at time t or the time evolution of a promotion hazard) and performance achievements as measured by experience accumulated in granting patents in a given year. In other words, the USPTO quota system does not seem to relate to promotion outcomes, as we define them.

Also consistent with results found in Tables 3 and 4, an examiner percentage of self-citations significantly increases the risk of leaving and reduces the promotion hazard. Regarding repeated interactions with the same assignee, the positive correlation comes out strong for the hazard of leaving and interactions with low innovative activity inventors implying that such repeated interactions do increase the risk of leaving over time. The negative correlation with the promotion hazard for low innovative activity assignees is strong but imprecisely estimated.

The one factor which was not found to be significantly related to the unconditional probability of leaving and is found to significantly increase the risk of leaving over time is being a female. Notice however that the estimated coefficient for female in all the promotion equations (Table 4-6) is positive but weak and imprecisely estimated (likely the result of an attenuation bias as discussed earlier). Together the results suggest that female examiners may be more likely to leave the USPTO than their male counterparts but probably not due to a glass ceiling problem.

Our additional measures related to Art Unit mobility (the Art Unit switch dummy and the number of times an examiner switched Art Units) significantly increase the risks of leaving and promotions, with larger estimates in the latter case than in the former. This suggests that lateral mobility across Art Units is an important factor developing the scope of knowledge necessary to move up in administrative and supervisory responsibilities.

4.4 Summary of Main Results

In this section, we highlight the results of each type of analysis to present a synthetic view of the various approaches we used in this paper. The main results are summarized in Table 7.

AGPC and examiner tenure - The main result from this analysis is the significant difference in the AGPC-tenure profiles (after controlling for examiners and Art Unit fixed-effects) in the first five years of USPTO experience for examiners who end up leaving or being promoted compared to stayers with no change in duties. This is the case for examiners average backward citations as well as average generality and originality of their granted patents. For example, examiners who receive a promotion some time after the first five years have on average 1.8 more citations already after the first year of tenure as primary examiner at the USPTO, and grant patents with on average 6% more originality relative to others. Similarly, examiners who end up leaving some time after 5 years have 1.2 less citations and grant patents which are on average 2.2% more general relative to stayers, after the first year of primary examiner tenure.

Who leaves or gets promoted? - We find that after controlling for years of accumulated tenure as primary examiner and for Art Unit fixed-effects, the technological field in which examiners accumulate granting experience has a strong and robust explanatory power in predicting mobility outcomes. Examiners who end up leaving tend to have granted patents in the field of Drug and Medical products. Examiners who end up getting promoted tend to have accumulated granting experience in the fields of Computers and Communication and Electronic products. In other words, mobility outcomes strongly interact with which technological field an examiner grants patents in. Some fields seem to be more prone to turnover and others, more prone to lead to promotions.

Moreover, controlling for tenure, technological field and Art Unit fixed-effects, a higher (respectively, smaller) percentage of examiner self-citations is associated with leaving (resp., promotion). Further analysis indicates a lack of evidence of differences in self-citations across technological categories (Appendix A Table A5). We interpret this finding as suggesting that the self-citations variable is more likely to proxy for examiner's low effort rather than for examiner's depth of knowledge. Therefore, examiners leaving and lack of promotion seem to be associated with lack of effort as reflected by the self-citations measure.

Finally, still controlling for examiner tenure, technological field, Art Unit fixed-effects and self-citations, early leavers experience more repeated interactions with both high- and low- innovative assignees while promotees experience less repeated interactions with low and medium-innovative assignees. Our interpretation of these findings relies on factors which affect the nature or type of interactions. Positive interactions may generate attractive job opportunities at the assignee firm or its lawyer. Negative interactions resulting from the persistence of the applicant is more likely to lead to quitting the job of examiner. The time involved implicitly in repeated interactions with assignees is also expected to reduce examiners time investment in factors leading to a promotion.

Timing related to lags - Exploiting time variations in AGPC and the dynamics of departures and promotions highlights the importance of past period average originality of an examiner's patents for predicting next period departure and past period average generality of an examiner's patent for predicting next period promotion probabilities. Moreover, a significant predictor of next period departure is the *decrease* in the number of patents granted in the field of Drugs and Medical products. The likelihood of a promotion increases with the *increase* in the number of patents granted in Electronic products.

Timing related to duration - Regarding leaving and promotion hazard rates over time, the analysis complements well the previous findings. Some AGPC do influence the hazards of leaving and promotion over time (average generality index of granted patents and average percentage of patents with U.S. innovators, respectively). Self-citations and repeated interactions with low-innovative assignees also influence leaving and promotion risks over time. The new results from this analysis is the finding of a gender effect showing a significant increase in the turnover risk for female examiners and the lateral mobility effect by which switching Art Unit significantly increases promotion hazards.

Table 7: Summary of Main Results

	Leaving				Promotion			
Estimation Model	*Ten.*	$P(l_i)$	$P(l_t)$	$P(l_t \mid t > T)$	*Ten.*	$P(p_i)$	$P(p_t)$	$P(p_t \mid t > T)$
Tables	2	3	5	6	2	4	5	6
Technological Fields		+	+	+		+		
Citations / Originality	*U shape*		+		*U shape*			
Citations/ Generality	*U shape*			+			+	
% US Patents, Pendency time			+			+	+	+
Self Citations		+	+	+		−	−	−
Repeated Interactions		+	+	+		−	−	−
Lateral Art Unit Mobility				+				+

5 Conclusion

The attrition rate of patent examiners over the last 15 years has been an issue for the USPTO. Concerns have also been raised about the incentive mechanisms designed to induce examiners to grant patents to only deserving innovations. Various criticisms have emerged about the issuance of too many questionable patents. Even though patent applicants have their share of responsibility (it is their innovation to start with, so they should provide accurate information to those who must judge their novel content), patent examiners should also be liable as they are those who, ultimately, grant temporary monopoly rights (Langinier and Marcoul, 2015). To the best of our knowledge, little attention has been devoted to the attrition rate and career outcomes of examiners.

Our objective is to study and document the possible links between various aspects of the patent review process and examiners' mobility outcomes. We consider mobility inside and outside of the institution. Mobility inside is defined as the change of job away from the main duties of primary examiner and towards greater supervisory and administrative duties. Mobility outside represents examiners who are leaving the institution. We use characteristics of an examiner's granted patents and two new measures of an examiner's grant related behavior: examiner self-citations and repeated interactions with the same inventor.

Overall, we find consistent evidence from static, dynamic and duration models of the importance of an examiner's average patent characteristics (generality and originality), granting experience, but only in specific technological fields (Drugs and Medical or Mechanical products for departures and Computers and Communication or Electronic products for promotions), repeated interactions with the same inventor, and percentage of self-citations in predicting examiners' departure and promotion probabilities.

