

The Idiosyncrasy of Patent Examiners: Effects of Experience and Attrition

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I. Introduction

In recent years, problems with the U.S. patent system have garnered attention from scholars and policymakers of all types. Concerns about the competitiveness of U.S. industry undergird worries that the Great Recession will linger as long as the 1990s downturn in Japan.¹ It is no coincidence that a Congress that has remained at loggerheads on most aspects of economic policy could reach a consensus on the enactment of the Leahy-Smith America Invents Act of 2011,² by far the most important statutory reform of U.S. patent law since 1995. Yet, despite Congress's long-overdue attention to patent law, it is unlikely that the statute will resolve the troubling quality issues that have dogged the system for years. Prominent critics of the patent system argue that a decades-long decline in the quality of patents undermines the effectiveness of the system.³ Some go so far as to insist that poor-quality patents cause a drag on the competitiveness of the national economy.⁴ Those concerns are prominently displayed in the Supreme Court's spring 2012 decision in *Mayo Collaborative Services v. Prometheus Laboratories, Inc.*,⁵ which emphasized the Court's view that

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1. See James Solloway, *Comparing Recessions: U.S. "Great Recession" vs. Japanese "Lost Decade,"* SEI 1 (Sept. 2010), http://www.seic.com/docs/Canada-IMU/SEI_Comparing-Recessions-Japanese-Lost-Decade_10-5-10_CA.pdf (addressing concerns that the U.S. economy is facing a "lost decade" similar to that experienced by Japan 1991–2001).

2. Leahy-Smith America Invents Act, Pub. L. No. 112-29, 125 Stat. 284 (2011) (codified in scattered sections of 35 U.S.C.).

3. See generally A PATENT SYSTEM FOR THE 21ST CENTURY (Stephen A. Merrill et al. eds., 2004) (combining perspectives on patent law and innovation and suggesting methods for reinventing the patent system); JAMES BESSEN & MICHAEL J. MEURER, PATENT FAILURE: HOW JUDGES, BUREAUCRATS, AND LAWYERS PUT INNOVATORS AT RISK (2008) (synthesizing empirical evidence regarding recent patent history and finding that patents are an inefficient property); ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS: HOW OUR BROKEN PATENT SYSTEM IS ENDANGERING INNOVATION AND PROGRESS, AND WHAT TO DO ABOUT IT (2004) (conducting an economic analysis of the past two decades of patent law and concluding that the U.S. patent system is profoundly broken).

4. See BESSEN & MEURER, *supra* note 3, at 1–5 (giving an overview of economic harms that result from the defective patent system); DAN L. BURK & MARK A. LEMLEY, THE PATENT CRISIS AND HOW THE COURTS CAN SOLVE IT 95–100 (2009) (detailing the disadvantages and negative effects of industry-specific patent statutes).

5. 132 S. Ct. 1289 (2012).

the Federal Circuit has gone so far in liberalizing patent policy as to inhibit the pace of innovation.⁶

As concerns about systemic failure have come to the fore, attention in recent years increasingly has focused on the role of examiners in this process. If examiners differ from each other in how they approach applications, then they introduce arbitrariness into the process. In that vein, remarking on notable levels of examiner idiosyncrasy, Iain Cockburn, Samuel Kortum, and Scott Stern notably quip that “there may be as many patent offices as patent examiners.”⁷ In a recent paper in the *Review of Economics and Statistics*, Mark Lemley and Bhaven Sampat follow Cockburn, Kortum, and Stern, arguing that applications examined by those with more experience are more likely to be granted than applications examined by those with less experience.⁸

At the same time, during the tenure of David Kappos as Director of the Patent and Trademark Office (PTO), the PTO has taken vigorous steps to limit attrition among the examination corps, hoping to improve the quality of examiner work by increasing the tenure of examiners.⁹ Among a variety of quality-of-life initiatives designed to enhance the attractiveness of the position,¹⁰ the PTO has, for the first time, initiated plans to open satellite offices around the country, hoping to improve the attractiveness of long-term PTO employment.¹¹ Plans to open an office in Detroit are well advanced¹² and Denver seems not far behind.¹³ An overwhelming focus of the initiatives has been to decrease the increasingly large backlogs that have

6. See *id.* at 1301–02, 1305 (finding that several patent claims raise concerns regarding “inhibit[ing] further discovery” and reversing the Federal Circuit).

7. Iain M. Cockburn, Samuel Kortum & Scott Stern, *Are All Patent Examiners Equal? Examiners, Patent Characteristics, and Litigation Outcomes*, in *PATENTS IN THE KNOWLEDGE-BASED ECONOMY* 19, 21 (Wesley M. Cohen & Stephen A. Merrill eds., 2003) (internal quotation marks omitted).

8. Mark A. Lemley & Bhaven Sampat, *Examiner Characteristics and Patent Office Outcomes*, 94 *REV. ECON. & STAT.*, 817, 817, 821–22 (2012).

9. *USPTO FY 2013 Budget Request: Hearing Before the Subcomm. on Commerce, Justice, Sci., & Related Agencies of the H. Comm. on Appropriations*, 112th Cong. 2–3 (2012) (statement of David J. Kappos, Under Secretary of Commerce for Intellectual Property & Director of the United States Patent and Trademark Office).

10. Request for Comments on Additional USPTO Satellite Offices for the Nationwide Workforce Program, 76 *Fed. Reg.* 73,601, 73,601 (Nov. 29, 2011).

11. *Id.*

12. See *USPTO FY 2013 Budget Request*, *supra* note 9, at 3 (stating that the Detroit office is “on track” to open in the summer of 2012).

13. *USPTO Satellite Offices (In Progress)*, U.S. PAT. & TRADEMARK OFF., <http://www.uspto.gov/about/locations/satellites.jsp> (last modified May 30, 2013).

plagued the office for years; increasing the pace of examination thus has become a major goal of the PTO administration.¹⁴

This Article offers a deeper look at examiner idiosyncrasy. The combination of a hand-collected data set of examiner patent portfolios with the National Bureau of Economic Research (NBER) patent data set and internal PTO data about examiner education facilitates a richer analysis of examiner variation and its causes than anything in the existing literature. Part II describes the existing literature, the background of this project, and the model of the examination process on which the Article builds. Part III summarizes the data collection. Part IV presents the results, and Part V briefly concludes. The Article reaches three important conclusions:

- The existing literature overemphasizes the importance of experience, largely because it fails to consider the importance of attrition and tenure differences among examiners that relate to their total career in the office. The Article documents a substantial relation between the tenure of an examiner and the attributes of the patents approved by the examiner. Thus, from the first months of work, the output of examiners who will stay in the office the longest differs markedly from the output of examiners whose stay in the office will be the shortest. This finding holds for a wide variety of objective metrics commonly used in the existing literature.
- The effects of tenure are substantial and cut in the opposite direction from experience. For example, where the number of claims in a patent or the time spent in examination increases markedly with the experience of the examiner, both attributes decrease markedly with increasing tenure. The relative size and opposing directions of those effects are robust across a variety of specifications and patent attributes. A smaller (but cognizable) “lame-duck” effect, cutting in the same direction as the effects of experience, is apparent in the last year before the end of the examiner’s employment.
- Education affects the work of examiners in important ways. Certain educational attainments correlate with substantially increased tenure (especially professional degrees, such as a J.D.), while others correlate with substantially reduced tenure (especially a Ph.D.). Those attainments also relate to the output of the examiner as well; although the effects are neither as consistent nor as large as the effects of experience

14. See Request for Comments on Additional USPTO Satellite Offices for the Nationwide Workforce Program, 76 Fed. Reg. at 73,601 (mentioning the USPTO’s efforts to “reduce patent application pendency”).

and tenure, they are statistically significant for all of the metrics available in the data analyzed here.

II. Background

A. *Literature Review*

The existing research documents substantial heterogeneity among patent examiners. The seminal work is by Cockburn, Kortum, and Stern, which analyzes 196 examiners who had worked on 182 patents involved in Federal Circuit litigation between 1997 and 2000.¹⁵ Collectively, those examiners had worked on about 300,000 patents between 1976 and 2000 (at the time the data were collected).¹⁶ Analyzing all patents for which an individual served either as primary or secondary examiner, Cockburn, Kortum, and Stern find marked heterogeneity on all of the characteristics they examine, including the technological breadth of their examination portfolios, the citations received per patent examined, and the citations that appear in the patents examined.¹⁷ Although Cockburn, Kortum, and Stern have evidence about the total number of patents examined, they make scant use of it; primarily, they note the substantial variation in the total number of patents examined.¹⁸

Douglas Lichtman similarly documents variation in the effect that examiners have on textual changes in patent claims during the examination process. Lichtman collected the first 300,000 patent applications published after 2000 (when the PTO first began to publish patent applications)¹⁹ and quantified the extent of textual changes between the application and the issued patent.²⁰ From those 300,000 applications, he examines the patents that were issued in the “ten classes for which [he] had the most observations to study examiners one technology at a time.”²¹ Lichtman’s object of study is application–patent pairs, and he “restrict[s] the study to include only those examiners for whom he had ten or more observations.”²² He

15. Cockburn et al., *supra* note 7, at 35.

16. *Id.* at 36.

