Subordinates' Task Performance when the Supervisor Works from Home

In Gyun Baek
National University of Singapore
igbaek@nus.edu.sg

April 2022

This paper is based on the second research chapter of my dissertation at the University of Wisconsin. I sincerely appreciate the guidance and support of my dissertation committee: Ella Mae Matsumura (chair), Willie Choi, Dan Lynch, Tyler Thomas, and Zhengjun Zhang. I also thank Wei Cai, Stephen Glaeser, Taehoon Kim, Jan Lampe (discussant), Mary Lee, Jae Yong Shin, Jee-Eun Shin, Ayung Tseng (discussant), Fiona Wang, and workshop participants at Seoul National University, the University of Wisconsin, the 2021 Management Accounting Section Midyear Meeting, the 2021 American Accounting Association Annual Meeting, and the 2022 NUS/SMU/NTU Tri Uni Accounting Research Conference for helpful comments and suggestions. I thank the United States Patent and Trademark Office (USPTO) for access to the detailed personnel data on patent examiners. I have benefited from interviews and conversations with patent examiners at the USPTO. The views expressed herein are those of the author and do not reflect the views of the USPTO. All errors are my own.

Subordinates' Task Performance when the Supervisor Works from Home

ABSTRACT

Many organizations require employees to have several years of experience on the job to be eligible to work from home. A consequence of this requirement is that experienced supervisors work from home, while relatively inexperienced subordinates work at the office. I examine whether such scenarios affect subordinates' task performance. I find evidence that task performance is lower when the supervisor works from home, relative to when the supervisor works at the office. I also find the negative effect of the supervisor working from home is more pronounced for tasks that have a greater need for advising, such as those that are more complex and require greater tacit knowledge. Further, I find a slower completion of a task when the supervisor works from home, relative to when the supervisor works at the office. My study highlights the importance of in-person interactions in advising relatively inexperienced employees performing technical analysis in organizations.

Keywords: Telecommuting, Work from Home, Advising

1. INTRODUCTION

Management controls, a process by which organizations ensure that their employees carry out organizational objectives and strategies (Merchant 1985; Fisher 1998), are "critical tools for ensuring organizational performance" (Christ and Vance 2018, 20). Because management controls are a set of interrelated elements and therefore do not operate in isolation (Grabner and Moers 2013; Choi 2020), it is important to understand how management controls at one level of an organization influence employee performance at another level (Martin, Thomas, and Yatsenko 2021; Bol, Haesebrouck, and Loftus 2021). This stream of research mainly uses experimental methods and investigates whether the use of management controls at the supervisor level affects subordinates' behavior, a phenomenon that Christ and Vance (2018) label as "cascading controls." One increasingly popular management control that organizations adopt to improve employee productivity is working from home policies (WFH; also called telecommuting or telework) (Bloom, Liang, Roberts, and Ying 2015). The purpose of this study is to extend this emerging literature on cascading controls, using a field-research setting in which the organization allows the researcher to observe whether the supervisor works from home in each supervisor-subordinate dyad for each task. Specifically, I examine the effect of the supervisor working from home on the subordinate's task performance.

In recent years, WFH policies have become increasingly common. As of 2016, a third of all workers in the U.S. had the option to work from home at least part of the day, and 23% of employees worked some or most (10-99%) of their usual hours at home (Matos, Galinsky, and Bond 2016). More recently, the COVID-19 global pandemic has instigated a massive experiment in WFH around the world (Guyot and Sawhill 2020; Dreyfuss 2020; Jones, Philippon, and Venkateswaran 2021). While scholars and practitioners debate the potential benefits and costs of adopting WFH policies, we still have limited knowledge of *when* and *how* WFH impacts employee- and organization-level outcomes (Bloom et al. 2015; Gonsalves 2020).

One reason for the lack of knowledge on the effect of WFH on employee performance is the failure to consider *who* is working from home. Prior literature almost exclusively focuses on examining the effect of telecommuting on various work-related outcomes in environments where employees working on tasks are telecommuting (Osterman 1995; Rothbard, Phillips, and Dumas 2005; Gajendran and Harrison 2007; Bloom et al. 2015; Lyttelton, Zang, and Musick 2020; Gonsalves 2020). However, there has been little research examining the effect of telecommuting in environments where supervisors charged with monitoring, advising, and approving work done by their subordinates work from home while those subordinates work at the office.[1]

Examining the effects of telecommuting in such work arrangements is important because many organizations require employees to have several years of experience on the job and reach a certain rank within the organization to be eligible for working from home (Beauregard, Basile, and Canónico 2019). For example, when Facebook, Inc. announced its plan to move into remote work on May 21, 2020, the Chief Executive Officer (CEO) Mark Zuckerberg stated that "[w]e're going to focus on experienced employees rather than new college grads, who I think need to be in the office more, for training" (Newton 2020).[2] This announcement suggests Facebook, Inc. will likely be facing situations in which supervisors who work from home oversee office-working subordinates. Therefore, it is crucial for organizations to know whether task performance will differ based on whether relatively inexperienced office-working employees

[1] An exception is Lill (2020), who uses an experiment and finds greater physical monitoring distance between a supervisor and employee increases performance misreporting.
[2] Specifically, Mark Zuckerberg announced that "[i]f you're experienced, if you're at a certain level within the company, if you have good performance ratings, […] and if you get approval, then you'll be able to know now that you'll be a […] remote worker" (Newton 2020).

work with home-working supervisors. I address this gap in the literature by analyzing whether and when the supervisor working from home affects task performance.

I predict task performance is lower when the office-working subordinate works with the supervisor who works from home, relative to when they work with the office-working supervisor. Media reports indicate greater physical distance between supervisors and subordinates negatively affects task performance by reducing subordinates' learning opportunities and hindering the development of mentoring relationships (Dhaliwal 2020; Cutter 2020). One reason telecommuting hinders subordinates' learning opportunities is subordinates interact with their supervisors using electronic media that constrains the spontaneous flow of information, leading to frequent misunderstandings about their job (Golden and Fromen 2011).

I test my predictions using archival data across multiple tasks and individual employees. I use a data set containing the work of patent examiners at the United States Patent and Trademark Office (USPTO) for the period 2006 to 2016 that I obtain directly from the USPTO via Freedom of Information Act (FOIA) requests. The USPTO has provided a WFH program for patent examiners since 2006. To be eligible for working from home, patent examiners must have at least two years of experience on the job. In addition, the USPTO requires supervisors to approve the subordinates' patent decisions (e.g., whether to grant a patent) and oversee the underlying examination process. This feature allows me to analyze whether examination quality of each patent differs based on whether a supervisor works from home.

An advantage of this setting is that I can exploit the quasi-random assignment of patent applications to examiners, regardless of whether a supervisor works from home or at the office (Lemley and Sampat 2012; Sampat and Williams 2019; Farre-Mensa, Hegde, and Ljungqvist

2020; Shu, Tian, and Zhan 2021; Hegde, Ljungqvist, and Raj 2021a).[3] This setting allows me to isolate the effects of supervisors working from home from those of the underlying invention. In addition, the USPTO requires subordinates to work under different supervisors in each "Art Unit" to learn different patent examination styles.[4] Therefore, the subordinate-fixed-effects strategy allows me to compare across patents that are overseen and approved by exogenously assigned supervisors who work from home versus at the office but whose examination is completed by the *same* subordinate.

I measure subordinates' task performance using the quality of patents reviewed by subordinates, following the USPTO's mission that examiners issue high-quality patents (Department of Commerce [DOC] 2015). Specifically, I use the dollar value of a patent estimated based on the equity market response to news about patents (Kogan, Papanikolaou, Seru, and Stoffman 2017). I expect the dollar value of a patent to be lower when the *same* subordinate works with the supervisor who works from home versus at the office.[5]

Consistent with my predictions, patents examined by the office-working subordinate are of lower examination quality when the supervisor works from home, relative to when the supervisor works at the office. Specifically, the *same* subordinate grants a patent that is 5.7 percent lower in the dollar value when the supervisor works from home, relative to when the supervisor works at the office. This result is robust to the inclusion of additional controls

[3] Specifically, there are two ways the USPTO assigns patent applications to examiners. First, the USPTO assigns patent applications to examiners based on the last digit of the application serial number. Second, the USPTO gives "the oldest unassigned application to an examiner when that examiner finished examining a prior application" (Lemley and Sampat 2012, 822).