Our dataset limits our ability to precisely identify reasons for the observed mobility outcomes. Additional analysis of our measure of examiner self-citations suggest an interpretation based on low effort rather than based on knowledge depth. Poor performance from lack of effort in searching for prior art may explain increased turnover and reduced promotion opportunities. On the other hand, job opportunities might be easier or more attractive in the fields of Drugs and Medical or Mechanical products leading to greater turnover for examiners who accumulated granting experience in these particular fields.

Another result is the importance of the originality of an examiner's granted patents in predicting future departure (but unrelated to promotions). Combined with the previous interpretation of the results in terms of differentially attractive job opportunities in specific technological fields, granting experience associated with original patents may reflect an examiner's valuable and unique expertise in such fields. In fact, when interacting information about examiners self-citations and average originality of their patents, our data suggests that examiners self-citations are negatively correlated with the average originality of their patents granted for the sample of early leavers (maximum tenure at the USPTO is less than 10 years) while it is positively correlated for the sample of examiners who left the USPTO after 20 years. It is possible that self-citations help predict turnover because it proxies for poor performance during an examiner's early career and that it also predicts turnover for more senior examiners because it reflects the depth of an examiner's field of expertise accumulated over the years. Self-citations combined with granting experience in patents considered more original reflect valuable and unique field-specific knowledge likely to raise examiners' labour market opportunities at innovating firms and their R&D branch, or at the law office of these firms' patent attorneys.

Further investigation of our sample of examiners who left the USPTO by matching names to the LinkedIn database (26% match rate[44]) confirms that examiners leave the USPTO to work as patent attorneys either in law firms (about half of them) or in consulting firms specialized in providing legal advice on issues of Intellectual Property Rights such as Ditthavong and Steiner (a quarter of them) or in the R&D of private firms (other quarter). Lastly, the fact that repeated interactions with assignees (with low innovative activities) increase departure and reduce promotion probabilities suggests that relationship building with inventors is an important factor to consider when analyzing the mobility implications of examiners grant related behavior.

Overall, our results invite academic research, in pursuit of a more efficient patent granting system, and human resources policy makers in pursuit of a better workplace in patent offices worldwide, to further think about the implications of examiners career outcomes in the functioning of the patent examining process. Closer attention needs to be devoted to the link between examiner mobility outcomes and patent characteristics and patent granting behavior (citations, self-citations and the non-random assignment of assignees to examiners). In particular, theoretical work on mobility and career prospects needs to incorporate measures of the characteristics and conditions of the job (work environment within the institution as well as outside opportunities) as important factors influencing leaving and promotion outcomes.

Finally, a comparison of the results related to turnover and promotions provides interesting insights for developing further research projects. We find that all the predictors which increase the likelihood of leaving decrease the promotion probability. This result by itself suggests that explanations of mobility decisions based on incentives and outside options by which outside

[44] In most cases we did not find the names in the LinkedIn database. In other cases, the names matched but there was no indication that the person had worked as an examiner at the USPTO.

options increase both departure and promotion prospects (as a retention strategy) do not seem to be relevant in the labor market of patent examiners.

Table 2a. Regressions of Patent Characteristics on Tenure at the USPTO, 1976-2006

Variables[45]	Pendency	Claims	%US(*100)	Citations	Orig(*100)	Gen^{al}(*100)
Tenure	0.020***	0.039*	-0.207**	-0.117**	-0.271*	0.023
	(0.003)	(0.022)	(0.102)	(0.054)	(0.099)	(0.105)
$Tenure^2$	-0.000***	-0.000	0.005*	0.003	0.004	0.002
	(0.000)	(0.000)	(0.003)	(0.002)	(0.003)	(0.003)
R^2	0.33	0.39	0.14	0.31	0.05	0.09

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

Table 2b. Regressions of Patent Characteristics on Tenure at the USPTO, 1992-2006

Variables[35]	Pendency	Claims	%US(*100)	Citations	Orig(*100)	Gen^{al}(*100)
Tenure	0.019***	0.010	0.168	-0.073**	-0.276***	-0.179
	(0.003)	(0.024)	(0.106)	(0.038)	(0.108)	(0.137)
$Tenure^2$	-0.0008 ***	-0.000	-0.006**	0.002	0.007**	0.009**
	(0.000)	(0.000)	(0.003)	(0.001)	(0.003)	(0.004)
R^2	0.38	0.31	0.16	0.16	0.06	0.10

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

Table 2c. Regressions of Patent Characteristics on Tenure at the USPTO, 1992-2006
With 4-Digit Art Unit Fixed-Effects

Variables[35]	Pendency	Claims	%US(*100)	Citations	Orig(*100)	Gen^{al}(*100)
Tenure	0.007**	-0.006	-0.037	-0.122***	-0.436***	-0.359***
	(0.003)	(0.024)	(0.099)	(0.038)	(0.094)	(0.127)
$Tenure^2$	-0.0003***	0.0007	-0.004	0.003**	0.009***	0.011***
	(0.000)	(0.000)	(0.003)	(0.001)	(0.003)	(0.004)
R^2	0.64	0.54	0.51	0.42	0.57	0.48

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

[45] Also includes dummies for technological categories of the last patent granted in the year, 4 digit Art Unit and year dummies. Robust standard errors in parenthesis.

Table 2d. Fixed-effect Estimations of Patent Characteristics on Tenure with Mobility Interactions, 1992-2006

Examiners' First 15 years of Tenure

Variables[46]	Pendency	Claims	%US(*100)	Citations	Orig(*100)	Gen^{al}(*100)
Stayers						
Tenure*Stayers	-0.021	0.369*	0.260	0.394**	-1.527**	-3.133***
	(0.037)	(0.233)	(1.232)	(0.172)	(0.681)	(0.920)
$Tenure^2$*Stayers	0.002*	-0.007	0.069	-0.002	0.063***	0.012
	(0.001)	(0.007)	(0.036)	(0.007)	(0.022)	(0.027)
Leavers						
Tenure*Leavers	0.128	-0.696	6.689***	0.833*	-1.082	-2.577*
	(0.089)	(1.406)	(1.828)	(0.441)	(1.292)	(1.539)
$Tenure^2$*Leavers	-0.003	0.042	-0.231**	-0.018	0.044	-0.030
	(0.004)	(0.062)	(0.074)	(0.017)	(0.053)	(0.058)
Promotees						
Tenure*Promotees	0.024	0.645	1.166	0.410*	-0.388	-2.879**
	(0.061)	(0.453)	(1.655)	(0.318)	(1.233)	(1.190)
$Tenure^2$*Promotees	0.002	-0.023	0.013	-0.004	0.021	0.006
	(0.002)	(0.017)	(0.065)	(0.017)	(0.052)	(0.050)
F-test of joint significance						
For tenure	1.15	1.05	5.72	2.59	1.98	4.00
(p-value)	(0.33)	(0.37)	(0.00)	(0.05)	(0.11)	(0.00)
For $tenure^2$	1.32	1.10	4.59	0.37	2.76	0.16
(p-value)	(0.27)	(0.35)	(0.00)	(0.77)	(0.04)	(0.92)
R^2	0.64	0.58	0.31	0.61	0.36	0.37

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

[46] Also includes technological category of the last patent granted in the year, year dummies and 4-Digit Art Unit dummies.