17. *Id.* at 39–44.

18. *See id.* at 39, 40 fig.1 (noting that the wide variation in the number of patents reviewed among examiners “is consistent with the substantial variation we see in the examiners’ length of tenure”).

19. Press Release, U.S. Patent & Trademark Office, USPTO Will Begin Publishing Patent Applications (Nov. 27, 2000), available at <http://www.uspto.gov/news/pr/2000/00-72.jsp>.

20. Douglas Lichtman, *Rethinking Prosecution History Estoppel*, 71 U. CHI. L. REV. 151, 157 (2004).

21. *Id.* at 160, 161 tbl.1.

22. *Id.* at 162.

concludes that differences among the responsible examiners account for about two-thirds of the variation in rigor of editing.²³

Cockburn, Kortum, and Stern and Lichtman are primarily interested in documenting the existence of variation, reasoning that variation is self-evidently arbitrary if its effects are substantive.²⁴ As a result, they are less interested in identifying the sources of variation. Lemley and Sampat are the first to provide serious attention to the sources of variation and their impact on patent-application outcomes.²⁵ They use about 10,000 patent applications (the universe of new utility patent applications filed in January 2001 and published before April 2006).²⁶ For that sample, they relate information about the final disposition of the application (whether it was granted and whether it was granted with no rejections) to information about the examiners.²⁷ Their analysis takes account of the most junior examiner on each patent: the secondary examiner if there was one and, otherwise, the responsible primary examiner.²⁸ Having obtained the PTO Employee Directories from 1992 onwards, they are able to determine how long each examiner had been employed at the PTO as of the date of the application.²⁹ Ultimately, they conclude that the experience of the examiner relates importantly to the treatment of the application in three ways.³⁰ The most experienced examiners add fewer citations to the patent (two citations per

23. *Id.* at 168.

24. *See* Cockburn et al., *supra* note 7, at 21 (summarizing that “substantial—and quantifiable—heterogeneity” among patent examiners may affect the patent examination process); *see* Lichtman, *supra* note 20, at 155 (discussing how examiner disparities render the entire patent system “more random” because those disparities link a patent’s scope to the personal characteristics of the examiner).

25. *See* Lemley & Sampat, *supra* note 8, at 817 (explaining the differences between their study, which analyzes “the impact of examiner characteristics on patent application outcomes,” and previous studies, which examined the effect of patent-examiner heterogeneity on issued patents).

26. *Id.* at 819.

27. *Id.*

28. *See id.* (describing how the authors assigned examiners to each patent based on which examiner undertook “the most direct work”).

29. *Id.* Two recent papers explore other possible sources of variation. Frakes and Wasserman match longitudinal data about PTO fee structures to examiner grant rates to support the idea that shifts in the urgency of agency underfunding alter PTO vigilance in substantial ways. Michael D. Frakes & Melissa F. Wasserman, *Does Agency Funding Affect Decisionmaking?: An Empirical Assessment of the PTO’s Granting Patterns*, 66 VAND. L. REV. 67, 70, 92 (2013). Tu argues that the count system separates examiners into two populations that behave distinctly by showing excessive deference or excessive hostility to applications. Sean Tu, *Luck/Unluck of the Draw: An Empirical Study of Examiner Allowance Rates*, 2012 STAN. TECH. L. REV., art. 10, ¶¶ 5–6 (2012), <http://stlr.stanford.edu/pdf/tu-luckunluckofthedraw.pdf>. Although both papers contribute to an understanding of examiner motivations and practices, neither uses the kind of examiner-level data analyzed here and in Lemley and Sampat. Lemley & Sampat, *supra* note 8, at 819–20; *see infra* text accompanying notes 52–74.

30. Lemley & Sampat, *supra* note 8, at 822.

patent) than the least experienced examiners.³¹ Similarly, the grant rate increases monotonically with experience, so that the most experienced examiners have a grant rate eleven percentage points higher than the least experienced examiners.³² Although the emphasis of Lemley and Sampat is on documenting the importance of experience as a source of variation,³³ in their view, both data points suggest a negative return to experience.³⁴ They note, among other things, that citations added reflect “how deeply [the examiner] searches,”³⁵ and add that their findings about the grant rate “suggest[] that examiners are doing more work, and rejecting applications with more rigor, at early stages in their career[s], and both doing less work and allowing more patents as their [experience] increases.”³⁶

B. *Background and Hypotheses*

The most important reason to understand examiner variation is that examiner effort likely relates directly to the quality of the patents on which the examiner works.³⁷ For example, Ronald Mann and Marian Underweiser present a model of the patent production process in which the quality of the issued patent is a function of the joint efforts of the applicant and the examiner.³⁸ Focusing solely on quality as a function of expected validity in the event of Federal Circuit adjudication, that paper emphasizes a number of institutional features of the existing system that limit the incentives of applicants and examiners to give their best effort to individual applications.³⁹ Those results, then, have implications for the structure of the examination process.

By focusing on differentiation among examiners, this Article extends that work in a human-resources direction. Instead of focusing on the incentives of the applicant and examiner, this Article examines the ways in

31. *Id.* at 821.

32. *Id.* Lemley and Sampat also found that the most experienced examiners are significantly more likely to grant without rejections than the least experienced examiners. *Id.* at 822.

33. *Id.* at 817.

34. *See id.* at 826 (arguing those findings raise an inference that more experienced examiners do less work, rather than “getting it right more often,” than less experienced examiners).

35. *Id.* at 820–21.

36. *Id.* at 822. To be sure, as discussed in Mann and Underweiser, it is possible that a decline in rejections could actually reflect an increase in effort; for example, if the count system makes it easier for examiners to reject patents out of hand instead of working with the applicants to revise the claims so as to limit them to patentable subject matter, we might see a decline in the rate of rejection with increased examiner effort. Ronald J. Mann & Marian Underweiser, *A New Look at Patent Quality: Relating Patent Prosecution to Validity*, 9 J. EMPIRICAL LEGAL STUD. 1, 24–25 (2012).

37. *See* Lemley & Sampat, *supra* note 8, at 819 n.4 (noting the difficulties of evaluating complex patent claims for less experienced examiners).

38. Mann & Underweiser, *supra* note 36, at 2.

39. *Id.* at 24–29.

which the qualities of the examiners themselves influence the output of the process. Robert Merges argued more than two decades ago that making the job of an examiner more attractive as an employment opportunity would improve examiner output,⁴⁰ but he did not undertake to document the benefits of a change in the quality of examiner candidates or of improved retention of those that enter the office.

Because of the emphasis on human-resources attributes, this Article necessarily also confronts a different type of “quality” of examiner output: the efficiency of the examiner’s work from a labor and employment perspective. Thus, examiner attributes or institutional factors that cause examiners to work more (or less) efficiently in the office are important even if they have no effect on the likely validity of the patents that flow from the examiners’ work. This suggests, at least conceptually, the possibility of a balance among factors that improve examiner efficiency in the workplace and those that improve the likely validity of each examiner’s output.

For reasons that will be clear when I discuss the constraints on the available data below,⁴¹ I distinguish two ways in which differences among examiners relate to the quality of the examiner’s work: those that are fixed (time-invariant) and those that vary with the examiner’s time in the office. Lacking any data about individual examiners other than their time in the office, Lemley and Sampat emphasize the way in which experience alters the quality of an examiner’s work as the examiner’s career progresses.⁴² This is not a novel idea. Various scholars have documented a positive return to experience in a variety of employment settings.⁴³ If an examiner’s relationship with the PTO has a life cycle, we can imagine that examiners change in many ways as the years of their work at the PTO elapse. On the one hand, they learn more and more about the examination process, about the prior art that is relevant to the technologies on which they work, and about the behavior of applicants and others in the PTO as it affects their

40. Robert P. Merges, *As Many as Six Impossible Patents Before Breakfast: Property Rights for Business Concepts and Patent System Reform*, 14 BERKELEY TECH. L.J. 577, 606–07 (1999).

41. See *infra* Part III.

42. Lemley & Sampat, *supra* note 8, at 826.

43. The return is most commonly attributed to “learning by doing” or the like. See, e.g., David S. Abrams & Albert H. Yoon, *The Luck of the Draw: Using Random Case Assignment to Investigate Attorney Ability*, 74 U. CHI. L. REV. 1145, 1150 (2007) (examining the impact of experience on the performance of public defenders); Hassan Ali & D. Roy Davies, *The Effects of Age, Sex and Tenure on the Job Performance of Rubber Tappers*, 76 J. OCCUPATIONAL & ORGANIZATIONAL PSYCHOL. 381, 383, 387–88 (2003) (examining rubber tappers in Malaysian forests); Christian Dustmann & Costas Meghir, *Wages, Experience and Seniority*, 72 REV. ECON. STUD. 77, 77–79, 92–94 (2003) (studying young workers entering the German labor market between 1975 and 1995); Paul R. Sparrow & D. R. Davies, *Effects of Age, Tenure, Training, and Job Complexity on Technical Performance*, 3 PSYCHOL. & AGING 307, 307–08, 312–13 (1988) (examining engineers at a multinational office-equipment business).

work. Collectively, those suggest a positive return to experience—a “learning by doing” effect.