[4] An Art Unit is an examining division at the USPTO consisting of patent examiners who specialize in a particular area of technology. While the majority of Art Units include fewer than 20 examiners, some Art Units have more than 60 examiners (Kuhn and Thompson 2019). Art Units are grouped into nine "Technology Centers" based on the area of technological expertise (e.g., biotechnology, chemical engineering, information security).

[5] In Section 5.4., I also find my results are robust to using a patent's forward citation as an alternative measure of patent quality.

capturing supervisors' span of control in a given month and prior supervision experience, in addition to supervisors' and subordinates' tenure, rank, gender, and ethnicity. My results are also robust to the inclusion of firm-year fixed effects that allow me to identify whether the supervisor working from home has a significant effect on patent quality within a firm's patent portfolio in a given year. Finally, this result is robust to using entropy balancing that addresses covariate imbalance and relaxes functional form misspecification.

In cross-sectional analyses, I find the negative effects of the supervisor working from home on patent quality are more pronounced for more complex technologies.[6] I also find the negative effects of the supervisor working from home are more pronounced if an application needs greater tacit knowledge to examine. I measure the extent to which an application requires tacit knowledge for a review using the expected number of interactions between examiners and patent applicants (and their attorneys), following Cockburn et al. (2002, 8) that supervisors at the USPTO teaches their subordinates "subtle lessons about the practice of dealing with applicants and their attorneys." These results provide support for my theory that in-person interactions play a significant role in advising relatively inexperienced employees.

One way for examiners to grant higher-value patents is a speedier patent examination. Patents that are granted sooner exhibit higher value because they help innovators quickly commercialize their innovation and preempt the entry of rivals (Hegde et al. 2021a). If, as I theorize, the frequency and richness of interactions between supervisors and subordinates are lower and the use of electronic media constrains the spontaneous flow of information when supervisors are working from home, then I predict a slower completion of a review of an

[6] All inventions examined by patent examiners are assigned a particular U.S. Patent Classification (USPC) class-subclass combination that corresponds to one complexity factor that reflects the underlying level of technological complexity (deGrazia, Frumkin, and Pairolero 2018). A higher complexity factor indicates a more complex technology underlying the invention examined. For further details, please see Section 4.5.1.

application and therefore granted patents will exhibit lower value. I find evidence consistent with my prediction.

In additional analyses, I find patents examined by the home-working subordinate show similar examination quality regardless of whether the supervisor works from home versus at the office. Because subordinates must meet the USPTO's requirement that they have at least two years of experience on the job before working from home, this result lends further support for my argument that the difficulty of advising subordinates in distributed work settings, rather than physically monitoring them to ensure that they do not shirk, drives my findings. Further, to address the potential concern that low-ability supervisors choosing to work from home drives my findings, I perform an out-of-sample test to examine whether the quality of patents reviewed only by the supervisor differs between WFH and non-WFH supervisors used in my main sample. I find the quality of patents reviewed only by the primary examiner does not differ between WFH and non-WFH primary examiners, indicating low-ability supervisors choosing to work from home does not drive my findings. I also find the *same* subordinate working with the home-working supervisor spends *more* (not less) effort in examining an application relative to when working with the office-working supervisor. These results indicate patents exhibit lower quality when the supervisor works from home versus at the office, despite subordinates' greater effort in the review process. Finally, I find my results are robust to using the number of forward citations as an alternative measure of patent quality.

My results enrich the emerging literature in management accounting and control on the effects of management controls at one level of an organization on employees at a different level. A few studies in this research stream focus on an incentive contract; for instance, laboratory experiments find penalty contracts can lead to significant additional consequences for employees who are not subjected to such contracts (Christ and Vance 2018; Martin et al. 2021). Using a field experiment, Casas-Arce and Martínez-Jerez (2021) find the extent to which team members respond to their managers' explicit incentives depends on managers' leadership styles. This study, however, investigates how the supervisor's WFH, an increasingly important management control, affects the subordinate's performance. This study finds a management control system that is designed to improve employee performance at one hierarchical level of an organization can have adverse consequences at a different hierarchical level. Therefore, my results strongly echo the cautions of Christ and Vance (2018) about focusing only on the effects of management controls on the target employee subjected to the control.

My study also contributes to the WFH literature by identifying a new potential cost of WFH. To my knowledge, this study is the first to provide field data evidence demonstrating the negative effects of supervisors working from home. While the use of WFH has become an important trend in business practice, academic research addressing the effectiveness of WFH focuses on examining the effect of WFH on employee performance in environments where employees working on tasks work from home and generally finds positive effects (Bloom et al. 2015; Barrero, Bloom, and Davis 2021; Choudhury, Foroughi, and Larson 2021). By contrast, I provide new insight into the effectiveness of WFH policies by finding the negative effects on subordinates' task performance when supervisors charged with overseeing work done by their relatively inexperienced subordinates work from home.

Finally, my study has important implications for the physical distance between supervisors and subordinates that is increasing as distributed work settings become more common. The few studies examining physical distance suggest detrimental effects of physical distance between supervisors and subordinates on employee performance, but do not distinguish the environment where the supervisor working from home oversees the subordinate working at the office from the environment where the supervisor working at the office oversees the subordinate working from home (Antonakis and Atwater 2002; Lill 2020). By finding negative effects on task performance in the former while finding insignificant effects on task performance in the latter, my results contribute to prior research by providing a more nuanced view on the role of physical distance between supervisors and subordinates in affecting productivity.

2. HYPOTHESES DEVELOPMENT

With advances in mobile connection technologies and the shift from a manufacturing to a knowledge-intensive economy, organizations have increasingly implemented WFH policies over the last few decades (Allen, Golden, and Shockley 2015). In 2018, about 4 percent of employees in the U.S. worked from home more than half a week. The proportion of employees working from home rose more than ten-fold in 2020 due to the COVID-19 pandemic. Dingel and Neiman (2020) estimate about 37 percent of the workforce is working from home. Using two waves of surveys conducted in 2020, Brynjolfsson et al. (2020) find about half the workforce now work from home. As organizations now take part in an unprecedented experiment in WFH, academics and practitioners alike are eager to examine the effects of WFH on organizations.

Previous literature on WFH reports various positive outcomes when employees work from home. For example, when employees are working from home, they show higher organizational commitment and lower intent to leave the organization (Golden 2006). WFH employees also show greater job satisfaction and lower work-family conflict (Allen et al. 2015). In a firm studied by Bloom et al. (2015), call-center employees increase their productivity by 13 percent after they work from home. Using more than 20,000 survey responses, Barrero et al. (2021) find WFH employees can devote more time to their primary job, indoor leisure, and childcare by not commuting. The shift to WFH also provides organizations with other benefits, such as lower office space expenses and an access to a larger pool of job candidates (Levanon 2021).

While prior literature finds WFH is positively related to many individual- and organization-level outcomes, possible negative effects might emerge. Of great concern is whether young, inexperienced employees can receive the same level of guidance, attention, and training from their WFH supervisors. Media reports indicate WFH can have a negative impact on the development of mentoring relationships between supervisors and young employees (Davis 2020; Kelly 2021). Concerned with such drawbacks of WFH, JP Morgan Chase decided that, even during the pandemic, it would bring back at least a portion of its employees to the office. Specifically, the Chief Executive Officer (CEO) Jamie Dimon stated that young workers in their apprenticeship period were "disadvantaged by missed learning opportunities as they were not in the offices" (Dhaliwal 2020). Similarly, the CEO of Stifel Financial Corp. Ronald J. Kruszewski expresses concerns over WFH that inexperienced employees do not acquire skills necessary to perform tasks (Cutter 2020):

"Junior employees learn how to underwrite deals or develop pitch books by sitting beside more experienced colleagues and watching them work. That's hard to do remotely."