Table 2e Fixed-effect Estimations of Patent Characteristics on Tenure with Mobility Interactions, 1992-2006

Examiners' First 5 years of Tenure

Variables[47]	Pendency	Claims	%US(*100)	Citations	Orig(*100)	Gen^{al}(*100)
Stayers						
Tenure*Stayers	0.080	0.564	2.620	0.128	2.044	2.529
	(0.064)	(0.564)	(2.802)	(0.401)	(3.462)	(2.439)
$Tenure^2$*Stayers	-0.007	-0.041	-0.452	0.011	-0.305	-0.395
	(0.007)	(0.061)	(0.304)	(0.047)	(0.364)	(0.272)
Leavers						
Tenure*Leavers	-0.059	0.974*	-2.750	-1.694***	-0.092	2.870*
	(0.091)	(0.613)	(3.665)	(0.515)	(1.982)	(1.427)
$Tenure^2$*Leavers	0.006	-0.098	0.416	0.239***	0.064	-0.371*
	(0.011)	(0.071)	(0.414)	(0.059)	(0.246)	(0.218)
Promotees						
Tenure*Promotees	0.266**	-0.739	-1.490	2.313***	8.001***	0.834
	(0.110)	(0.807)	(3.958)	(0.716)	(2.553)	(2.028)
$Tenure^2$*Promotees	-0.027**	0.086	0.097	-0.245***	-0.947***	-0.175
	(0.013)	(0.102)	(0.450)	(0.081)	(0.327)	(0.235)
F-test of joint significance						
For tenure	2.52	1.51	0.57	7.25	3.60	1.25
(p-value)	(0.05)	(0.21)	(0.63)	(0.00)	(0.01)	(0.29)
For $tenure^2$	1.78	1.04	1.08	8.13	2.56	1.94
(p-value)	(0.15)	(0.37)	(0.35)	(0.00)	(0.05)	(0.12)
R^2	0.25	0.16	0.08	0.32	0.07	0.08

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

[47] Also includes technological category of the last patent granted in the year, year dummies and 4-Digit Art Unit dummies.

Table 3. Determinants of Leaving the USPTO

Logisitic Estimations with Clustered Standard Errors

Variables	S1	S2	S3	S4	S5 Tenure ≺15
Patent Characteristics	Coef.	Coef.	Coef.	Coef.	Coef.
Pendency Time	-0.065	-0.233	-0.220	-0.275	0.010
	(0.185)	(0.184)	(0.033)	(0.192)	(0.389)
Number of Claims	0.018	0.018	0.022	0.014	0.006
	(0.029)	(0.032)	(0.033)	(0.035)	(0.052)
Pct US	0.063	0.317	-0.063	0.003	0.507
	(0.677)	(0.726)	(0.740)	(0.743)	(1.585)
Backward Citations	-0.021	-0.031	0.007	0.008	0.054***
	(0.024)	(0.025)	(0.017)	(0.016)	(0.019)
Generality	1.090	0.582	0.433	0.549	0.775
	(0.756)	(0.862)	(0.930)	(0.940)	(1.764)
Originality	-0.350	0.272	0.800	0.826	1.612
	(0.633)	(0.668)	(0.733)	(0.735)	(1.488)
Number of Patents as Primary by Category:					
Chemical (cat. 1)	-	0.468***	0.636***	0.640***	0.130
		(0.194)	(0.186)	(0.187)	(0.450)
Computers/Comm. (cat. 2)	-	-0.190	-0.077	-0.080	-0.105
		(0.169)	(0.173)	(0.179)	(0.386)
Drugs/Med (cat. 3)	-	0.065	0.165	0.226	0.662***
		(0.198)	(0.169)	(0.171)	(0.169)
Electronic (cat. 4)	-	-0.318*	-0.197	-0.185	-0.468
		(0.170)	(0.167)	(0.169)	(0.664)
Mechanical (cat. 5)	-	-0.108	0.038	0.099	0.671***
		(0.194)	(0.192)	(0.187)	(0.262)
Other (cat. 6)	-	-0.092	0.074	0.173	0.561***
		(0.167)	(0.154)	(0.157)	(0.227)

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

Table 3. Continued. Determinants of Leaving the USPTO

Logisitic Estimations with Clustered Standard Errors

Variables[48]	S1	S2	S3	S4	S5 Tenure≺15
Examiner Characteristics	Coef.	Coef.	Coef.	Coeff.	Coef.
Female		0.481	0.488	0.336	0.563
		(0.331)	(0.342)	(0.344)	(0.447)
Experience Variables					
Tenure (Years) as Assistant		-0.101***	-0.084**	-0.088***	0.089
		(0.035)	(0.036)	(0.036)	(0.068)
Tenure (Years) as Primary		0.159***	0.121***	0.131***	-0.271***
		(0.021)	(0.022)	(0.024)	(0.046))
Number of Patents as Assistant		-0.198*	-0.204*	-0.190*	0.002
		(0.108)	(0.115)	(0.115)	(0.164)
Examiner-Patent Characteristics					
Pct Self-citations			0.109***	0.103***	0.106**
			(0.026)	(0.026)	(0.053)
Repeat High Assignee				0.048*	0.087**
				(0.030)	(0.033)
Repeat Medium Assignee				-0.051	-0.016
				(0.053)	(0.058)
Repeat Low Assignee				0.741	2.584***
				(0.537)	(0.566)
Log Pseudo Likelihood	-4549.9	-3699.1	-3541.7	-3516.7	-705.9
N	7435	7435	7435	7435	4315

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

[48] Also includes technological category of the last patent granted in the year and year dummies.

Table 4. Determinants of Promotions at the USPTO

Logisitic Estimations with Clustered Standard Errors

Variables	S1	S2	S3	S4	S5 Stayers
Patent Characteristics	Coef.	Coef.	Coef.	Coef.	Coef.
Pendency Time	0.340**	0.563***	0.603***	0.727**	0.859***
	(0.176)	(0.180)	(0.193)	(0.195)	(0.217)
Number of Claims	-0.042	-0.023	-0.029	-0.017	-0.017
	(0.029)	(0.032)	(0.034)	(0.034)	(0.037)
Pct US	-0.039	0.326	0.638	0.481	0.218
	(0.757)	(0.808)	(0.873)	(0.920)	(0.988)
Backward Citations	0.048*	0.038	0.004	0.004	-0.000
	(0.026)	(0.026)	(0.021)	(0.018)	(0.023)
Generality	-0.213	-0.049	0.122	0.083	0.087
	(0.754)	(0.745)	(0.791)	(0.832)	(0.872)
Originality	-0.046	-0.779	-1.375	-1.783**	-1.125
	(0.767)	(0.795)	(0.871)	(0.856)	(0.999)
Number of Patents as Primary by Category:					
Chemical (cat. 1)	-	0.158	-0.046	-0.105	-0.418*
		(0.195)	(0.200)	(0.198)	(0.266)
Computers/Comm. (cat. 2)	-	0.723***	0.570***	0.647***	0.479***
		(0.168)	(0.177)	(0.201)	(0.175)
Drugs/Med (cat. 3)	-	0.369**	0.218	0.061	-0.074
		(0.163)	(0.158)	(0.150)	(0.154)
Electronic (cat. 4)	-	0.475***	0.283**	0.254**	-0.315
		(0.134)	(0.125)	(0.126)	(0.133)
Mechanical (cat. 5)	-	0.275*	0.101	-0.081	-0.298
		(0.160)	(0.157)	(0.174)	(0.216)
Other (cat. 6)	-	0.389**	0.196	-0.061	-0.116
		(0.174)	(0.181)	(0.221)	(0.237)