On the other hand, as an examiner’s experience increases, the examiner might for any number of reasons become less effective—a “burnout” effect. Workload might get heavier. The steady acquisition of tacit knowledge might lead to an increasingly rule-bound (and thus less vigilant) approach to tasks. From this perspective, as the examiner becomes more senior, the examiner might do a less thorough job. This suggests a contrary hypothesis—supported by Lemley and Sampat, as discussed above⁴⁴—that the quality of work declines with experience, which would appear in the data either as a negative return to experience or as a decline in the return to experience.⁴⁵

The preceding discussion assumes that examiners are relatively homogeneous at the time they come to the PTO and that the length of time they stay in the office is a largely fortuitous happenstance of events after they begin work at the PTO. Yet, research in other employment contexts suggests that it is likely that much of the variation in tenure relates to individual characteristics of the examiner that are, for all practical purposes, time-invariant, fixed at or shortly after the commencement of the examiner’s employment. For example, Gary Henry, Kevin Fortner, and Kevin Bastian find that teachers who will remain in teaching more than five years are substantially more effective than those that will exit teaching within five years; at the same time, they find that the initially positive returns to experience peak quickly and thereafter diminish, and identify a substantial drop in effectiveness during the last year of employment.⁴⁶

Conceptually, the idea for present purposes is that individuals differ in their suitability for the job of patent examiner. This might be true for a variety of overlapping reasons, ranging from personality attributes (such as the ability to work to quotas, or the ability to work without detailed supervision) to life-choice attributes (the desire for a long-term career with relatively little risk) to past experience (either in education or prior employment).

Moreover, those attributes could affect the quality of work in distinct ways. Most obviously, they could directly affect the examiner’s intellectual preparation to make the judgments necessary for high-quality patent examination. But they also could have more complex, indirect effects. They could, for example, alter the likely period of time for which the

44. See *supra* notes 25–36 and accompanying text.

45. See Lemley & Sampat, *supra* note 8, at 826 (finding evidence that more experienced examiners were doing less work than junior examiners).

46. Gary T. Henry, C. Kevin Fortner & Kevin C. Bastian, *The Effects of Experience and Attrition for Novice High-School Science and Mathematics Teachers*, 335 SCIENCE 1118, 1118–20 (2012).

examiner would remain in the office. Thus, some individuals might come to the PTO expecting to work as an examiner for a short period of time, hoping to gain experience that would help in some more lucrative opportunity elsewhere (at a law firm or technology company, for example). Others might come to the PTO hoping, or planning, to make a career out of the relative stability that comes with government employment. The prior experience and education of the examiner are likely to be relevant to those effects, as are the opportunities in the labor markets external to the PTO. But whatever the reasons, it would not be surprising if these kinds of relatively stable examiner characteristics related directly to the quality of the work done by the examiners while in the office. In the abstract, it is difficult to predict which effect would dominate. Better qualifications might lead to superior capability and thus a longer stay in the office—a “careerist” outcome. Conversely, it well might be that better qualifications would lead to superior external opportunities, and thus less attachment to the PTO work. Those disparate effects well might mean that objectively better credentials could relate either to superiority or inferiority as an examiner. Lemley and Sampat discuss, for example, the possibility that term of employment might relate inversely to quality of output because of the superior external labor opportunities of more qualified examiners.⁴⁷

The indirect effects related to the duration of the examiner’s attachment to the office warrant particular attention, in part because of the difficulty of separating them from the time-variant effects of experience. One way to think about those latter effects is that they relate to the examiner’s “tenure” (a fixed attribute of the examiner—the total length of the examiner’s career) as distinct from the examiner’s “experience” (an attribute that shifts over time—the period the examiner already has spent in the office at any given point). In other employment contexts, scholars have identified separate effects of those two attributes.⁴⁸ Again, however, as with experience, the effect of tenure could cut in both directions. On the one hand, it might be that “short-timers”—those who will turn out to have a short tenure—are relatively disinterested in the work because they know that they will be there only briefly, while careerists—those who will turn out to have a long tenure—will work harder from the first day, knowing that they have a greater period over which to reap the rewards of investment in the job. Or the causation could run in the opposite direction

47. Lemley & Sampat, *supra* note 8, at 824.

48. Comparing the effects of experience and tenure for teachers, Henry, Fortner, and Bastian separately identify positive effects for both experience and tenure. Henry et al., *supra* note 46, at 1119–20. In their data, the returns to increasing experience diminished rapidly. *Id.* They also find a substantial negative effect for short-term teachers in their last year of employment. *Id.* at 1120.

(notwithstanding the difficulties of firing government employees)⁴⁹: those who do better work remain in their jobs longer than those who do worse work. In either event, this would appear in the data as a positive return to increasing tenure. On the other hand, if those who have realistic, superior outside opportunities are systematically better qualified, then short-timers might be superior to careerists, even if they are not as motivated by the prospect of a long PTO career. Though uncommon, this is not unheard of, and would appear in the data as a negative return to tenure.⁵⁰

At first glance, it might seem difficult to distinguish between the effects of experience and tenure. Any data analysis of examiners who have been at the office for an extended period of time necessarily will involve those with high levels of experience and tenure. Similarly, analysis of examiners who have been at the office only a short time will necessarily involve low experience and naturally would disproportionately involve the efforts of those with short tenure. To complicate matters still further, it is easy to imagine scenarios in which the relevant factors—private employment market, depth of tacit knowledge, workload pressures, etc.—vary by industry, and that these differences offset for particular categories of patents. Finally, any analysis is doubtlessly complicated by the overlapping effects at the individual level; presumably, there is some truth, for some examiners, to all of the hypotheses summarized above. With those concerns in mind, the following sections discuss an effort to design a data structure to test and quantify the relative weight of those hypotheses.

III. Data and Methods

To examine the effects of examiner tenure and experience, I started with a data set of 366 patents, which constitute the universe of patents for which the Federal Circuit issued a final decision on validity during the period 2003–2009. I then identified the primary examiner on each of those patents and collected a data set of all of the patents for which that individual

49. Angie Drobnic Holan, *Firing Federal Workers is Difficult*, POLITIFACT (Sept. 5, 2007, 5:52 PM), <http://www.politifact.com/truth-o-meter/article/2007/sep/05/mcain-federal/>.

50. Although literature examining tenure is relatively uncommon, it generally finds a positive return to tenure. See, e.g., Katharine G. Abraham & Henry S. Farber, *Job Duration, Seniority, and Earnings*, 77 AM. ECON. REV. 278, 295 (1987) (finding a “strong positive relationship between job duration and earnings”); Richard T. Boylan, *Salaries, Turnover, and Performance in the Federal Criminal Justice System*, 47 J.L. & ECON. 75, 83 (2004) (showing that shorter tenure for U.S. attorneys results in worse performance); Dustmann & Meghir, *supra* note 43, at 100 (finding positive returns to firm tenure for both skilled and unskilled workers in Germany); Henry et al., *supra* note 46, at 1118 (noting research that shows exiting teachers are less effective than comparable teachers who stay in the occupation). But see Richard T. Boylan & Cheryl X. Long, *Salaries, Plea Rates, and the Career Objectives of Federal Prosecutors*, 48 J.L. & ECON. 627, 627–28 (2005) (finding an inverse relation between tenure and quality among U.S. attorneys, at least in markets with unusually high external labor opportunities).

ever served as the primary examiner through the spring of 2011 (when the data were collected). I should mention that many patents indicate two examiners: a more senior primary examiner (with supervising responsibility for the patent) and a secondary examiner (a relatively inexperienced employee at the assistant-examiner rank).⁵¹ Although it might make a great deal of sense to allocate applications based on the experience and capabilities of particular examiners, it seems quite clear that this is not how it is done. Rather, confirming the findings of Lemley and Sampat on this point, I conducted a series of interviews with examiners of all ranks, which confirmed that once applications reach a particular art unit, they are allocated randomly among examiners in that unit.⁵² Supervisory examiners explained that the effort required to determine whether any particular examiner in the unit might have more expertise for a particular application would dwarf the time available for distributing applications. Lower-level examiners, in contrast, emphasized the perceived unfairness of any allocation that allocated more (or less) work based on the views of “management” about the capabilities of particular examiners. In an office like the PTO with a strong union presence,⁵³ line-level examiners credibly emphasized that no such practice could persist without detection or survive its discovery.