While the impact of WFH on inexperienced employees' work outcomes and career prospects seems to be of great concern to organizations, executives, and the media, however, the academic literature on WFH is relatively silent on such dimensions. An exception is Golden and Fromen (2011), who, using an online survey, document that subordinates whose managers are telecommuting produce less favorable work outcomes than those with office-working managers. Golden and Fromen (2011) explain that less desirable work outcomes of subordinates arise because the frequency and richness of interactions between supervisors and subordinates are lower in distributed work settings (Daft and Lengel 1984). In interacting with WFH supervisors, subordinates need to rely on electronic media that "can constrain the spontaneous flow of information because it contains fewer cues and contextual indicators" (Golden and Fromen 2011, 1454). While subordinates can relatively easily identify salient information and cues from their interactions with collocated supervisors, subordinates with WFH supervisors are more prone to misunderstandings and experience a greater lack of clarity in their interactions due to the decrease in the quality of information transmission (Bass 1990; Napier and Ferris 1993; Antonakis and Atwater 2002; Hinds and Bailey 2003; Hinds and Mortensen 2005).

In contrast to Golden and Fromen (2011), who find work outcomes of subordinates working with WFH supervisors are less favorable, Neufeld, Wan, and Fang (2010) conduct a survey and find physical distance between supervisors and subordinates does not influence performance and communication effectiveness among them. However, Neufeld et al. (2010, 240) suspect that these results arise because their survey respondents have an average of 12 years of tenure at their respective organizations and therefore have already absorbed "the details and nuances of an organization's culture and managerial norms over time." Such learning over time may attenuate the negative effect of physical distance on performance. Therefore, whether inexperienced workers may still be disadvantaged due to a loss of learning opportunities when working with WFH supervisors is an empirical question that warrants further investigation. Based on the above discussion, I propose the following hypothesis:

> **Hypothesis:** Task performance is lower when office-working subordinates are working with home-working supervisors than when they are working with collocated office-working supervisors.

3. RESEARCH SITE

I examine my hypotheses using data from the USPTO. At the USPTO, patent examiners review, evaluate, and decide whether to grant patents on inventions. Patent examiners can be classified into two categories: junior examiners and primary examiners (designed as subordinates and supervisors, respectively, in this study). Primary examiners have signatory authority, which allows examiners to sign their own office actions (e.g., allowances, rejections, etc.) without review by others. Junior examiners do not have signatory authority, and therefore must have their office actions reviewed and approved by primary examiners.[7] Specifically, at grade GS (General Schedule)-13, examiners are eligible to participate in the Partial Signatory Authority Program, which grants examiners signatory authority to sign their non-final rejections and other non-final communications to patent applicants.[8] [9] After patent examiners achieve GS-14 and complete an additional phase (the Full Signatory Authority Program), they become a primary examiner with full signatory authority.

Patent examiners are eligible to participate in the Patents Hoteling Program (PHP) that allows them to work from home for four days a week. The PHP began in 2006 and requires examiners to have worked at the USPTO for at least two years. Figure 1 presents the percentage of supervisory examiners working from home by year. By the end of my sample period, around 25 percent of supervisory examiners work from home.

For each patent application, a junior examiner is assigned to one primary examiner who works in the same Art Unit. In addition, there is variation in which primary examiner is assigned to each junior examiner within the Art Unit because junior examiners rotate to work under different primary examiners to learn different patent examination styles. Such rotation highlights

[7] In the rest of the paper, I use the terms "supervisor" and "primary examiner" interchangeably, and also use "subordinate" and "junior examiner" interchangeably.
[8] The General Schedule (GS) system refers to the U.S. government's classification system for organizing and defining federal positions. While the GS system includes 15 defined grade levels (from GS-1, the lowest level, to GS-15, the highest level), USPTO examiners operate at eight grade levels, namely, GS-5, 7, 9, 11, 12, 13, 14, and 15 (Frakes and Wasserman 2017). An USPTO examiner generally starts at a GS-7 or GS-9 level.
[9] However, *final* office actions by examiners with partial signatory authority must be approved and signed off by primary examiners.

the role of primary examiners in educating their junior examiners on what they think are best practices in the examination process, or the "systematic apprenticeship process within the USPTO" (Cockburn, Kortum, and Stern 2002, 8). For example, primary examiners deliver subtle and nuanced lessons about how to deal with applicants and their attorneys, and the objective and subjective criteria for the granting of patent rights that are likely to vary across technology fields (Cockburn et al. 2002; Raffiee and Teodoridis 2020). Appendix A provides an example of a patent document (Notice of Allowance) reviewed by both junior and primary examiners.

In addition to training junior examiners, primary examiners are responsible for carefully overseeing every patent examination process that their junior examiners work through, therefore ensuring the quality of issued patents. In my conversations with patent examiners, one examiner indicated that, in order to meet production goals, junior examiners need to convince their primary examiners that an application is allowable or not. If primary examiners do not agree with their junior examiners, primary examiners do not sign off on the junior examiners' work, and the work does not qualify for meeting workload goals.

Meeting production goals is important for examiners because goal attainment is a key metric for their annual performance ratings and performance bonuses (Frakes and Wasserman 2015; Tabakovic and Wollmann 2018). These production goals are designed to ensure examiners complete their assigned patent examinations in given timeframes that expire at the end of each bi-week period and account for 35 percent of their annual performance rating. An internal survey conducted by the USPTO reveals most examiners have "less time than needed to complete a thorough examination" and often work voluntary or uncompensated overtime to meet their goals (U.S. Government Accountability Office [GAO] 2016, 25).[10] Examiners must attain satisfactory

[10] The same survey also indicates 67 percent of examiners who participated in the survey identified the USPTO's production targets as a primary reason they would consider leaving the USPTO.

ratings to avoid disciplinary actions by the USPTO and to be eligible for a promotion to higher level positions. In addition, when examiners exceed their production goals by 10 percent or more, the USPTO provides an examiner with performance bonuses that can amount to about $20,000 per year.[11]

Further, the USPTO evaluates examiners based on the average number of days an examiner takes to complete an office action ("docket management"). Docket management accounts for 20 percent of examiners' annual performance rating and ensures that "office actions are completed in a timely manner" (Hegde, Ljungqvist, and Raj 2021b, 7). Examiners can earn bonuses of up to four percent of their annual base salary for meeting docket management goals.

The USPTO also evaluates examiners' examination quality based on a review of at least one office action of each examiner per quarter. While examination quality accounts for 35 percent of their annual performance rating, the USPTO does not adequately discriminate among examiners in terms of their performance ratings, partly due to its subjective evaluation criteria.[12] In addition, the USPTO provides examiners with monetary bonuses for the production and docket management goals, but not for conducting high-quality examinations, indicating a stronger focus on promoting examination throughput (Frakes and Wasserman 2017). Further, the "USPTO issues far fewer written warnings for quality compared to those issued for two other performance elements–docket management and production" (DOC 2015, 8).[13] For these reasons, the Office of Inspector General (OIG) for the Commerce Department, the USPTO's parent

[11] In 2018, an average patent examiner is paid approximately $125,000, which includes base salary and bonuses.
[12] Specifically, out of the five rating grades, more than 95 percent of examiners receive the highest or second highest performance grades for the examination quality element (DOC 2015).
[13] The USPTO issues written warnings if an examiner underperforms in a certain performance criterion. If examiners receive three written warnings in five years, they can be terminated. DOC (2015) indicates that while 264 (233) examiners out of approximately 8,000 examiners received at least one written warning for the production (docket management) performance element during the period 2011 to 2013, only 7 examiners received written warnings for low-quality examinations.

agency, indicates the "USPTO's performance appraisal plan and related policies are ineffective at measuring whether examiners are issuing high-quality patents" (DOC 2015, 3).[14]

4. HOME-WORKING SUPERVISORS AND TASK PERFORMANCE

4.1. Data

To test the effects of supervisors working from home on their (office-working) subordinates' task performance, I construct my data set using multiple sources. I start with the Public Patent Application Information Retrieval (Public PAIR), which contains detailed information on more than 11 million patent applications filed with the USPTO. Public PAIR contains data on the technology field and the Art Unit to which an application was assigned, and the names of the examiner assigned to each patent application. Public PAIR also assigns a unique identifier to each listed examiner, which allows me to analyze the decisions (e.g., allowances, rejections, etc.) made by examiners on each application. Critical for my study is information identifying the assignment of primary and junior examiners to each patent application. Because Public PAIR only allows researchers to identify who was assigned as a junior examiner, I use another data source to identify primary examiners assigned to each application.