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

Table 4. Continued. Determinants of Promotions at the USPTO

Logisitic Estimations with Clustered Standard Errors

Variables[49]	S1	S2	S3	S4	S5 Stayers
Examiner Characteristics	Coef.	Coef.	Coef.	Coeff.	Coef.
Female		-0.167	-0.083	-0.023	-0.115
		(0.318)	(0.324)	(0.328)	(0.361)
Experience Variables					
Tenure (Years) as Assistant		0.002	0.019	-0.017	-0.005
		(0.027)	(0.029)	(0.029)	(0.032)
Tenure (Years) as Primary		-0.110***	-0.055***	-0.076***	-0.098***
		(0.021)	(0.023)	(0.023)	(0.026)
Number of Patents as Assistant		0.036	0.017	0.008	0.044
		(0.073)	(0.081)	(0.082)	(0.032)
Examiner-Patent Characteristics					
Pct Self-citations			-0.346***	-0.295***	-0.329***
			(0.098)	(0.089)	(0.124)
Repeat High Assignee				0.005	-0.012
				(0.040)	(0.047)
Repeat Medium Assignee				-0.087	-0.134**
				(0.058)	(0.066)
Repeat Low Assignee				-1.876**	-2.179***
				(0.856)	(0.930)
Log Pseudo Likelihood	-3471.7	-3287.8	-3046.3	-2976.2	-2486.1
N	7435	7435	7435	7435	7137

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

[49] Also includes technological category of the last patent granted in the year and year dummies.

Table 5a. Lagged Determinants of Leaving the USPTO

Random-Effect Logisitic Estimations with Clustered Standard Errors

	S1			S2		
Variables	Xt	Xt-1	Xt-2	Xt	Xt-1	Xt-2
Patent Characteristics	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Pendency Time	0.930***	-0.878**	0.141	0.901***	-0.847**	0.151
	(0.245)	(0.399)	(0.434)	(0.248)	(0.399)	(0.441)
Number of Claims	-0.019	-0.011	0.016	-0.018	-0.011	0.019
	(0.035)	(0.045)	(0.041)	(0.035)	(0.083)	(0.042)
Pct US	-0.225	-0.053	0.955	-1.196	-0.071	1.026
	(0.917)	(1.048)	(0.961)	(0.911)	(1.025)	(2.176)
Backward Citations	-0.006	0.019	-0.030	-0.005	0.016	-0.032
	(0.014)	(0.041)	(0.049)	(0.015)	(0.042)	(0.050)
Generality	-1.215	0.417	-0.116	-1.027	0.282	-0.06
	(0.902)	(1.227)	(1.619)	(0.911)	(1.237)	(1.651)
Originality	0.536	3.387**	-2.675*	0.382	3.469**	-2.704*
	(1.231)	(1.602)	(1.316)	(1.231)	(1.576)	(2.793)
Number of Patents as Primary by Category:						
Chemical (cat. 1)	-0.144**	0.020	0.067*	-0.141***	0.022	0.064*
	(0.064)	(0.040)	(0.022)	(0.064)	(0.040)	(0.037)
Computers/Comm. (cat. 2)	-0.140***	0.028	-0.014	-0.142***	0.027	-0.007
	(0.042)	(0.042)	(0.041)	(0.042)	(0.042)	(0.040)
Drugs/Med (cat. 3)	-0.121***	-0.074*	0.091***	-0.115***	-0.077*	0.089***
	(0.044)	(0.045)	(0.020)	(0.048)	(0.048)	(0.021)
Electronic (cat. 4)	-0.157***	0.012*	0.031	-0.159***	0.010	0.033
	(0.036)	(0.043)	(0.032)	(0.036)	(0.043)	(0.037)
Mechanical (cat. 5)	-0.185***	0.006	0.070***	-0.186***	0.008	0.071***
	(0.036)	(0.038)	(0.025)	(0.053)	(0.038)	(0.025)
Other (cat. 6)	-0.219***	0.108**	-0.039	-0.217***	0.107**	-0.038
	(0.059)	(0.046)	(0.054)	(0.059)	(0.045)	(0.052)

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

Table 5a Continued. Lagged Determinants of Leaving the USPTO

Random Effect Logisitic Estimations with Clustered Standard Errors

	S1			S2		
Variables[50]	Xt	Xt-1	Xt-2	Xt	Xt-1	Xt-2
Examiner Characteristics	Coef.	Coef.	Coef.	Coeff.	Coef.	Coef.
Female	0.317			0.331		
	(0.284)			(0.286)		
Experience Variables						
Tenure (Years) as Assistant	-0.085***			-0.086***		
	(0.023)			(0.024)		
Tenure (Years) as Primary	0.191***			0.189***		
	(0.024)			(0.025)		
Number of Patents as Assistant	-0.061	0.037	-0.005	-0.059	-0.037	0.079*
	(0.047)	(0.063)	(0.036)	(0.050)	(0.067)	(0.043)
Switched Art-Unit (4D)					0.171	-0.702**
					(0.293)	(0.332)
Number of Art Units				-0.256	0.631	-0.449
				(0.298)	(0.490)	(0.387)
Log Pseudo Likelihood	-462.80			-460.38		
N	3668			3668		

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

[50] Also includes technological category of the last patent granted in the year and year dummies.