Because the secondary examiner does not have the authority to grant or deny a patent,⁵⁴ and because all actions of a secondary examiner must be reviewed and verified by the primary examiner,⁵⁵ it seemed more sensible for my purposes to use the primary examiners.⁵⁶ Specifically, because my aim is to understand the quality of the work reflected in the issued patents, it seems appropriate to match the patents to the individual responsible for

51. Lichtman, *supra* note 20, at 158.

52. Lemley & Sampat, *supra* note 8, at 822.

53. See U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-05-720, INTELLECTUAL PROPERTY: USPTO HAS MADE PROGRESS IN HIRING EXAMINERS, BUT CHALLENGES TO RETENTION REMAIN 27 (2005), available at <http://www.gao.gov/assets/250/246777.pdf> (noting that the examiners' union is the “exclusive representative” of patent examiners with respect to any issues surrounding working conditions).

54. See Lemley & Sampat, *supra* note 8, at 819 (stating that secondary examiners do not have independent signatory authority until promoted to the rank of GS-14).

55. *Id.* at 818–19.

56. Because the decision to use primary examiners rather than secondary examiners eliminates separate consideration of the shortest-tenure examiners, those who are never promoted, it should make it harder to identify the differences between short- and long-tenure examiners that I discuss in the sections that follow.

the patents in question.⁵⁷ That data collection produced a total of slightly more than 500,000 patents for 257 different examiners.⁵⁸

Because the goal of the project was to understand the way in which examiner tenure and experience relate to the examiners' output (the issued patents), I then matched that data set to the most recent version of the NBER Patent Citations Data File.⁵⁹ Although an updated version, that would include all patents issued through 2006 was scheduled for release in 2011, the most current version includes citations through 1999 for patents issued through 1999.⁶⁰ Because much of my analytical strategy depends on the average characteristics of the patents of each examiner, I excluded all examiners who examined fewer than fifty patents. At the end, this produced a data set of about 310,000 patents examined by 231 different examiners.⁶¹

For each of those patents, the data set includes several categories of variables. The first are patent-level variables that describe the characteristics of individual patents. These come either from the NBER data file, from International Business Machines Corporation (IBM's) "SIMPLE" database,⁶² or are constructed from my calculations. The most important of the variables from the NBER and SIMPLE databases are the following:

- claims (the number of claims in the issued patent)

57. As I explain below, the regression models reported in the body of the Article, where appropriate, control for the presence of a secondary examiner. *See infra* Tables 1 & 2.

58. Because many examiners have quite similar names, and because the name by which an individual examiner is identified on issued patents may change through the examiner's tenure, it is not possible with any degree of accuracy to match patents to examiners in an automated way. Rather, I "overcollected" for each examiner name with broad name searches, and then matched by hand the collected patents where appropriate to examiners in my data set. To be sure that I was matching the patents to the correct examiners, I used internal PTO records (obtained through a Freedom of Information Act request) that identify each examiner with a unique "worker number" that remains with the examiner throughout tenure in the office.

59. Bronwyn H. Hall et al., *The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools* (Nat'l Bureau of Econ. Research, Working Paper No. 8498, 2001), available at <http://www.nber.org/papers/w8498.pdf>.

60. *The NBER U.S. Patent Citations Data File: Lessons, Insights, and Methodological Tools*, NAT'L BUREAU OF ECON. RES., <http://www.nber.org/patents/> (last modified May 16, 2012).

61. Examiners with longer tenure are overrepresented in the data set because it is based on a sample of patents rather than a sample of examiners. Moreover, by dropping all examiners with fewer than fifty patents, I directly limit the information about extremely short-tenure examiners. Although these aspects of the data set make it unreliable for some purposes (such as describing the distribution of tenure among all examiners), they should, if anything, make it harder to identify the differences between short- and long-tenure examiners that I discuss in the sections that follow. Because all of the regression models reported below control for tenure, the overrepresentation of longer-tenure examiners should not bias the results.

62. *See generally* Ying Chen et al., *SIMPLE: A Strategic Information Mining Platform for IP Excellence*, IBM (Aug. 24, 2009), [http://domino.research.ibm.com/library/cyberdig.nsf/papers/95D73078344701C9852576350055DBF3/\\$File/rj10450.pdf](http://domino.research.ibm.com/library/cyberdig.nsf/papers/95D73078344701C9852576350055DBF3/$File/rj10450.pdf) (describing how SIMPLE operates to parse patent data).

- references (the number of references in the patent)
- originality (the technological breadth of the references, calculated according to the methodology of Manuel Trajtenberg, Rebecca Henderson, and Adam Jaffe)⁶³
- the mean age of the patents cited in the patent (calculated according to the methodology of Trajtenberg, Henderson, and Jaffe)⁶⁴

Several of those variables have frequently been used in the existing literature assessing patents in various contexts. For example, the patent-quality literature in legal journals frequently has emphasized the number of claims and references in a patent as important indicators of litigation, and thus, indirectly of value.⁶⁵ Similarly, the econometric literature studying the diffusion of knowledge through patents often has emphasized the originality and age of references in a patent.⁶⁶ Because of the prominence of those variables in prior work, I use them in the analyses below assessing the relative importance of the effects of tenure and experience.⁶⁷ Recognizing the centrality of the pace of examination to recent PTO policy initiatives,⁶⁸ I add to that list one additional variable, the time that the patent spent in examination.⁶⁹ Collectively, those variables should illuminate enough disparate aspects of examiner output to shed light on the relative

63. Manuel Trajtenberg, Rebecca Henderson & Adam Jaffe, *University Versus Corporate Patents: A Window on the Basicness of Invention*, 5 ECON. INNOVATION & NEW TECH. 19, 29–30 (1997).

64. *Id.* at 28–30.

65. See, e.g., John R. Allison & Ronald J. Mann, *The Disputed Quality of Software Patents*, 85 WASH. U. L. REV. 297, 316–19 (2007) (noting that litigated patents have significantly more claims and references than nonlitigated patents); John R. Allison et al., *Valuable Patents*, 92 GEO. L.J. 435, 439–43, 451 (2004) (equating patent litigation with patent value and finding that patents with more claims and citations are more likely to be litigated); Kimberly A. Moore, *Worthless Patents*, 20 BERKELEY TECH. L.J. 1521, 1546 tbl.6 (2005) (categorizing valuable patents as litigated patents and showing that valuable patents have both more claims and cites).

66. See, e.g., Adam B. Jaffe & Manuel Trajtenberg, *Introduction*, in PATENTS, CITATIONS, AND INNOVATIONS 3 (Adam B. Jaffe & Manuel Trajtenberg eds., 2002) (using patent-citation data to derive information about originality and citation time lag); see also Cockburn et al., *supra* note 7, at 36, 37 tbl.1 (noting that citations reveal patent characteristics such as technology class and date of approval); Trajtenberg et al., *supra* note 63, at 21–24 (discussing the data that can be determined by reference to patent citations).

67. See discussion *infra* subparts IV(A)–(B).

68. See, e.g., 2013 USPTO PERFORMANCE & ACCOUNTABILITY REP. FISCAL YEAR 2013, at 17 [hereinafter USPTO PERFORMANCE], available at <http://www.uspto.gov/about/stratplan/ar/USPTOFY2013PAR.pdf> (detailing the agency's progress toward reducing patent application backlog as part of the agency's strategic goal to optimize patent timeliness).

69. To be sure, speed of examination is not necessarily positive because it could reflect cursory attention to work rather than diligence. It is, accordingly, important to consider the speed of examination in light of other attributes of issued patents.

effects of experience and tenure. Figure 1 illustrates the variation in those variables.

The data set also includes a variety of other variables, including several variables related to future citations to the patent (the number of forward references, a measure of the breadth of those references, and a measure of the timing of those references).⁷⁰ As discussed by Mann and Underweiser, those variables have only indirect value in understanding the examination process because they measure events that occur after the patent has been issued.⁷¹ Accordingly, although I use them in the descriptive portion of the discussion (largely because of their frequent use in existing literature about patent quality), I do not use any of the variables related to “forward” references in my analysis of the examiner’s output. To facilitate analysis of changes in those variables through an examiner’s career, as well as within- and between-examiner effects, I also use the mean values for all of the patent attribute variables for each examiner.

Figure 1: Variation in Patent Characteristics

70. Those data are the focus of a substantial body of work analyzing the pathways through which patents relate to the dissemination of technology over time. *See, e.g.*, Jaffe & Trajtenberg, *supra* note 66, at 66–67 (exemplifying the need to examine forward linkages in patent citations).

71. *See* Mann & Underweiser, *supra* note 36, at 15 (“[P]ostissuance variables are irrelevant to analysis of the decision to issue.”). The variables related to forward references are even more problematic here because they are likely to be affected by the examiner’s own behavior. For example, examiners who have a longer tenure after examination of a particular patent will have a greater opportunity to cite the patent in the future than examiners who leave office shortly after issuance of the first patent.