Another primary source of patent data is PatentsView. Supported by the USPTO Office of the Chief Economist, PatentsView is a collaborative effort between the U.S. government agencies such as the USPTO and the U.S. Department of Agriculture (USDA), and universities such as New York University and the University of California, Berkeley. I use PatentsView to collect information identifying the primary examiner for each patent application. Because this data set provides readily available data on primary examiners only on granted patents, I limit my

[14] The final performance element for examiners is stakeholder engagement, which evaluates whether examiners "treat external stakeholders with courtesy and professionalism" (Hegde et al. 2021b, 7). While stakeholder engagement accounts for 10 percent of the examiners' annual performance rating, it is considered non-critical in determining examiners' rating grades.

analyses to granted patent observations and eliminate patent applications that are rejected by examiners or abandoned by applicants.[15]

Through a series of FOIA requests, I also collect a range of information on examiners, including the day in which they joined and left the USPTO, each examiner's gender and GS-level in each year, and the day in which they started to work from home.[16] I then merge these examiner-specific observations with the application-level data from Public Pair and PatentsView. Because the USPTO's telecommuting program started in 2006, I require granted patents to have their first substantive decision made by an examiner regarding the patentability of the claimed invention (i.e., the first office action on the merits, hereafter FOAM) in or after 2006. In addition, because Public PAIR provides information on patent applications through 2017 when I started my data collection, I also require granted patents to have their FOAM by 2016 because it takes approximately one year, on average, to have a patent granted from the time the application receives its FOAM.

4.2. Sample Selection

My final sample consists of 60,028 patent-level observations for which the FOAMs are completed between 2006 and 2016. Consistent with prior studies (e.g., Sampat and Williams 2019), I restrict my sample to utility patent applications and exclude plant, design, divisional, continuation, and continuation-in-part patents from the sample. In my final sample, there are

[15] In order for this sample selection criteria (limiting analyses to granted patents) to introduce bias, there would need to be systematic differences in granting versus rejecting patent applications between telecommuting and non-telecommuting primary examiners. To test this possibility, in untabulated analyses I examine primary examiners' granting propensity based on whether they were working from home as of FOAM date and do not find evidence that the likelihood of granting patent applications differs based on whether examiners were working from home (69.02%) versus at the office (68.98%) (two-tailed $p > 0.10$ for differences between two subsamples). This result lends support for the claim that my sample selection criteria is not likely to introduce bias into the empirical analyses.

[16] With regard to data on each examiner's gender, the data that the USPTO provided me through a FOIA request was incomplete. To complement this data set, I use the online service genderize.io, which provides gender probabilities to first names of examiners used in my analyses.

2,504 junior examiners and 1,338 primary examiners. On average, each junior examiner rotates to work under 2.216 primary examiners. For my research purposes, I eliminate patents reviewed by only a primary examiner so that my sample consists only of patents that are reviewed by both junior and primary examiners. In addition, I limit my analyses to patents examined by junior examiners who work at the office as of the FOAM date to eliminate the effects of subordinates working from home. Table 1 presents my sample selection process.

4.3. Research Design

To explore the relationship between whether a primary examiner works from home and task performance of office-working junior examiners, I estimate the following patent-level ordinary least squares (OLS) regression:

$$Patent\ Value_{\alpha} = \alpha + \beta_1 Primary\ WFH_{\alpha} + \gamma Fixed\ Effects_{\alpha} + \varepsilon_{\alpha}. \quad (1)$$

The dependent variable, *Patent Value*, is the natural logarithm of one plus the dollar value of a patent estimated based on the stock price response to news about patents, a measure proposed by Kogan et al. (2017).[17] I measure a junior examiner' task performance using the quality of patents following the USPTO's mission, which is to foster innovation by issuing high-quality patents (DOC 2015).[18] I do not use the examiners' internal performance ratings for examination quality for two reasons: 1) the USPTO's performance evaluation system is "ineffective at measuring whether examiners are issuing high-quality patents" (DOC 2015, 3) (see section 3), and 2) the

[17] Specifically, I use the dollar value of a patent that is deflated to 1982 (million) dollars using the consumer price index. I thank the authors of Kogan et al. (2017) for sharing their data on the dollar value of a patent. The data is available at https://github.com/KPSS2017.

[18] A potential concern with my proxy for examination quality, *Patent Value*, is that patents can be valuable because the scope of patents is overly broad, impinging on follow-on innovation (Sampat and Williams 2019). In untabulated analyses, I estimate Model (1) by replacing *Patent Value* with two measures representing patent scope (Hegde et al. 2021a; Kuhn and Thompson 2019). I do not find evidence that patent scope relates to whether a junior examiner works with a primary examiner working from home (two tailed $p > 0.10$ for all specifications), mitigating validity concerns.

USPTO does not disclose examiners' internal performance ratings.[19] I include the subscript α to index the individual applications. Panels B and C of Table 2 present the summary statistics of *Patent Value* by the FOAM year and technology, respectively.

The explanatory variable of interest is *Primary* WFH_{α}, which indicates whether a patent was approved by a primary examiner who worked from home when the FOAM was completed. I expect a negative coefficient on *Primary* WFH_{α}, indicating patents reviewed by junior examiners who work at the office and primary examiners who work from home are of lower quality than patents reviewed by office-working junior examiners and office-working primary examiners. Table 2, Panel A indicates the average value of *Primary WFH* is 0.115, indicating 11.5 percent of applications were reviewed by a primary examiner who works from home when the FOAM was completed.

I include junior examiner fixed effects and Art Unit fixed effects to account for variation in the examination quality by each examiner and Art Unit, respectively.[20] I also include a junior examiner's GS-Level fixed effects to account for concerns that examination time constraints that differ based on the GS levels affect the examination quality. I also control for a junior examiner's tenure fixed effects, with tenure defined as the number of years each examiner has worked as of the FOAM year, to control for variation in the examination quality by experience level. I cluster standard errors at the primary examiner level to correct for autocorrelation within given examiners across applications. Finally, I include technology-subclass-by-filing-year fixed effects based on the United States Patent Classification (USPC) system to account for concerns that time-varying technology-specific characteristics might affect the quality of patents. The

---

[19] Specifically, the USPTO declines my FOIA request for examiners' internal performance ratings due to privacy concerns.

[20] I do not include Art Unit fixed effects when I include junior examiner fixed effects because the effect of Art Unit fixed effects is subsumed by the junior examiner fixed effects.

inclusion of technology-subclass-by-filing-year fixed effects also helps "address the concern that the assumption of quasi-random assignment may not be met" (Hegde et al. 2021a, 20).[21]

4.4. Empirical Results

4.4.1. Main Results

The regression results reported in Table 3 provide support for my hypothesis, which predicts task performance is lower when the supervisor works from home versus at the office. Columns (1) through (4) of Table 4 present results for testing the association between *Patent Value* and *Primary WFH*. The main difference across the models in Columns (1) through (4) is the use of alternative estimation techniques. The estimated coefficient on *Primary WFH* is negative and statistically significant in all specifications (two-tailed $p < 0.05$ for Columns (1) through (3) and two-tailed $p < 0.01$ for Column (4)), supporting my hypothesis that a patent exhibits lower quality when a primary examiner works from home on the FOAM date, relative to when a primary examiner works at the office. Specifically, in Column (4) the estimated coefficient on *Primary WFH* is −0.059, suggesting the *same* junior examiner grants a patent that is 5.7 percent ($= (e^{-0.059} - 1) \times 100$) lower in the dollar value when the primary examiner works from home versus at the office.