Table 5b. Lagged Determinants of Promotions at the USPTO

Random-Effect Logisitic Estimations with Clustered Standard Errors

	S1			S2		
Variables	Xt	Xt-1	Xt-2	Xt	Xt-1	Xt-2
Patent Characteristics	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Pendency Time	0.095	0.255	0.298	0.106	0.250	0.299
	(0.298)	(0.466)	(0.418)	(0.300)	(0.464)	(0.413)
Number of Claims	0.017	-0.014	0.037	0.016	-0.015	0.039
	(0.036)	(0.047)	(0.056)	(0.037)	(0.047)	(0.055)
Pct US	-0.779	-0.470	1.575	-0.773	-0.460	1.592
	(0.934)	(1.143)	(1.172)	(0.936)	(1.157)	(2.010)
Backward Citations	-0.029	-0.019	0.045	0.030	-0.021	0.046
	(0.040)	(0.056)	(0.043)	(0.041)	(0.057)	(0.043)
Generality	-1.628**	-0.744	2.763*	-1.649**	-0.795	-2.787*
	(0.829)	(1.071)	(1.614)	(0.838)	(1.072)	(1.609)
Originality	0.658	0.541	-1.987	0.639	0.620	-2.006
	(1.371)	(1.811)	(1.775)	(1.375)	(1.807)	(1.783)
Number of Patents as Primary by Category:						
Chemical (cat. 1)	0.011	0.010	-0.000	-0.011	0.009	0.000
	(0.043)	(0.052)	(0.048)	(0.043)	(0.051)	(0.049)
Computers/Comm. (cat. 2)	0.040	-0.041	-0.036	0.040	-0.040	-0.038
	(0.030)	(0.048)	(0.048)	(0.030)	(0.068)	(0.047)
Drugs/Med (cat. 3)	0.032	-0.014	-0.012	0.032	-0.013	-0.013
	(0.021)	(0.031)	(0.031)	(0.022)	(0.032)	(0.033)
Electronic (cat. 4)	0.050**	-0.082**	-0.035	0.049**	-0.082***	-0.034
	(0.022)	(0.032)	(0.035)	(0.023)	(0.031)	(0.035)
Mechanical (cat. 5)	-0.028	0.041*	-0.000	-0.028	0.042	-0.001
	(0.047)	(0.027)	(0.034)	(0.047)	(0.027)	(0.034)
Other (cat. 6)	-0.063	0.053	0.002	-0.063	0.053	0.001
	(0.073)	(0.077)	(0.058)	(0.076)	(0.080)	(0.058)

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

Table 5b. Continued. Lagged Determinants of Promotions at the USPTO

Random-Effect Logisitic Estimations with Clustered Standard Errors

	S1			S2		
Variables[51]	Xt	Xt-1	Xt-2	Xt	Xt-1	Xt-2
Examiner Characteristics	Coef.	Coef.	Coef.	Coeff.	Coef.	Coef.
Female	-0.081			-0.081		
	(0.245)			(0.246)		
Experience Variables						
Tenure (Years) as Assistant	-0.028			-0.027		
	(0.023)			(0.022)		
Tenure (Years) as Primary	-0.124**			-0.124***		
	(0.022)			(0.022)		
Number of Patents as Assistant	-0.082	-0.064	-0.051***	0.077	-0.066	-0.051**
	(0.113)	(0.073)	(0.021)	(0.108)	(0.071)	(0.021)
Switched Art Unit					-0.347	0.033
					(0.383)	(0.266)
Number of Art Units				1.174	-0.891	-0.016
				(0.440)	(0.494)	(0.388)
Log Pseudo Likelihood	-475.37			-462.14		
N	4997			4997		

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

[51] Also includes technological category of the last patent granted in the year and year dummies.

Table 6. Leaving/Promotion Duration Analysis

Weibull Distribution Survival Estimation Model

Variables	Leaving		Promotion	
Patent Characteristics	Coef.	Coef.	Coef.	Coef.
Pendency Time	-0.158	-0.185	-0.348	-0.517*
	(0.245)	(0.252)	(0.241)	(0.285)
Number of Claims	-0.006	-0.010	-0.064*	-0.054*
	(0.032)	(0.031)	(0.035)	(0.035)
Pct US	1.349	1.413	1.804**	1.459*
	(0.974)	(0.958)	(0.947)	(0.913)
Backward Citations	0.004	0.004	-0.035	-0.020
	(0.017)	(0.016)	(0.040)	(0.035)
Generality	1.794*	1.670*	-0.392	-0.751
	(1.019)	(1.043)	(1.055)	(1.235)
Originality	-0.006	-0.004	-0.004	-0.001
	(0.011)	(0.011)	(0.011)	(0.013)
Number of Patents by Cat.				
Chemical (cat. 1)	-0.395	-0.390	-0.011	0.054
	(0.325)	(0.327)	(0.177)	(0.169)
Computers/Comm. (cat. 2)	-1.276***	-1.370***	-0.039	-0.078
	(0.413)	(0.483)	(0.154)	(0.152)
Drugs/Med (cat. 3)	0.043	0.055	-0.129	-0.156
	(0.248)	(0.249)	(0.170)	(0.170)
Electronic (cat. 4)	-0.742*	-0.724*	-0.116	-0.095
	(0.425)	(0.426)	(0.126)	(0.324)
Mechanical (cat. 5)	-0.683*	-0.708*	-0.209	-0.165
	(0.365)	(0.376)	(0.335)	(0.324)
Other (cat. 6)	-0.335	-0.381	-0.460	-0.398
	(0.359)	(0.370)	(0.354)	(0.322)

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

Table 6. Continued. Leaving/Promotion Duration Analysis

Weibull Distribution Survival Estimation Model

Variables[52]	**Leaving**		**Promotion**	
Examiner Characteristics	Coef.	Coef.	Coef.	Coef.
Pct Self-citations	0.028**	0.028**	-0.254***	-0.264***
	(0.012)	(0.012)	(0.074)	(0.074)
Repeat High Assignee	0.036	0.040	-0.005	-0.011
	(0.035)	(0.033)	(0.038)	(0.037)
Repeat Medium Assignee	-0.006	0.0008	-0.075	-0.050
	(0.047)	(0.045)	(0.053)	(0.050)
Repeat Low Assignee	0.911***	0.886***	-0.961	-1.008
	(0.288)	(0.283)	(0.845)	(0.786)
Female	0.853**	0.861**	0.411	0.380
	(0.347)	(0.341)	(0.283)	(0.257)
Tenure (Years) as Assistant	-0.043	-0.049*	-0.008	-0.006
	(0.033)	(0.031)	(0.026)	(0.026)
Tenure (Years) as Primary	0.106***	0.108***	-0.046***	-0.025
	(0.022)	(0.022)	(0.018)	(0.017)
Number of Patents as Assistant	-0.101	-0.075	-0.125	-0.113
	(0.124)	(0.115)	(0.092)	(0.088)
Art Unit Switch Dummy		0.408*		1.978***
		(0.261)		(0.217)
Art Unit Number		0.328**		0.512***
		(0.162)		(0.127)
Log Pseudo Likelihood	-174.65	-171.96	-281.32	-236.99
N	4362	4362	4362	4362

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

[52] Also includes technological category of the last patent granted in the year and year dummies.