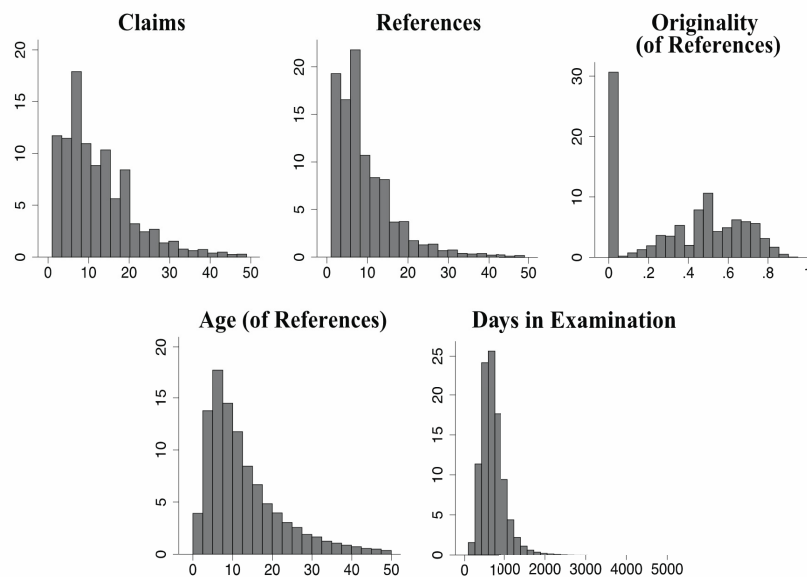


Figure 1: Panels display percentage distributions of the listed attributes. Claims, references, and age (of references) truncated at fifty. $N = 288,982 - 313,247$.

Because the purpose of the Article is to assess the relationship between the career paths of examiners and the quality of their output, I also created variables to measure those paths. Thus, to measure the experience and tenure of the examiner, I calculated for each patent the following characteristics:

- Experience (Years)—the number of years between the first patent examined by the relevant examiner and the patent
- Tenure (Years)—the total number of years between the first and last patents examined by the relevant examiner
- Career—the share of the examiner’s career (measured in patents) that has elapsed when the patent is issued

Following convention in the labor-relations literature on employment and tenure,⁷² the analyses in the sections that follow use the measures of tenure and experience based on time in the office rather than patents examined.

I also matched the data described above to data about the attributes of individual examiners that I obtained through a Freedom of Information Act

72. See, e.g., Sparrow & Davies, *supra* note 43, at 309 (defining tenure as length of service).

request submitted to the PTO. Although I was unable to obtain information about age or demographic characteristics (because of privacy concerns), I did obtain information about the examiners' time in the office, the art units in which they worked, the ranks that they held, and most importantly, the degrees that the examiners held when they came to the office. Figure 2 illustrates the variation in the most important variables used in the analysis below: tenure and educational attainments among examiners.

Figure 2: Variation Among Examiners

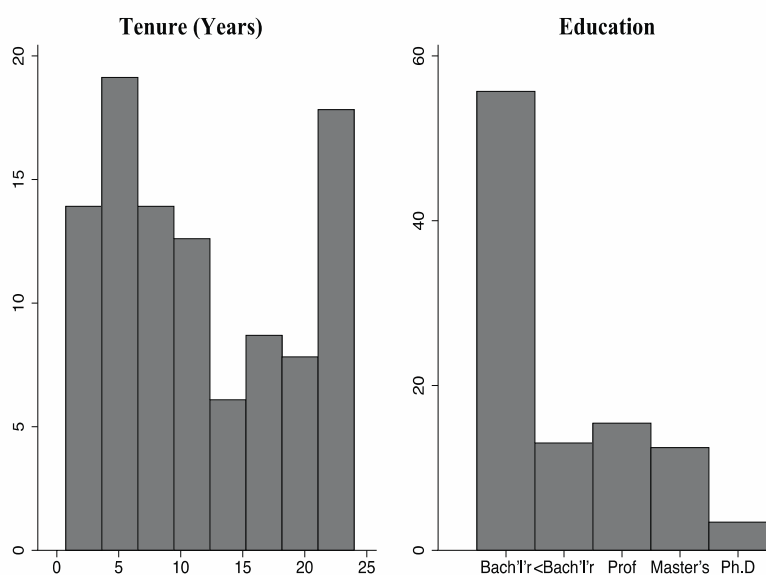


Figure 2: Variation Among Examiners. $N = 218, 230$. Figures display percentage distributions of examiner attributes.

Recognizing the likelihood that the measurements of examiner tenure and quality will differ substantially over time and by technology, the data set also includes three sets of controls for technology and cohort. The first is the national class in which the patent was issued. Because this variable has more than 400 values, it is not useful for understanding differences among broad technological groups. The analyses below use the two overlapping constructed variables described by Bronwyn Hall, Adam Jaffe, and Manuel Trajtenberg: the more general of which allocates all patents to six technological categories, and the more finely grained of which allocates all patents to thirty-six technological categories.⁷³ Where it is useful to

73. Hall et al., *supra* note 59, at 12–13.

account for cohort effects, the models described below control for the year in which the relevant application was filed.

IV. Results

I present the analysis in three steps. First, I document the substantive importance of the effects of tenure. Second, I show that the effects of tenure and experience point in opposite directions, with a lame-duck effect exacerbating the effects of experience in the last year before the end of employment. Finally, I discuss the effects of education: although educational attainments correlate in important ways with tenure and have substantial effects on the output of the examiners, they do not explain a substantial part of the experience and tenure effects discussed in the preceding sections.

A. Tenure

Prior efforts to consider the features of individual examiners that might explain variation between examiners have been limited for various reasons. Most importantly, it has been difficult for a variety of reasons to obtain any substantial information about the characteristics of individual examiners.⁷⁴ Thus, prior work has emphasized what can be inferred from the output of the examiners: their time at the PTO and their workflow while there.⁷⁵ Lemley and Sampat specifically note the possibility that the total length of employment might relate to examiner output (and thus explain, in part, the effects of experience that they document).⁷⁶ They emphasize, however, their inability to examine the effects of long-term employment directly because of limitations in their data structure.⁷⁷

The data analyzed here, however, permits more intricate analysis. Given the obvious relation between the effects of experience (which should grow over time) and the effects of careerism (which would be apparent in the data immediately upon employment), it is particularly valuable to have data that can distinguish those effects. To be sure, it is somewhat harder to identify the effects of tenure because they are so closely related to the

74. See Lemley & Sampat, *supra* note 8, at 819 (characterizing officially reported PTO examiner data as disorganized and error filled).

75. See *id.* at 817 (assessing how examiner experience affects patent outcomes).

76. See *id.* at 825 (positing that examiner tenure may affect output).

77. See *id.* at 824 (citing the limited data available to examine effects of long-term employment). The final models presented in Lemley and Sampat do control for the possibility that the examiner will leave within five years after the date that the patent was examined and find relatively limited effects. *Id.* at 825. That analysis does not seem to suggest anything about effects related to the examiner's tenure; rather, it simply shows whether the patent was examined close to the end of the examiner's tenure (however long it might be). As discussed below, I do find a small, but statistically significant, lame-duck effect. See *infra* subpart IV(B).

effects of experience. The variables obviously are at least partially collinear: all of the patents examined by examiners with the highest level of experience will have been examined by examiners who have the longest tenure.⁷⁸ Moreover, there are theoretical reasons for thinking tenure might affect experience: Ray Reagans, Linda Argote, and Daria Brooks argue that the returns to learning by doing will increase with the average tenure of workers in the office.⁷⁹

One simple way to distinguish between the two variables would be to look at the earliest patents for all examiners. Thus, Figure 3 illustrates the mean attributes for the first fifty patents examined by the examiners with the shortest tenure—less than five years total employment—with the mean attributes for the first fifty patents examined by the examiners with the longest tenure—more than twenty years total employment.⁸⁰ As that figure illustrates, the data provide strong support for the idea that tenure has an effect distinct from that of experience. Already within the first fifty patents, the output of the examiners who will remain as examiners for the longest period differs markedly from the output of those who will stay the shortest period. For each of the five reference variables, the difference is statistically significant at the 0.001% level. More importantly, in most cases the differences are substantively noteworthy. To take only the simplest variables, the patents of the longest-tenured examiners, on average, have more than twice as many references (16 versus 7) as those of the shortest-tenure examiners, substantially more claims (17 versus 11), and a much faster period of examination (710 days versus 820).

Although Figure 3 suggests that long- and short-tenure examiners behave very differently when they first begin work at the PTO, it tells us little about how behavior shifts as tenure progresses, about the returns to increasing tenure, or how increasing tenure might affect the returns to experience documented by Lemley and Sampat⁸¹ and confirmed above.⁸² Nor does it explore the possibility that education might explain or

78. See Lemley & Sampat, *supra* note 8, at 826 (observing the “strong relationship” between experience and tenure).

79. See Ray Reagans, Linda Argote & Daria Brooks, *Individual Experience and Experience Working Together: Predicting Learning Rates from Knowing Who Knows What and Knowing How to Work Together*, 51 *MGMT. SCI.* 869, 874 (2005) (postulating that because professional experience grows concomitantly with tenure, productivity should increase as well).