4.4.2. Robustness Tests

4.4.2.1. Inclusion of Control Variables

In this subsection, I examine whether my results are robust to the inclusion of control variables capturing individual characteristics of primary and junior examiners. Specifically, I include the natural logarithm of the number of junior examiners that each primary examiner

---

[21] Specifically, Righi and Simcoe (2019) raise the possibility that the USPTO's random matching assumption does not hold and provide evidence of technological specialization of patent examiners. To address this potential concern, Hegde et al. (2021a) suggest that a study relying on the assumption of quasi-random assignment use finely-grained subclass-by-year fixed effects because examiner specialization is less pronounced at the subclass level.

supervises in the FOAM month (*Primary Span of Control*$_{\alpha}$) to account for supervision constraints that differ based on each primary examiner's span of control. I also include the natural logarithm of the number of prior patents on which each primary examiner supervised a junior examiner before the FOAM date of an application α (*Primary Prior Patents*$_{\alpha}$) to account for variation in task performance by supervision experience level. To account for different examination styles across genders, I include indicator variables equal to one if a primary examiner is female (*Primary Female*$_{\alpha}$) and a junior examiner is female (*Junior Female*$_{\alpha}$), respectively, as control variables. I also include indicator variables equal to one if a primary examiner is ethnic minority (*Primary Minority*$_{\alpha}$) and a junior examiner is ethnic minority (*Junior Minority*$_{\alpha}$) to account for different work styles across ethnicity.[22] *Primary Grade*$_{\alpha}$ (*Junior Grade*$_{\alpha}$) represents an ordinal variable classifying a primary (junior) examiner's GS-level ranging from one to 15 as of the FOAM year. I include these variables to account for examination time constraints and workplace responsibilities that differ based on the GS levels. In addition, I include the number of years each primary (*Primary Tenure*$_{\alpha}$) and junior examiner (*Junior Tenure*$_{\alpha}$) has worked for the USPTO as of the FOAM year to control for variation in task performance by experience level. Finally, I follow Shu et al. (2021) and include the natural logarithm of the number of patents that each junior examiner reviews in the FOAM year (*Junior Busyness*) to account for variation in task performance by time constraints faced by examiners.

Table 2, Panel A presents the summary statistics for these measures. The mean of *Primary Span of Control* is 9.05 (before taking the log), suggesting an average primary examiner

[22] To identify whether an examiner is ethnic minority, I follow prior literature (Jung, Kumar, Lim, and Yoo 2019; Merkley, Michaely, and Pacelli 2020; Flam, Green, Lee, and Sharp 2020) and classify examiners of Latin America, Southern America, Confucian Asia, Middle East, and Sub-Saharan Africa descent as ethnic minority and those of Anglo, Nordic Europe, Latin America, Eastern Europe, Latin Europe, and Germanic Europe descent as ethnic nonminority based on an examiner's surname.

supervises nine junior examiners each month. The mean of *Primary Prior Patents* is 88.57 (before taking the log), indicating an average primary examiner supervised approximately 89 patents before a primary examiner supervises a focal patent application. The mean of *Primary Female* (*Junior Female*) is 0.12 (0.25), suggesting female examiners account for 12 percent (25 percent) of primary examiners (junior examiners) used in my analyses. The mean of *Primary Minority* (*Junior Minority*) is 0.23 (0.30), suggesting ethnic minority examiners account for 23 percent (30 percent) of primary examiners (junior examiners) used in my analyses. The mean of *Primary Tenure* is 15.42, suggesting an average primary examiner has job tenure of around 15 years at the USPTO. The mean of *Junior Tenure* is 2.69, indicating an average junior examiner has job tenure of less than three years at the USPTO. Finally, the mean of *Junior Busyness* is 34.99 (before taking the log), suggesting an average junior examiner reviews approximately 35 patents a year.

In Table 4, Panel A, I present the results of Model (1) after including the control variables mentioned above.[23] Panel A of Table 4 follows the same structure as Table 3. In all models, the coefficient on *Primary WFH* is negative and statistically significant (two-tailed $p < 0.05$ for Columns (1) and (2) and two-tailed $p < 0.01$ for Columns (3) and (4). In addition, the coefficient on *Junior Busyness* is negative and statistically significant (two-tailed $p < 0.05$ for Columns (1), (3), and (4), and two-tailed $p < 0.10$ for Column (2)), confirming prior research that finds patents granted by busy examiners exhibit lower quality (Shu et al. 2021). Taken together, these results indicate my results presented in Table 3 are robust to the inclusion of control variables capturing individual characteristics of primary and junior examiners.

4.4.2.2. Inclusion of Firm-Fixed Effects

[23] When I include junior examiner fixed effects, I do not include *Junior Female* and *Junior Minority* in the regression because these variables are also subsumed by junior examiner fixed effects.

While I follow prior literature (Hegde et al. 2021a) and include finely-grained technology-subclass-by-year fixed effects in Model (1), I also test whether my results are robust to controlling for time-varying firm-specific characteristics. Specifically, I additionally include firm-by-filing-year fixed effects in Model (1), allowing me to control for any firm-year specific effects (Islam and Zein 2020; Shu et al. 2021). The results presented in Panel B of Table 4 indicate patent-filing firms' time-varying characteristics do not impact the inferences of my main findings (two-tailed $p < 0.01$ for Columns (1) and (3) and two-tailed $p < 0.05$ for Columns (2) and (4)).

4.4.2.3. Entropy Balancing

While I exploit plausibly random variation in the assignment of patent examiners to applications, I also use entropy balancing to increase the similarity of a patent on which a primary examiner who works from home supervises a junior examiner and a patent on which a primary examiner who works at the office supervises a junior examiner. Entropy balancing allows researchers to weight control sample to achieve covariate balance and adjusts for random and systematic inequalities in the variable distributions between the treatment (i.e., *Primary WFH*=1) and control groups (i.e., *Primary WFH*=0). I follow the method described by Hainmueller (2012) and match the first and second moments of treatment and control groups on all covariates described in section 4.4.2.1.: *Primary Span of Control*, *Primary Prior Patents*, *Primary Female*, *Primary Minority*, *Primary Tenure*, *Primary Grade*, *Junior Busyness*, *Junior Tenure, Junior Grade, Junior Female*, and *Junior Minority*. Table 4, Panel C reports the results from estimating Model (1) using entropy balancing weights. Across all specifications, I continue to find negative and statistically significant coefficients on *Primary WFH* (two-tailed $p < 0.01$ for Columns (1) through (4)), suggesting my results are not driven by differences in observable characteristics of primary and junior examiners between treatment and control groups.

4.5. Cross-Sectional Tests

4.5.1. Moderating Effects of Technological Complexity

I predict supervisors working from home leads to worse task performance by inhibiting in-person interactions that play an important role in advising relatively inexperienced employees. To provide support for this argument, I test whether the negative effect of a primary examiner working from home on office-working junior examiners' task performance is more pronounced for junior examiners examining more complex technologies, as the need for advising is greater for these applications.

To capture technological complexity of a patent, I use the expected number of hours allocated to review one patent application (expectancy). The USPTO determines the expectancy of a patent application based on the belief that a patent examiner in a more complex technology field will need more time to review an application. For example, a GS-12 examiner is expected to review a patent in the "fishing lures" technology field in 16.6 hours and the same-rank examiner is expected to review a patent in the "satellite communication" technology field in 27.7 hours. I received the data set on the expectancy of each technology field pursuant to a FOIA request. I construct a measure of technological complexity, *Complex Tech*, three alternative ways: an indicator variable equal to one if a patent is assigned 1) the highest expectancy of 31.6 hours for a GS-12 examiner, and zero otherwise, 2) the above-quartile expectancy (28.9 hours) for a GS-12 examiner, and zero otherwise, and 3) the above-tercile expectancy (28.2 hours) for a GS-12 examiner, and zero otherwise. Table 5, Panel A presents examples of technology fields corresponding to expectancy. Table 5, Panel B reports the summary statistics of expectancy in my sample. I define all variables in Appendix B.

To test the prediction that the decrease in patent value is more pronounced for more complex technologies, I estimate the following OLS model:

$$\begin{aligned} Patent\ Value_{\alpha} &= \alpha + \beta_1 Primary\ WFH_{\alpha} \times Complex\ Tech_{\alpha} + \beta_2 Primary\ WFH_{\alpha} \\ &+ \beta_3 Complex\ Tech_{\alpha} + \gamma Fixed\ Effects_{\alpha} + \varepsilon_{\alpha}. \end{aligned} \tag{2}$$

All variables in Model (2) are defined above. I expect having a primary examiner work from home is associated with a greater decrease in the patent quality (i.e., lower task performance) for examiners reviewing more complex technologies than for those reviewing less complex technologies. Therefore, I predict the coefficient on the interaction term of *Primary WFH* and *Complex Tech* to be negative.