APPENDIX A: Information on Main Variables

Variables	Definitions
IDEXAM	Examiner ID
ID	Patent ID
Yeara	Year of patent application
Yearg	Year the patent was granted
Patents	
Pendency time	Number of years between application and grant (Yearg-Yeara)
# of Claims	Number of claims
US	Dummy indicating whether assignee/inventor is from the US
Backward Citations	Number of citations made for the patent
Generality Index	Trajtenberg and al. (1997) index of patent generality
Originality Index	Trajtenberg and al. (1997) index of patent originality
Technological Categories	
Category 1	Chemical
Category 2	Computers and Communications
Category 3	Drugs and Medical
Category 4	Electronic and Electric
Category 5	Mechanical
Category 6	Other
Examiners	
Female	Indicator of whether the examiner is female (constructed)
PatentA_{it}	Yearly number of granted patents as assistant examiner
PatentP_{it}	Yearly number of granted patents as primary examiner
TenureA_{i}	Number of years at the USPTO as Assistant examiner
TenureP_{it}	Number of years at the USPTO as primary examiner
Self-cite_{i}	Percentage of backward citations that are examiner i's own granted patents
Pct Repeat Assignee_{i}	Ratio of the maximum # of repeated assignee over total patents granted
Artunit_{it}	2 Digit indicator of the examiner's artunit in year t

APPENDIX A

Table A1. Comparison of Summary Statistics for Patent Characteristics between NBER Database Sample and Main Sample

Variables	NBER Data Sample		Examiner-Patent Sample	
	Mean	Std	Mean	Std
Pendency time	2.04	1.02	1.94	0.96
# of Claims	15.23	12.95	14.79	12.39
Pct US (/100)	0.48	0.49	0.47	0.49
Backward Citations	9.74	13.14	9.37	11.49
Generality Index	0.54	0.34	0.55	0.33
Originality Index	0.51	0.35	0.52	0.35
Technological Categories[53]				
Chemical (cat. 1)	0.15	-	0.15	-
Computers/Comm. (cat. 2)	0.19	-	0.14	-
Drugs/Med (cat. 3)	0.08	-	0.09	-
Electronic (cat. 4)	0.21	-	0.22	-
Mechanical (cat. 5)	0.17	-	0.20	-
Other (cat. 6)	0.18	-	0.19	-
N	1602904		786602	

[53] Proportion (/100).

APPENDIX A

Table A2. Number of Examiners in the Sample by Year - 1976-2006

1976	204	1991	590
1977	212	1992	595
1978	221	1993	604
1979	233	1994	605
1980	234	**1995**	**623**
1981	241	1996	621
1982	271	1997	595
1983	303	1998	581
1984	336	1999	559
1985	364	2000	533
1986	385	2001	492
1987	415	2002	464
1988	449	2003	440
1989	500	2004	424
1990	551	2005	398
		2006	381

Table A3. Tenure Distribution by Departure Year - 1996-2006

Departure	Tenure as Primary Examiner	
Year	$\prec$ 20 years	$\succeq$ 25 years
1996	40.7	0
1997	45.4	0
1998	35.7	0
1999	38.5	50
2000	33.3	58.2
2001	0	75
2002	18.2	63.6
2003	12.5	62.5
2004	0	100
2005	50	50
2006	0	66.6

APPENDIX A

Table A4. Probability of Leaving/Promotion by Art Unit - 1992-2006

Art Unit (2-Digit #)	% Total	% Left	%Promoted
Biotechnology and Organic Chemistry (1600)	0.19	0.49	0.13
Chemical and Materials Engineering (1700)	0.13	0.36	0.21
Computer Architecture and Software (2100)	0.08	0.42	0.17
Networking, Multiplexing, Cable, and Security (2400)	0.05	0.44	0.20
Communications (2600)	0.06	0.26	0.50
Semiconductors/Memory, Circuits/Measuring & Testing, and Optics/Photocopying (2800)	0.06	0.27	0.40
Designs (2900)	0.21	0.45	0.16
Transportation, Construction, Electronic Commerce, Agriculture, National Security and License & Review (3600)	0.06	0.19	0.24
Mechanical Engineering, Manufacturing, and Medical Devices/Processes (3700)	0.13	0.22	0.28

APPENDIX A

Table A5. F-test of Differences in Examiner Self-citations by Art Units and Technological Fields

1992-2006 Panel data - Last year in the Sample

	Full Sample		Leavers	
F-test for ≠ in Art Units	3.82	5.17	2.62	2.28
(p-value)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.001)*
F-test for ≠ in Tech. Cat.	1.01	1.13	0.59	0.40
(p-value)	*(0.407)*	*(0.342)*	*(0.705)*	*(0.85)*
Tenure Primary incl.	No	Yes	No	Yes

APPENDIX A FIGURES

Figure 1a: Age Distribution by Occupations (2000 Census Data)

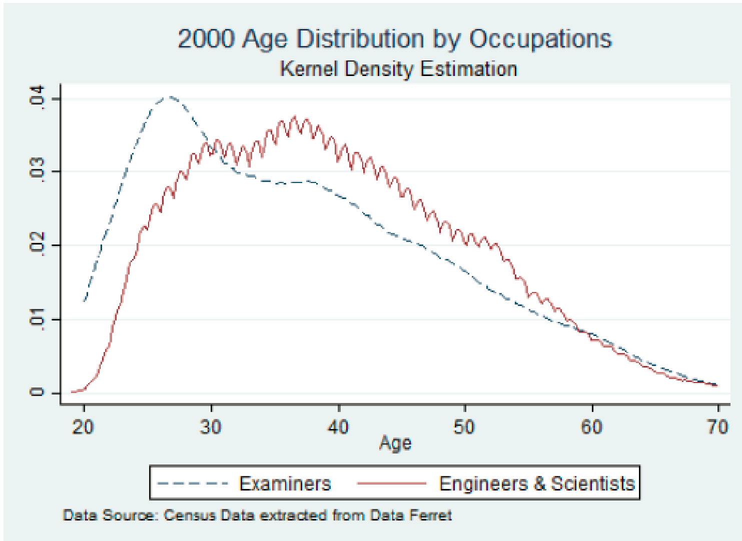


Figure 1b: Age Distribution by Occupations (CPS Data 2004-2008)

Figure 1c: Tenure Distribution by Occupations (CPS Data 2006)