80. I made similar calculations using the first 100 patents, but this required me to drop a number of the shortest-tenure examiners (because they examined fewer than 100 patents). The results are similar, though the differences are not as substantial as those summarized in Figure 3. To put the 50- and 100-patent levels in perspective, the median rate of patents examined per year in the data set is about 62.

81. See Lemley & Sampat, *supra* note 8, at 820–22 & tbls.2, 3 & 4 (documenting effects of examiner experience on citation patterns and patent grant rate).

82. See *supra* text accompanying notes 74–79.

contribute to any such returns. The sections that follow explore those questions in turn.

Figure 3: Experience and Tenure (1st 50 Patents)

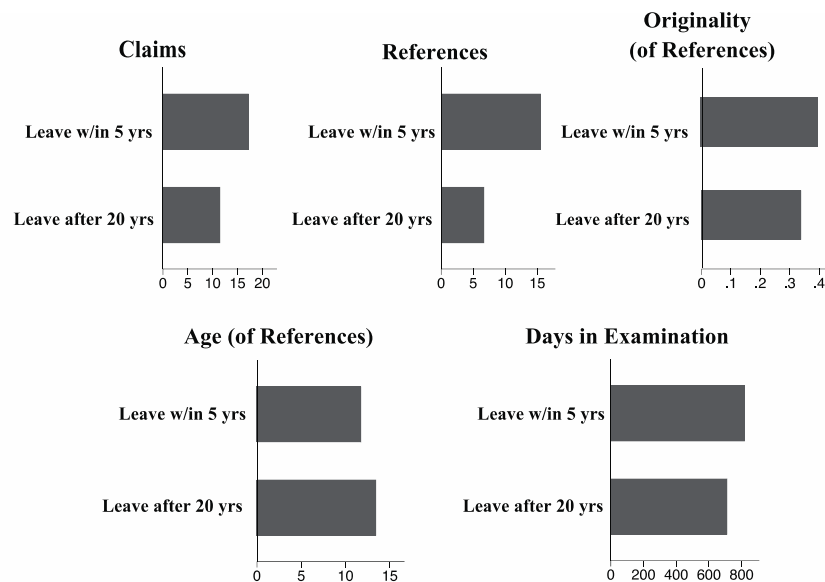


Figure 3: Experience Versus Tenure (First 50 Patents). $N = 4903 - 5299$. Bars show mean values on listed variables for the first fifty patents of shortest-career quintile of examiners (< 5 years in office) and longest-career quintile of examiners (> 20 years in office). All differences significant at 0.001%.

B. Specifying the Distinct Effects of Experience and Tenure

To disentangle the effects of experience and tenure, I estimated a series of five distinct random-effects models for each of the five patent attributes discussed above. Each of the models includes controls for technology, cohort,⁸³ type of assignee, and the presence of an assistant examiner. In each case, the dependent variable is the relevant patent attribute.⁸⁴

83. I explored different ways of accounting for cohort but settled on a linear variable that measures the date of the application (centered on 1990). Alternate specifications included a quadratic term, interactions, and a dummy for whether the patent was issued before or after formation of the Federal Circuit.

84. I also estimated models for each attribute with examiner-level fixed effects. Because tenure is an examiner-level variable, those models allow me to estimate the effects of experience, but do not allow me separately to estimate the effects of tenure. Accordingly, I discuss in the text only the random-effects models for which I can include both experience and tenure in the same

Collectively, the output of those models should tell us a great deal about the relation among those various examiner attributes. For illustrative purposes, the text displays only the results with regard to claims and days in examination. For all five variables, the results point in the same direction and have similar levels of magnitude and statistical significance.⁸⁵

The decision to emphasize claims and days in examination reflects the reality that those attributes, unlike references (and the generality and age of references), are most directly within the control of examiners. Indeed, if we accept the premise that assignment of applications is essentially random within art units,⁸⁶ then the results from models that control for technology and cohort should credibly identify differences in the work of different examiners. Moreover, each of those attributes has substantial policy significance. For example, the number of claims has been used most pervasively in the existing literature as an indicator of patent value; multiple papers document a substantially larger number of claims in litigated patents than in non-litigated patents.⁸⁷ Similarly, Kimberly Moore finds that assignees are more likely to pay (and continue to pay) maintenance fees on patents with more claims.⁸⁸ In the same vein, John Allison and Ronald Mann use the number of claims as a proxy for value to examine the relative value of software and non-software patents.⁸⁹

To be sure, the relation between claims and patent quality is much more ambiguous than between claims and value. As Allison and Mann explain, the relation between claims and value is just as likely to relate to the likelihood that patents with more claims are more likely to be challenged in litigation as it is to relate to the likelihood that the patents are better crafted.⁹⁰ Building on that insight, Mann and Underweiser show that the relation between claims and validity is weak at best and negative if anything.⁹¹ The general idea is that a more thorough examination will result in a patent with fewer claims because the examiner's effort will force the

model. The results of the fixed-effects models are substantively similar and available from the author on request.

85. Results available from the author on request.

86. See *supra* note 52 and accompanying text.

87. E.g., Allison et al., *supra* note 65, at 438; Jean O. Lanjouw & Mark Schankerman, *Characteristics of Patent Litigation: A Window on Competition*, 32 RAND J. ECON. 129, 131 (2001).

88. See Moore, *supra* note 65, at 1530, 1531 tbl.1 (finding patents that expired due to nonpayment of maintenance fees “had fewer claims than patents that were maintained to the full term” and that “[p]atents that expired earlier . . . had fewer claims than patents that expired later”).

89. Allison & Mann, *supra* note 65, at 318, 321.

90. *Id.* at 318.

91. Mann & Underweiser, *supra* note 36, at 26.

applicant to remove the more marginally valid claims before the patent is issued.⁹²

Though not as well established in the academic literature, time in examination is similarly important in policy analysis of the patent system. This metric has preoccupied the PTO during recent decades as backlogs of applications awaiting examination have pushed the time of issuance farther and farther from the original date of invention.⁹³ Increased time between an application and a grant has several noteworthy pernicious effects. Most obviously, it shortens the patent term, thus undermining the value of the monopoly the system is designed to promote.⁹⁴ More perversely, it shifts the beginning of the monopoly later in time, increasing the likelihood that when others in the industry first learn of the patent, they will have developed related technologies that now for the first time infringe a just-issued patent.⁹⁵ That problem is particularly serious when the technologies overlap, so that competing patents “block” each other, which means that neither patentee can exploit its patent without consent from the other.⁹⁶ For that reason, time in examination seems an important patent attribute for purposes of assessing variation in examiner output.

Tables 1 and 2 summarize the results of those models for claims and days in examination. As those Tables indicate, the results for the two variables are substantively quite similar. In the first model for both variables, the effects of experience are essentially linear, increasing monotonically with experience. The effects of tenure, by contrast (in Model 2) are negative in both cases up to the twenty-year point. Model 3 includes both tenure and experience. As expected, the inclusion of the two cross-cutting variables in the model magnifies the opposing effects for each; in all cases the coefficients for experience and tenure are larger in Model 3 than in Models 1 and 2. In both cases, the effects of tenure and experience are magnified when both variables are included in the same model; this makes sense if the effects cut against each other because the

92. See *id.* at 8–9 (noting that the relationship between invalid patents and numerous claims may be mitigated by a thorough examination).

93. See, e.g., USPTO PERFORMANCE, *supra* note 68, at 8 (characterizing reduction in application backlog as an integral part of USPTO’s organizational mission).

94. See 35 U.S.C. § 154(a)(1) (2012) (defining the grant of a patent as the “right to exclude others from making, using, offering for sale, or selling the invention throughout the United States”).

95. See, e.g., Warren K. Mabey, Jr., *Deconstructing the Patent Application Backlog . . . A Story of Prolonged Pendency, PCT Pandemonium & Patent Pending Pirates*, 92 J. PAT. & TRADEMARK OFF. SOC’Y 208, 244–45 (2010) (acknowledging the argument that prolonged pendency encourages competitors to design similar products).