Table 5, Panel C reports the results of estimating Model (2). The results in Columns (1) through (6) suggest the negative effect of the supervisor working from home on task performance is more pronounced for patents that involve more complex technologies, as indicated by statistically significant coefficients on the interaction of *Primary WFH* and *Complex Tech* (two-tailed $p < 0.05$ for all specifications). These results suggest the effects of the supervisor working from home on task performance are more pronounced for more complex tasks, providing support for my theory that in-person interactions play a significant role in advising relatively inexperienced employees performing technical analysis in organizations.

4.5.2. Moderating Effects of the Degree to which Tacit Knowledge is Required

Next, I examine whether the degree to which tacit knowledge is required moderates the effect of a primary examiner working from home on office-working junior examiners' task performance. If the difficulty of advising junior examiners drives my results, I expect the negative effect of a primary examiner working from home to be more pronounced if a task needs greater tacit knowledge to complete. To construct a measure capturing the degree to which tacit knowledge is required, I use insights from Cockburn et al. (2002, 8) that a "primary examiner focuses on teaching more subtle lessons about the practice of dealing with applicants and their attorneys" to a junior examiner. Indeed, my conversation with a patent examiner indicated reaching an agreement with patent attorneys is often the most challenging task of an examiner. Drawing from these insights, I expect that an examiner will need greater tacit knowledge to review an application that requires greater interactions with applicants and their attorneys.

An examiner interacts with applicants and their attorneys more if an applicant chooses to start the examination process over by filing requests for continued examination (RCEs). RCEs provides "the applicant who has been denied the coverage she seeks with an additional chance for her patent application to be allowed" (Frakes and Wasserman 2015, 625). Even when an applicant files RCEs, the same examiner has, in most cases, the continuing responsibility for examination that involves an interaction between the examiner and attorneys (Choudhury et al. 2021). Therefore, I define *High RCE* as an indicator variable that equals one if a Technology Center that an examiner belongs to has an above-median propensity of RCEs, and zero otherwise, following Frakes and Wasserman (2015) who find the propensity of RCEs varies substantially across technological fields.

Table 6, Panel A presents the average value of *RCE* (an indicator variable equal to one if an applicant files an RCE on an application, and zero otherwise) across eight Technology Centers.[24] Overall, an applicant files at least one RCE on 42.6 percent of patents in my analyses. *High RCE* is equal to one for Technology Centers with an above-median RCE propensity (i.e., computer networks, software, communications, and chemical engineering), and zero for

[24] While there are nine Technology Centers at the USPTO, I exclude a Technology Center that provides examination for design applications (Technology Center 2900) because the USPTO uses fundamentally different examination guidelines in reviewing design applications, such as aesthetic appeals.

Technology Centers with a below-median RCE propensity (i.e., mechanical engineering, transportation, semiconductors, and biotechnology).

To provide descriptive evidence that *High RCE* captures the degree to which tacit knowledge is required, I examine whether characteristics of the application differ across high- versus low-RCE Technology Centers. I find that while the average number of words in patent claims (*# Words in Claims*) and the average number of patent claims (*# Claims*) are greater in *High RCE* Technology Centers, the average number of figures in an application (*# Figures*) is lower in *High RCE* Technology Centers (presented in Panel B of Table 6). These results provide descriptive evidence that applications examined in *High RCE* Technology Centers require greater tacit knowledge for a review, consistent with prior literature that non-textual materials, such as pictures, graphs, and tables, better "enhances the ability of the reader to understand the intended message" than textual materials (Loughran and Mcdonald 2016, 1193).[25]

To test the prediction that the decrease in patent value is more pronounced in *High RCE* technological centers, I estimate the following OLS model:

$$
\begin{aligned}
Patent\ Value_{\alpha} &= \alpha + \beta_1 Primary\ WFH_{\alpha} \times High\ RCE_{\alpha} + \beta_2 Primary\ WFH_{\alpha} + \beta_3 High\ RCE_{\alpha} \\
&\quad + \gamma Fixed\ Effects_{\alpha} + \varepsilon_{\alpha}. \qquad (3)
\end{aligned}
$$

All variables in Model (3) are defined above. I expect having a primary examiner work from home is associated with a greater decrease in the patent quality (i.e., lower task performance) in *High RCE* technological centers. Therefore, I predict the coefficient on the interaction term of *Primary WFH* and *High RCE* to be negative.

Table 6, Panel C reports the results of estimating Model (3). The results in Columns (1)

[25] Relatedly, recent work in the disclosure literature finds evidence that users' ability to understand disclosures increases with the use of information in graphical form (Christensen, Fronk, Lee, and Nelson 2021; Nekrasov, Teoh, and Wu 2021).

through (4) suggest the negative effect of a primary examiner working from home is more pronounced for patents requiring greater tacit knowledge for a review (i.e., *High RCE*=1), as indicated by statistically significant coefficients on the interaction of *Primary WFH* and *High RCE* (two-tailed $p < 0.05$ for all specifications). Taken together, these results suggest the negative effects of the supervisor working from home on task performance are more pronounced for tasks requiring greater tacit knowledge, providing further support for my claim that telecommuting by a supervisor inhibits in-person interactions that play an important role in advising relatively inexperienced employees.

4.6. Review Speed

The results discussed so far suggest that the quality of patents is lower when office-working subordinates are working with home-working supervisors than when they are working with collocated office-working supervisors. One way for an examiner to grant higher-value patents is a timelier patent examination. Prior literature on innovation finds patents that are granted sooner are of higher value because they enable innovators "to more quickly commercialize their invention, while preempting the entry of rivals, and thus to enjoy higher growth" (Hegde et al. 2021a, 3). If, as I theorize, the frequency and richness of interactions between supervisors and subordinates are lower and the use of electronic media constrains the spontaneous flow of information when supervisors are working from home, then I predict the speed at which an examiner reviews a patent application will be lower and therefore granted patents will be of lower value.

To examine whether working with home-working supervisors relates to the examiner's review speed, I estimate the following OLS model:

$$Log(1 + Days\ to\ FOAM_{\alpha}) = \alpha + \beta_1 Primary\ WFH_{\alpha} + \gamma Fixed\ Effects_{\alpha} + \varepsilon_{\alpha}. \quad (4)$$

The dependent variable is the natural logarithm of one plus *Days to FOAM*, defined as the number of days from the application filing date to the FOAM date.[26] I expect *Days to FOAM* to be greater (i.e., less timelier examination) when a primary examiner works from home versus at the office. Therefore, I predict the coefficient on *Primary WFH* to be positive.

Table 7 reports the results of estimating Model (4). I find a significant increase in examination time when a primary examiner works from home versus at the office (two-tailed $p < 0.01$ for all specifications). Specifically, the results suggest the *same* junior examiner grants a patent 3.4 percent to 13.8 percent more slowly when the primary examiner works from home versus at the office. These results provide descriptive evidence that the lack of in-person interactions can hinder advising relatively inexperienced employees, leading to slower completion of work.

5. ADDITIONAL ANALYSES

5.1. Physical Distance between Supervisors and Subordinates

The results presented in prior sections suggest a negative effect of the supervisor working from home on task performance, and highlights the importance of in-person interactions in advising relatively inexperienced employees in organizations. An alternative explanation for my results is that supervisors find it difficult to monitor subordinates who are physically distanced, regardless of the work arrangement ("lack of monitoring"). For example, subordinates who are physically present at the workplace but physically distant from the supervisor may more easily shirk than if they are in close proximity to the supervisor (Lill 2020). This shirking concern remains, or is even exacerbated, if subordinates working from home are monitored by supervisors who work at the office because subordinates are then away from not only the direct

[26] I follow Hegde et al. (2021a) and measure the examiner's review speed as the application filing date to the FOAM date (not grant date). This is because "subsequent delays are inherently endogenous, as applicants' actions in response to the first-action letter affect the remaining timing of the patent evaluation process" (Hegde et al. 2021a, 9).

oversight of their supervisors, but also the indirect influence of their peers (Lautsch, Kossek, and Eaton 2009; Bloom et al. 2015; Groen, van Triest, Coers, and Wtenweerde 2018). Therefore, this alternative explanation suggests lack of monitoring is the mechanism underlying my results, and further suggests I will also observe negative effects on task performance when supervisors work at the office and subordinates work from home. However, if advising plays a more important role in explaining the unfavorable effects on task performance, as I hypothesize, then I will not likely observe the negative effects on task performance when supervisors work at the office and subordinates work from home. This is because subordinates who qualify for working from home must meet the organization's requirements that they have several years of experience on the job, suggesting a lower need for advising in performing technical analysis.