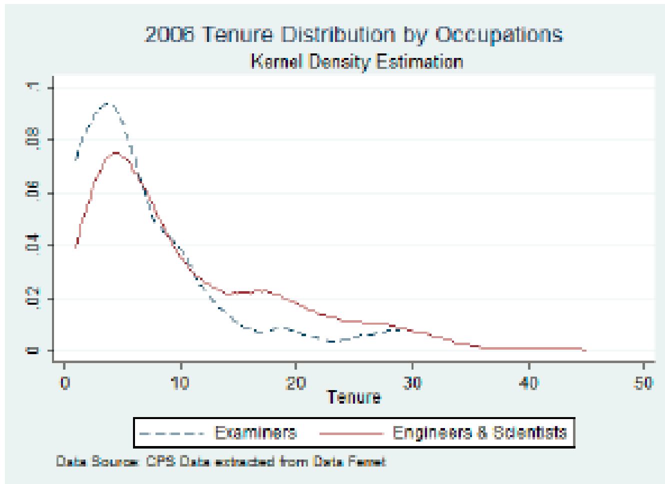


Figure 1d: Distribution of Examiner Tenure at the USPTO by Mobility

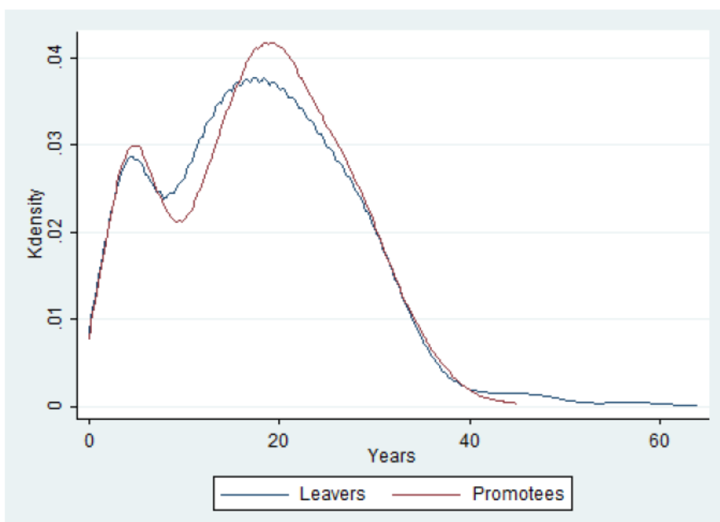
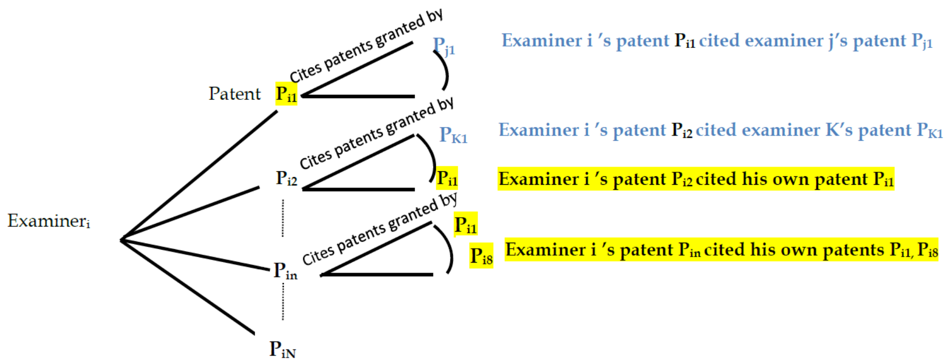


Figure 2a: Calculation of Measure of Self-citations

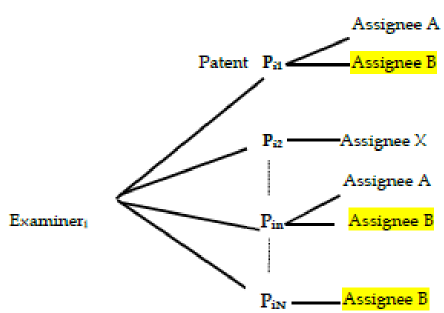
For an examiner i who granted N patents over his/her career, $P_{i1},\ldots P_{iN}$.



Selfcitations= # of citations of examiner i's own patents/total examiner i's citations

Figure 2b: Calculation of Measure of Repeated interactions with the same assignee

For examiner$_i$ i whose maximum repeated interactions were with Assignee B.



ExID	AssigneeID	Patent#	Repeat	Maxrepeat
i	Assignee A	P_{i1}	2	3
i	Assignee A	P_{in}	2	3
i	Assignee B	P_{i1}	3	3
i	Assignee B	P_{in}	3	3
i	Assignee B	P_{iN}	3	3
i	Assignee X	P_{i2}	1	3

Repeatassignee=Maxrepeat/total # patents granted

APPENDIX A: MOBILITY STATISTICS

Table A6. Summary Statistics of Patent Characteristics by Mobility Outcomes Pooled Cross-Section Sample of Examiner-Patent 1976-2006

	All		Leavers		Promotees		Prom/Stay	
Variables	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Pendency time	2.04	0.59	2.00	0.60	2.16	0.68	2.18	0.68
# of Claims	16.65	4.24	13.02	4.36	14.44	4.09	14.55	4.03
Pct US	44.5	16.8	45.4	17.7	45.5	16.8	45.4	16.5
Backward Citations	7.47	6.82	6.34	6.57	8.89	9.17	8.92	7.27
Generality Index	0.56	0.16	0.57	0.14	0.54	0.15	0.54	0.16
Originality Index	0.53	0.16	0.52	0.16	0.52	0.15	0.53	0.15
Technological Categories of Last Patent[54]								
Chemical (cat. 1)	0.19	-	0.25	-	0.14	-	0.12	-
Computers/Comm. (cat. 2)	0.12	-	0.10	-	0.22	-	0.22	-
Drugs/Med (cat. 3)	0.09	-	0.09	-	0.13	-	0.13	-
Electronic (cat. 4)	0.18	-	0.16	-	0.22	-	0.24	-
Mechanical (cat. 5)	0.20	-	0.19	-	0.15	-	0.14	-
Other (cat. 6)[55]	0.20	-	0.20	-	0.14	-	0.15	-
N	12014		5045		2201		1776	

[54] Proportion (/100).

[55] This field represent the following categories: Agriculture, husbandry, food, amusement devices, apparel and textile, earth working and wells, furniture and house fixtures, heating, pipes and joints, receptacles and miscellaneous.

APPENDIX A: MOBILITY STATISTICS

Table A7. Summary Statistics of Examiner Characteristics by Mobility Outcomes Pooled Cross-Section Sample of Examiner-Patent 1976-2006

	All		Leavers		Promotees		Prom/Stay	
Variables	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Examiners	1	0	0.42	-	0.18	-	0.15	-
Female	0.12	-	0.10	-	0.15	-	0.15	-
Tenure (Years) as Assistant	5.49	4.58	3.66	4.23	6.18	4.24	6.52	4.26
Tenure (Years) as Primary	12.02	7.89	13.04	7.96	10.84	7.48	10.66	7.27
Patents as Assistant (per year)	6.77	17.91	4.74	15.26	7.75	18.65	7.92	18.94
Patents as Assistant (total)	163.62	181.25	108.03	155.44	173.48	141.43	181.34	142.41
Patents as Primary (per year) by:								
Chemical (cat. 1)	12.88	37.59	17.69	44.77	9.69	37.15	7.13	33.39
Computers/Comm. (cat. 2)	9.71	39.93	7.72	35.97	22.02	68.47	21.86	65.86
Drugs/Med (cat. 3)	8.20	36.01	8.25	39.65	11.56	48.02	10.73	36.08
Electronic (cat. 4)	17.04	55.25	12.88	46.27	26.72	81.03	30.77	86.12
Mechanical (cat. 5)	17.35	45.16	15.51	41.48	16.52	52.75	14.67	50.71
Other (cat. 6)[56]	16.89	42.75	16.04	34.61	14.34	49.83	15.89	52.72
Pct Self-citations	3.91	7.06	6.88	9.26	0.73	1.48	0.62	1.35
Repeat Assignee	5.58	4.27	5.69	3.96	5.10	4.36	4.80	4.19
Repeat High Assignee	4.28	3.86	4.54	3.71	4.01	3.66	3.76	3.37
Repeat Medium Assignee	3.44	2.67	3.36	2.30	3.01	2.24	2.80	2.05
Repeat Low Assignee	0.26	0.21	0.26	0.22	0.23	0.18	0.22	0.16
N	12014		5045		2201		1776	

[56] This field represent the following categories: Agriculture, husbandry, food, amusement devices, apparel and textile, earth working and wells, furniture and house fixtures, heating, pipes and joints, receptacles and miscellaneous.