96. See, e.g., Steven C. Carlson, *Patent Pools and the Antitrust Dilemma*, 16 YALE J. ON REG. 359, 379 (1999) (explaining that overlapping patent rights require a cooperative agreement between patentees before a patent can be utilized).

inclusion of both variables helps to isolate the separate effects of tenure and experience more completely. The effects are substantively important. For example, against a constant of almost 19 claims, the average number of claims increases steadily with experience to about 25 claims for the patents of examiners with more than twenty years of experience at the time the patent issued. Conversely, the average number of claims decreases steadily with tenure to a minimum of about 13 for the patents of examiners whose time in the office exceeded twenty years. The results are parallel for time in examination. Against a constant of almost 1,500 days (a little more than four years), the time in examination more than doubles to an average of more than 3,300 days for the patents of examiners with more than twenty years of experience at the time the patent issued. Conversely, the average days in examination decreases steadily with tenure. Setting aside the effects of experience, the coefficient in the model suggests that the average days in examination in fact would be negative for the patents of examiners whose time in the office exceeded twenty years. This obviously reflects that many of those patents in fact involve examiners with lengthy experience, for which a countervailing increasing effect is present. Models 4 and 5 explore the role of education, which is discussed below.

Finally, following Henry, Fortner, and Bastian; and Lemley and Sampat, Model 6 explores the possibility of a lame-duck effect at the end of an examiner's time in the office. As summarized in the last column of Tables 1 and 2, there is a significant lame-duck effect in each case, of comparable magnitude, exacerbating the effects of experience; the relation with experience is most apparent from the slight decreases in each of the coefficients on experience as we move from Model 5 (which does not include last year) to Model 6 (which does). Thus, against a constant of almost 19 claims, the number of claims in the last year is about one higher; against a constant of 1,500 days in examination, the time in examination increases by about 100 days during the last year the examiner is in the office.⁹⁷

The robustness of those effects is supported by the similar results for the three variables not displayed in Tables 1 and 2, all of which point in the same directions as the results for claims and days in examination. To illustrate and quantify the overall patterns, Figures 4 and 5 display margins-plots illustrating the shifts in the net-predicted values for all five of the

97. The intuition here is that the presence of an assistant examiner is likely to affect the workflow. It could slow the process (if the assistant examiner works less rapidly than the primary examiner), or it could speed the process (if the assistant examiner has a lighter workload). For similar reasons, the presence of an assistant examiner could relate positively or negatively to the vigilance and effort with which the application is examined. This control is particularly important given the different ways in which prior literature has defined the concept of "examiner" to be studied.

variables with increasing experience and tenure. Starting with Figure 4, which displays the returns to experience, the most important thing about the figure is the parallel trends for all the variables. In each case, the patent attributes steadily increase with experience, and in most cases, the increases are substantively significant. So, for example, the predicted number of claims increases steadily from 11.0 for examiners with less than five years' experience to 16.9 for examiners with more than twenty years' experience; the predicted number of days in examination increases from 58 for examiners with less than five years' experience to 1,900 for examiners with more than twenty years' experience. The predicted number of references increases monotonically from 8.2 for examiners with less than five years' experience to 15.7 for examiners with more than twenty years' experience.

The marginsplots in Figure 5 confirm the converse effects of tenure, with all of the variables displaying decreases with increasing tenure. Although the declines are not as consistent across variables as they are for experience, they do for the most part display monotonic and substantively significant declines. Most notably, the predicted number of claims decreases steadily from 17.4 for examiners who will leave within five years to 11.9 for examiners who will remain more than twenty years, the predicted number of days in examination decreases steadily from more than 2,000 for examiners who will leave within five years to about 260 for examiners who will remain more than twenty years, and the predicted number of references decreases from 16.1 for examiners who will leave within five years to 8.9 for examiners who will remain more than twenty years.

Table 1: Examiner Characteristics and Claims

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
5–10 years experience	0.98 ^{***} (0.07)		1.37 ^{***} (0.08)	1.17 ^{***} (0.08)	1.55 ^{***} (0.09)	1.53 ^{***} (0.09)
10–15 years experience	1.64 ^{***} (0.16)		2.40 ^{***} (0.13)	1.95 ^{***} (0.13)	2.70 ^{***} (0.14)	2.68 ^{***} (0.14)
15–20 years experience	2.66 ^{***} (0.16)		3.75 ^{***} (0.18)	3.09 ^{***} (0.17)	4.17 ^{***} (0.20)	4.11 ^{***} (0.20)
>20 years experience	4.05 ^{***} (0.21)		5.42 ^{***} (0.24)	4.61 ^{***} (0.23)	5.96 ^{***} (0.26)	5.90 ^{***} (0.26)
Left w/in 5–10 years		–0.66 (0.41)	–1.49 ^{***} (0.41)		–1.51 ^{***} (0.42)	–1.57 ^{***} (0.38)
Left w/in 10–15 years		–1.27 ^{**} (0.45)	–3.52 ^{***} (0.47)		–3.17 ^{***} (0.51)	–3.15 ^{***} (0.45)
Left w /in 15–20 years		–1.29 ^{**} (0.47)	–5.05 ^{***} (0.47)		–4.98 ^{***} (0.56)	–4.97 ^{***} (0.50)
Left after >20 years		–0.80 (0.42)	–5.19 ^{***} (0.47)		–5.46 ^{***} (0.50)	–5.45 ^{***} (0.45)
<Bachelor's				–2.28 ^{***} (0.52)	–1.37 [*] (0.55)	–1.36 ^{**} (0.48)
Professional Degree				–2.53 ^{***} (0.55)	–1.38 [*] (0.57)	–1.19 [*] (0.50)
Masters				0.49 (0.45)	0.43 (0.45)	0.43 (0.39)
Ph.D.				–0.25 (0.60)	–0.89 (0.61)	–0.83 (0.53)
Last Year						1.06 ^{***} (0.24)
Constant	16.00 ^{***} (0.20)	17.08 ^{***} (0.33)	18.70 ^{***} (0.34)	16.32 ^{***} (0.24)	18.86 ^{***} (0.34)	18.90 ^{***} (0.33)
Number of observations	288,950	288,950	268,270	268,270	268,270	268,270

Table 1: Examiner Characteristics and Claims. Models report the coefficients on the listed examiner characteristics from random-effects models estimating the relation between the listed examiner characteristics and the number of claims in the issued patent. Controls for technology, cohort, type of assignee, and presence of an assistant examiner omitted. Standard errors in parentheses. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.

Table 2: Examiner Characteristics and Days in Examination

Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
5–10 years experience	407.64 ^{***} (1.95)		473.42 ^{***} (1.99)	428.51 ^{***} (2.04)	495.29 ^{***} (2.08)	490.22 ^{***} (2.07)
10–15 years experience	734.13 ^{***} (3.10)		864.20 ^{***} (3.22)	782.12 ^{***} (3.25)	914.18 ^{***} (3.37)	910.48 ^{***} (3.36)
15–20 years experience	1074.0 ^{***} (4.33)		1262.6 ^{***} (4.52)	1148.2 ^{***} (4.53)	1339.5 ^{***} (4.71)	1337.4 ^{***} (4.69)
>20 years experience	1499.1 ^{***} (5.69)		1741.6 ^{***} (5.92)	1594.2 ^{***} (5.92)	1840.0 ^{***} (6.15)	1815.1 ^{***} (6.14)
Left w/in 5–10 years		–99.97 ^{***} (14.37)	–426.9 ^{***} (14.19)		–407.5 ^{***} (14.29)	–385.3 ^{***} (14.15)
Left w/in 10–15 years		–157.4 ^{***} (16.71)	–974.9 ^{***} (16.97)		–772.2 ^{***} (17.93)	–745.2 ^{***} (17.76)
Left w /in 15–20 years		–211.7 ^{***} (17.60)	–1548.3 ^{***} (18.24)		–1491.4 ^{***} (19.26)	–1465.0 ^{***} (19.07)
Left after >20 years		–210.2 ^{***} (15.59)	–1747.4 ^{***} (16.47)		–1794.4 ^{***} (16.29)	–1763.7 ^{***} (16.14)
<Bachelor's				–627.4 ^{***} (19.24)	–262.6 ^{***} (20.07)	–256.7 ^{***} (19.86)
Professional Degree				–535.2 ^{***} (18.54)	–167.2 ^{***} (19.25)	–157.0 ^{***} (19.07)
Masters				71.53 ^{***} (16.22)	51.11 ^{**} (15.94)	49.00 ^{**} (15.77)
Ph.D.				331.99 ^{***} (22.01)	117.85 ^{***} (21.69)	114.17 ^{***} (21.46)
Last Year						103.24 ^{***} (2.04)
Constant	684.7 ^{***} (6.2)	922.1 ^{***} (11.22)	1519.4 ^{***} (11.20)	737.95 ^{***} (7.67)	1488.8 ^{***} (11.78)	1454.9 ^{***} (11.68)
Number of observations	311,518	311,518	311,518	290,826	290,826	290,826

Table 2: Examiner Characteristics and Days in Examination. Models report the coefficients on the listed examiner characteristics from random-effects models estimating the relation between the listed examiner characteristics and days between the application and issuance of the patent. Controls for technology, cohort, type of assignee, and presence of an assistant examiner omitted. Standard errors in parentheses. * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$.