To test which of the potential mechanisms drive my results, I compare task performance when both primary and junior examiners work at the office to when primary examiners work at the office and junior examiners work from home. If lack of monitoring drives my findings, then task performance in the latter case is likely to be lower than in the former case. I limit my analyses to patents reviewed by primary examiners who work at the office as of the FOAM date but do not impose such restrictions on junior examiners to allow for variation in where junior examiners work.

Panel A of Table 8 presents the summary statistics of *Junior WFH*, which is equal to one if a junior examiner works from home as of the FOAM date, and zero otherwise. The mean of *Junior WFH* is 0.155, indicating that, when the primary examiner works at the office, 15.5 percent of applications were reviewed by the home-working junior examiner.

Panel B of Table 8 reports the results for testing the association between patent value and *Junior WFH*. The estimated coefficient on *Junior WFH* is not statistically significant in all specifications (one-tailed $p > 0.10$), suggesting the negative effects on task performance are nonexistent when the supervisor works at the office while the subordinate works from home. In particular, the coefficients on *Junior WFH* are not statistically significant in specifications including primary examiner fixed effects (Columns (3) and (4)), indicating there is no distinguishable difference between the office-working junior examiner's task performance and the home-working junior examiner's task performance, when both junior examiners are reviewed by the *same* office-working primary examiner. These results suggest my findings are not explained by the mere physical distance between supervisors and subordinates, and lends further support for my argument that the difficulty of advising subordinates in distributed work settings, rather than physically monitoring them to ensure that they do not shirk, drives my findings.

5.2. Supervisors' Endogenous Decision to Work from Home

While I leverage the quasi-random assignment of applications to examiners to draw inferences about the effect of the supervisor working from home, one potential concern about my results is that low-ability supervisors choose to work from home. While the inclusion of various control variables capturing examiners' individual characteristics and the use of entropy balancing that adjusts for random and systematic inequalities in the variables distributions between the treatment and control groups should alleviate this concern to some extent, I nonetheless conduct an additional test described below.

To mitigate the concern that low-ability supervisors choosing to work from home drives my results, I examine whether the quality of patents reviewed only by the primary examiner differs between WFH and non-WFH primary examiners using an out-of-sample test. I limit my analyses to patents reviewed only by a primary examiner in my main sample, resulting in 177,082 patents. Out of these 177,082 patents, I identify 63,655 patents as reviewed by primary examiners working from home, suggesting 36.0% (=63,655 / 177,082) is reviewed by primary examiners working from home (untabulated). Using this sample, I test the association between patent value and *Primary WFH* and document the results in Table 9. The estimated coefficient on *Primary WFH* is not statistically significant in all specifications (one-tailed $p > 0.10$), suggesting the quality of patents reviewed only by the primary examiner does not differ between WFH and non-WFH primary examiners. This result alleviates the concern that low-ability supervisors choosing to work from home drives my findings. However, I acknowledge that I cannot rule out the possibility that a primary examiner's endogenous decision to work from home influences subordinates' task performance as I am not able to use an exogenous variation in a primary examiner's decision to work from home.

5.3. Examiner Effort

To further rule out an alternative explanation that subordinates spending less effort is the mechanism underlying my results, I investigate the relation between *Primary WFH* and the number of examiner-added citations. In assessing the patentability of an application, an examiner extensively searches for previous patents, patent applications, or other publications ("prior art") to delicately compare the claimed invention with prior art (Frakes and Wasserman 2017). I exploit this institutional feature and construct a measure of examiner effort as the total number of examiner-added citations used in office actions for a given patent application (*Examiner Backward Citation*). Shu et al. (2021) also use this measure as a proxy for examiner effort and find a significant reduction in the number of backward citations when busier examiners review an application.[27] Panel A of Table 10 shows an average application contains 3.58 examiner-added citations.

---

[27] Specifically, Shu et al. (2021) use the number of both examiner- and applicant-added citations as a proxy for examiner effort. However, I use the number of examiner-added citations only because the number of applicant-

Panel B of Table 10 reports the results for testing the association between the natural logarithm of one plus *Examiner Backward Citation* and *Primary WFH*. The estimated coefficient on *Primary WFH* is positive and statistically significant in all specifications (two-tailed $p < 0.05$), suggesting a significant increase in the number of examiner-added citations when a primary examiner works from home versus at the office. Taken together, these results indicate that despite junior examiners' greater effort in the review process, patents exhibit lower examination quality when the supervisor works from home, relative to when the supervisor works at the office. These results again provide further evidence that subordinates spending less effort does not drive my findings.

5.4. Alternative Measure

Besides a measure of patent quality proposed by Kogan et al. (2017), I follow the extant literature and use the number of forward citations received by a focal patent (*Forward Citations*) as an alternative measure that captures patent quality (Islam and Zein 2020; Shu et al. 2021; Li, Ma, and Shevlin 2021). I expect *Forward Citations* to be lower when the primary examiner works from home, relative to when the primary examiner works at the office.

The results presented in Table 11 suggest my findings are robust to the use of an alternative patent quality measure. Table 11 reports results of estimating Model (1) by replacing *Patent Quality* with the natural logarithm of one plus *Forward Citations*. In seven out of eight specifications I find *Primary WFH* is negatively associated with the number of forward citations (two-tailed $p < 0.05$ for all specifications except Column (4)), suggesting a patent receives fewer forward citations when it was approved by a primary examiner who worked from home on the

---

added citations does not necessarily reflect the extent to which an examiner spends effort on an application. In untabulated analyses I also use the number of both examiner- and applicant-added citations and find similar results (two-tailed $p < 0.05$ in all specifications).

FOAM date. Taken together, these results are consistent with a primary examiner working from home having a negative effect on patent quality, lending further support for my findings that task performance is lower when the supervisor works from home, relative to when the supervisor works at the office.

6. CONCLUSION

I study the effects of the supervisor working from home on the performance of subordinates working at the office. I find subordinates whose supervisors work from home approve patents that are lower in the dollar value relative to when the supervisor works at the office. I also find the unfavorable effects of the supervisor working from home are more pronounced for patents that are more technologically complex and require greater tacit knowledge for a review. Further, my findings suggest there is no distinguishable difference between the office-working subordinate's task performance and the home-working subordinate's task performance when both of the subordinates are all reviewed by the *same* office-working supervisor. These results suggest the difficulty of advising subordinates in distributed work settings, rather than physically monitoring them to ensure that they do not shirk, drives my findings. In addition, I find examiners spend more (not *less*) effort when the supervisor works from home versus at the office, suggesting subordinates spending less effort does not drive my findings.

These results contribute to a better understanding of current business practices. For example, the academic and practitioner literature often tout the benefits of companies encouraging their employees to work from home, suggesting employers' skepticism that employees would shirk at home is unwarranted (Bloom et al. 2015; Guyot and Sawhill 2020). While this study also complements the results in prior literature in that the difficulty of physically monitoring employees to ensure that they do not shirk does not drive my findings, I highlight an aspect of when and how we may observe detrimental effects of WFH policies that are overlooked in previous studies: the lack of in-person interactions can hinder advising relatively inexperienced employees in organizations.

REFERENCES

Allen, T. D., T. D. Golden, and K. M. Shockley. 2015. How effective is telecommuting? Assessing the status of our scientific findings. *Psychological Science* 16 (2): 40−68.

Antonakis, J., and L. Atwater. 2002. Leader distance: A review and a proposed theory. *The Leadership Quarterly* 13 (6): 673−704.

Barrero, J. M., N. Bloom, and S. J. Davis. 2021. *Why working from home will stick.* Working paper, Instituto Tecnológico Autónomo de México, Stanford University, and University of Chicago.

Bass, B. M. 1990. *Bass and Stogdill's handbook of leadership* (3rd ed.). New York, NY: Free Press.

Beauregard, T. A., K. A. Basile, and E. Canónico. 2019. Telework: outcomes and facilitators for employees. In *The Cambridge Handbook of Technology and Employee Behavior*, edited by R. N. Landers, 511-543. Cambridge, U.K.: Cambridge University Press.