APPENDIX A: MOBILITY STATISTICS

Table A8. Summary Statistics of Main Patent Characteristics
Longitudinal Sample of Examiner-Patent-Year 1992-2006

	All Examiners		Left at t		Promotion at t	
Variables at t-1	Mean	Std	Mean	Std	Mean	Std
Pendency time	2.021	0.53	2.12	0.53	2.13	0.66
# of Claims	14.91	3.56	15.59	3.88	15.09	3.48
Pct US	0.44	0.14	0.45	0.16	0.46	0.14
Backward Citations	9.24	5.16	10.13	4.96	9.09	3.49
Generality Index	0.5	0.14	0.56	0.14	0.55	0.13
Originality Index	0.54	0.13	0.55	0.14	0.53	0.13
Tenure (Years) as Assistant	6.65	4.85	4.89	5.40	6.80	4.25
Tenure (Years) as Primary	15.17	7.48	20.56	8.06	13.51	5.75
Patents as Assistant (per year)	2.75	10.33	0.45	3.56	0.23	1.83
Patents as Primary (per year) by Cat:						
Chemical (cat. 1)	14.00	42.35	17.59	41.69	12.34	35.11
Computers/Comm. (cat. 2)	12.90	48.60	8.90	35.54	17.03	46.24
Drugs/Med (cat. 3)	10.55	43.31	10.06	37.26	12.95	34.03
Electronic (cat. 4)	20.96	65.98	19.98	76.34	16.25	52.36
Mechanical (cat. 5)	20.02	50.84	18.32	47.62	22.83	61.62
Other (cat. 6)[57]	19.34	48.71	17.41	40.58	15.46	51.61
Pct Self-citations	2.80	5.56	6.17	8.91	0.62	1.32
Pct Repeat Assignee Interactions	9.13	6.56	9.14	6.65	8.74	5.82
N	6497		259		138	

[57] This field represent the following categories: Agriculture, husbandry, food, amusement devices, apparel and textile, earth working and wells, furniture and house fixtures, heating, pipes and joints, receptacles and miscellaneous.

APPENDIX B

Table B1. Determinants of Leaving/Promotion, 1992-2006

Logisitic Estimation with Clustered Standard Errors - Controlling for Art Unit Fixed-Effects

	Leavers		Promotees	
	S4	S5	S4	S5
Patent Characteristics	Coef.	Coef.	Coef.	Coef.
Pendency Time	0.123	0.456	0.772***	0.859***
	(0.209)	(0.376)	(0.215)	(0.217)
Number of Claims	0.011	-0.049	-0.004	-0.017
	(0.033)	(0.053)	(0.035)	(0.037)
Pct US	-0.447	0.835	0.713	0.218
	(0.866)	(1.260)	(1.070)	(0.988)
Backward Citations	0.028	0.055***	-0.002	-0.000
	(0.024)	(0.018)	(0.018)	(0.023)
Generality	-0.012	1.266	-0.074	0.087
	(1.069)	(2.027)	(0.892)	(0.872)
Originality	2.220**	2.776*	-1.714*	-1.125
	(1.109)	(1.587)	(1.003)	(0.999)
Number of Patents as Primary by Category:				
Chemical (cat. 1)	0.475***	0.407	0.040	-0.235
	(0.173)	(0.367)	(0.185)	(0.242)
Computers/Comm. (cat. 2)	0.004	0.176	0.749***	0.585***
	(0.167)	(0.319)	(0.215)	(0.193)
Drugs/Med (cat. 3)	0.220	0.653***	0.169	0.015
	(0.189)	(0.179)	(0.166)	(0.167)
Electronic (cat. 4)	-0.064	0.378	0.278**	0.295**
	(0.119)	(0.262)	(0.119)	(0.127)
Mechanical (cat. 5)	0.021	0.466	0.132	-0.054
	(0.186)	(0.342)	(0.165)	(0.193)
Other (cat. 6)	0.167	0.326	0.080	0.022
	(0.170)	(0.342)	(0.206)	(0.226)

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

APPENDIX B

Table B1. Continued. Determinants of Leaving/Promotion, 1992-2006

Logisitic Estimation with Clustered Standard Errors - Controlling for Art Unit Fixed-Effects

	Leavers		**Promotees**	
Variables	S4	S5	S4	S5
Examiner Characteristics	Coef.	Coef.	Coeff.	Coef.
Female	0.082	0.134	-0.062	-0.117
	(0.346)	(0.431)	(0.336)	(0.368)
Experience Variables				
Tenure (Years) as Assistant	-0.089**	0.044	-0.016	-0.002
	(0.039)	(0.072)	(0.030)	(0.033)
Tenure (Years) as Primary	0.132***	-0.256***	-0.076***	-0.099***
	(0.023)	(0.047)	(0.024)	(0.027)
Number of Patents as Assistant	-0.087	-0.192	-0.054	-0.042
	(0.125)	(0.199)	(0.092)	(0.095)
Examiner-Patent Characteristics				
Pct Self-citations	0.118***	0.192***	-0.281***	-0.318**
	(0.029)	(0.068)	(0.092)	(0.135)
Repeat High Assignee	0.043	0.073*	0.013	0.013
	(0.035)	(0.042)	(0.040)	(0.047)
Repeat Medium Assignee	-0.019	0.059	-0.107*	-0.153**
	(0.052)	(0.069)	(0.058)	(0.070)
Repeat Low Assignee	0.995*	2.494***	-1.972**	-2.291**
	(0.565)	(0.769)	(0.917)	(1.004)
Log Pseudo Likelihood	-2042.9	-531.4	-2076.9	-1829.8
N	4683	3183	4683	4683

Notes-***: significant at the 1% level, **: at the 5% level, *: at the 10 % level.

APPENDIX B

Table B2. Comparison of Survival Distributions

Distribution	Exponential	Weibull	Lognormal
Log Likelihood	-199.43	-172.96	-174.20
AIC	494.87	443.93	446.85