Figure 4: Returns to Experience

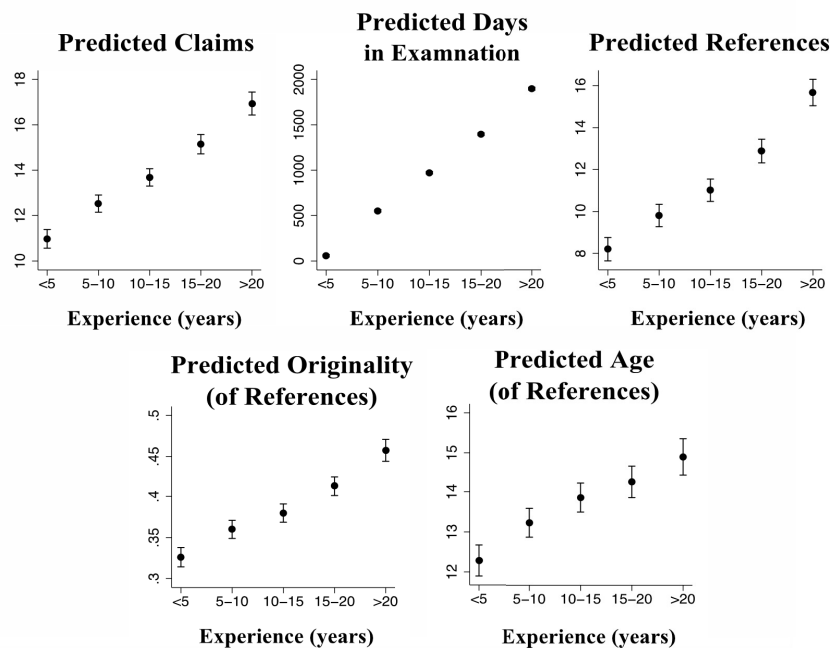


Figure 4: Returns to Experience. $N = 288,950 - 311,518$. Panels display predicted values of indicated patent attributes, with 95% confidence intervals, for the indicated years of experience of the examiner when the patent issued.

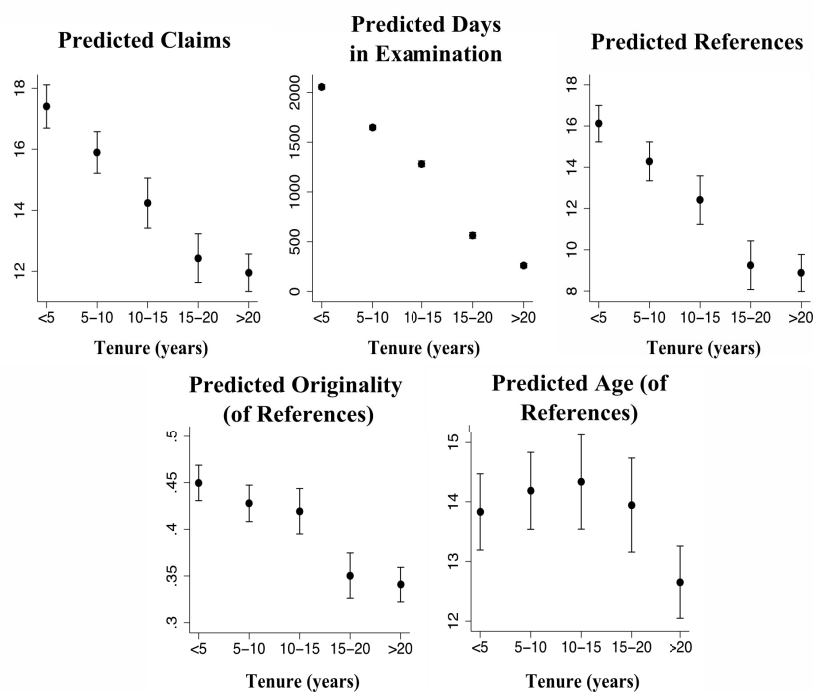
Figure 5: Returns to Tenure

Figure 5: Returns to Tenure. $N = 288,950 - 311,518$. Panels display predicted values of indicated patent attributes, with 95% confidence intervals, for the indicated years of total tenure of the examiner.

C. *The Effects of Education*

The final topic of interest is the role of education. The analysis summarized above models education as a static attribute of the examiner, fixed at the time the examiner begins work at the PTO, which is consistent with the structure of the data on education received from the PTO. Accordingly, education, like tenure, is an examiner-level variable in the regressions summarized in Tables 1 and 2. As those tables indicate, the effects of education are statistically and substantively significant. Several points are apparent.⁹⁸ Most obviously, the data (summarized in Models 4 and 5) indicate a substantial shift in the patent attributes (parallel to the

98. Although Tables 1 and 2 depict only the analysis of claims and days in examination, the relations between education and the other patent attributes (references, originality of references, and age of references) are similar.

effects of experience) as education increases. So, for example, for days in examination, the constant of about 1,500 days reflects the expectation for the omitted category—examiners with a bachelor's degree. The coefficient for examiners with less than a bachelor's degree suggests a decline of about 260 days for examiners without a bachelor's degree and about 160 days for examiners with a professional degree (presumably, mostly law degrees). Conversely, the data suggest an increase of about 50 days for examiners with a master's degree and 120 days for examiners with a Ph.D. In general, if we work here from the same premise as above (that increases in the attributes reflect a decline in the quality of output), this suggests that the least successful examiners are those with the most education. Also, interestingly, a professional degree seems to contribute positively as compared to a bachelor's degree alone, although master's and doctoral degrees do not. Although any attempted explanation is speculative, the results at least suggest that advanced degrees loosely correlate with a personality type unsuited for the routinized work of a patent examiner, and that the most common professional degree (a law degree) is a particularly useful credential.

The relations among education, tenure, and experience also are interesting. Because the effects of increasing education generally cut in the same direction as the effects of experience (and opposite to the effects of tenure), it is not surprising that the inclusion of education in Models 4 and 5 produces a lower set of coefficients on education than in Model 2 and 3 respectively (which omit education). The inclusion of education variables in Model 5 seems to support a substantial increase in the apparently positive effects of tenure (as compared to Model 3).

Accepting that understanding of improvement brings those figures directly into line with a relatively typical understanding of the employment relationship. On the one hand, the people who are more suited to the job stay longer (evidenced by a steady positive return to increasing tenure). On the other hand, at all levels, the quality of effort declines over time (a burnout effect). That effect appears to be relatively steady throughout the period of employment and across all levels of tenure.

V. Conclusion

Given the strong likelihood that assignment of patent applications to individual examiners is almost entirely random,⁹⁹ the findings summarized above suggest important differences in examiner output that rest on characteristics of the examiners themselves (as opposed to the experience that they have gained in the office), effects apparent from the earliest days

99. Lemley & Sampat, *supra* note 8, at 822.

of the individual examiner's work. That analysis thus has important implications for staffing and labor policies at the PTO. If we accept the idea that the findings related to tenure point in the direction of a positive return to tenure, then they suggest that the PTO would be better served by increasing the share of its workforce that is "careerist" in outlook. At the same time, the data do support the implication of Lemley and Sampat that increasing experience relates to a decline in the quality of output.¹⁰⁰

Responding to the problem is not simple. Reforms that encourage employees to stay in the office longer well might encourage the least capable employees not to leave. Similarly, reforms that shift the "selection" process of examiners well might increase the number of examiners who will perform poorly and well might even lead to the hiring of poor-performing long-tenure examiners. This suggests, relatively speaking, that a greater emphasis on recruiting and hiring would be more valuable than a greater emphasis on employee training and retention. So, for example, this strongly supports the ongoing initiatives undertaken in the last several years to decrease attrition by attracting employees who plan to work at the PTO for a longer share of their lifetime employment.¹⁰¹ It also suggests the benefits of a broader look at other alternatives for improving the attractiveness of the position, as emphasized by Merges.¹⁰²

In the end, given the limited understanding these data provide about precisely which features of examiners relate to the positive effects associated with tenure, it is quite difficult to be sure that any particular employment reforms would increase the share of high-quality examination. Thus, the plainest message of this work is to underscore the importance of further work that might relate individual characteristics of examiners (educational background, age, or the like) to tenure of employment at the PTO. Only with data about individual examiners can we identify directly the characteristics most likely to result in the long-term careerist behavior identified above. Still, the strength of the relationships summarized here suggests that the subject warrants further inquiry.

100. *See id.* at 826 (concluding that "senior examiners are doing less work, rather than . . . merely getting it right more often than junior examiners").

101. *See* U.S. GOV'T ACCOUNTABILITY OFFICE, GAO-05-720, INTELLECTUAL PROPERTY: USPTO HAS MADE PROGRESS IN HIRING EXAMINERS, BUT CHALLENGES TO RETENTION REMAIN 16-17 (2005), available at <http://www.gao.gov/assets/250/246777.pdf> (describing how the USPTO responded to calls "to better target candidates likely to stay" by studying the skills of experienced examiners and participating in recruiting events).

102. Merges, *supra* note 40, at 606-09.