Bloom, N., J. Liang, J. Roberts, and Z. J. Ying. 2015. Does working from home work? Evidence from a Chinese experiment. *The Quarterly Journal of Economics* 130 (1): 165−218.

Bol, J., K. Haesebrouck, and S. Loftus. 2021. *The ripple effect: The contagion impact of managers' perceptions of organizational trust on their subordinates.* Working paper, Tulane university and Maastricht University.

Brynjolfsson, E., J. J. Horton, A. Ozimek, D. Rock, G. Sharma, and H. Y. T. Ye. 2020. *COVID-19 and remote work: An early look at US data*. Working paper, Massachusetts Institute of Technology.

Casas-Arce, P., and F. A. Martínez-Jerez. 2021. Leader effects in competition among teams: Evidence from a field intervention. *The Accounting Review* (forthcoming).

Choi, J. 2020. Studying "and": A perspective on studying the interdependence between management control practices. *Accounting, Organizations and Society* 86: 101188.

Choudhury, P., C. Foroughi, and B. Larson. 2021. Work from anywhere: The productivity effects of geographic flexibility. *Strategic Management Journal* 42 (4): 655−683.

Christ, M. H., and T. W. Vance. 2018. Cascading controls: The effects of managers' incentives on subordinate effort to help or harm. *Accounting, Organizations and Society* 65: 20−32.

Christensen, T. E., K. E. Fronk, J. A. Lee, and K. K. Nelson. 2021. Data visualization in 10-K filings. Working paper, Uniersity of Georgia, Brigham Young University, and Texas Christian University.

Cockburn, I. M., S. Kortum, and S. Stern. 2002. *Are all patent examiners equal? The impact of examiner characteristics on patent statistics and litigation outcomes.* Working paper, Boston University, University of Minnesota, and Northwestern University.

Cutter, C. 2020. Companies start to think remote work isn't so great after all. *wsj.com* (July 24).

Daft, R. L., and R. H. Lengel. 1984. Information richness: A new approach to managerial behavior and organizational design. In *Research in Organizational Behavior*, edited by B. M. Staw and L. L. Cummings, Vol. 6, 191−233. Greenwich, CT: JAI Press.

Davis, M. F. 2020. At JP Morgan, productivity falls for staff working at home. *Bloomberg.com* (September 14).

deGrazia, C., J. P. Frumkin, and N. A. Pairolero. 2018. *Embracing technological similarity for the measurement of complexity and patent thickets.* Working paper, U.S. Patent and Trademark Office.

Dhaliwal, S. 2020. What JP Morgan has to say about young employees working from home.

yahoo.com (September 15).
Dingel, J. I., and B. Neiman. 2020. How many jobs can be done at home? *Journal of Public Economics* 189: 104235.
Dreyfuss, J. 2020. Here's how employees are using tech tools to keep a close watch on their remote workers. *cnbc.com* (June 24).
Farre-Mensa, J., D. Hedge, and A. Ljungqvist. 2020. What is a patent worth? Evidence from the U.S. Patent "Lottery". *Journal of Finance* 75 (2): 639−682.
Fisher, J. G. 1998. Contingency theory, management control systems and firm outcomes: Past results and future directions. *Behavioral Research in Accounting* 10 (supplement): 47−64.
Flam, R. W., J. Green, J. A. Lee, and N. Y. Sharp. 2020. *A level playing field? Empirical evidence that ethnic minority analysts face unequal access to corporate managers*. Working paper, Texas A&M University and Brigham Young University.
Frakes, M. D., and M. F. Wasserman. 2015. Does the U.S. Patent and Trademark Office grant too many bad patents?: Evidence from a quasi-experiment. *Stanford Law Review* 67: 613−676.
Frakes, M. D., and M. F. Wasserman. 2017. Is the time allocated to review patent applications inducing examiners to grant invalid patents? Evidence from microlevel application data. *Review of Economics and Statistics* 99 (3): 550−563.
Gajendran, R. S., and D. A. Harrison. 2007. The good, the bad, and the unknown about telecommuting: Meta-analysis of psychological mediators and individual consequences. *Journal of Applied Psychology* 92 (6): 1524−1541.
Golden, T. D. 2006. Avoiding depletion in virtual work: Telework and the intervening impact of work exhaustion on commitment and turnover intentions. *Journal of Vocational Behavior* 69 (1): 176−187.
Golden, T. D., and A. Fromen. 2011. Does it matter where your manager works? Comparing managerial work mode (traditional, telework, virtual) across subordinate work experiences and outcomes. *Human Relations* 64 (11): 1451−1475.
Gonsalves, L. 2020. From face time to flex time: The role of physical space in worker temporal flexibility. *Administrative Science Quarterly* 65 (4): 1058−1091.
Grabner, I., and F. Moers. 2013. Management control as a system or a package? Conceptual and empirical issues. *Accounting, Organizations and Society* 38 (6-7): 407−419.
Groen, B. A. C., S. P. van Triest, M. Coers, and N. Wtenweerde. 2018. Managing flexible work arrangements: Teleworking and output controls. *European Management Journal* 36 (6): 727−735.
Guyot, K., and I. V. Sawhill. 2020. Telecommuting will likely continue long after the pandemic. *Brookings.edu* (April 6).
Hainmueller, J. 2012. Entropy balancing for causal effects: A multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis* 20 (1): 25−46.
Hegde, D., A. Ljungqvist, and M. Raj. 2021a. Quick or broad patents? Evidence from U.S. startups. *Review of Financial Studies* (forthcoming).
Hegde, D., A. Ljungqvist, and M. Raj. 2021b. *Race, glass ceilings, and lower pay for equal work.* Working paper, New York University and Stockholm School of Economics.
Hinds, P. J., and D. E. Bailey. 2003. Out of sight, out of synch: Understanding conflict in distributed teams. *Organization Science* 14 (6): 615−632.

Hinds, P. J., and M. Mortensen. 2005. Understanding conflict in geographically distributed teams: The moderating effects of shared identity, shared context, and spontaneous communication. *Organization Science* 16 (3): 290−307.

Islam, E., and J. Zein. 2020. Inventor CEOs. *Journal of Financial Economics* 135 (2): 505−527.

Jones, C., T. Philippon, and V. Venkateswaran. 2021. Optimal mitigation policies in a pandemic: Social distancing and working from home. *Review of Financial Studies* 34 (11): 5188−5223.

Jung, J. H., A. Kumar, S. S. Lim, and C.-Y. Yoo. 2019. An analyst by any other surname: Surname favorability and market reaction to analyst forecasts. *Journal of Accounting and Economics* 67 (2-3): 306−335.

Kelly, J. 2021. How CEOs and workers feel about working remotely or returning to the office. *Forbes.com* (March 19).

Kogan, L., D. Papanikolaou, A. Seru, and N. Stoffman. 2017. Technological innovation, resource allocation, and growth. *The Quarterly Journal of Economics* 132 (2): 665−712.

Kuhn, J. M., and N. C. Thompson. 2019. *How to measure and draw causal inferences with patent scope.* Working paper, University of North Carolina at Chapel Hill and Massachusetts Institute of Technology.

Lautsch, B. A., E. E. Kossek, and S. C. Eaton. 2009. Supervisory approaches and paradoxes in managing telecommuting implementation. *Human Relations* 62 (6): 795−827.

Lemley, M. A., and B. Sampat. 2012. Examiner characteristics and patent office outcomes. *Review of Economics and Statistics* 94 (3): 817−827.

Levanon, G. Companies may regret jumping on the remote work bandwagon. *Forbes.com* (February 4).

Li, Q., M. Ma, and T. Shevlin. 2021. The effect of tax avoidance crackdown on corporate innovation. *Journal of Accounting and Economics* 71 (2−3): 101382.

Lill, J. B. 2020. When the boss is far away and there is shared pay: The effect of monitoring distance and compensation interdependence on performance misreporting. *Accounting, Organizations and Society* 86: 101143.

Loughran, T., and B. McDonald. 2016. Textual analysis in accounting and finance: A survey. *Journal of Accounting Research* 54 (4): 1187−1230.

Lyttelton, T., E. Zang, and K. Musick. 2020. *Gender differences in telecommuting and implications for inequality at home and work.* Working paper, Yale University and Cornell University.

Martin, R., T. F. Thomas, and D. Yatsenko. 2021. *Shielding the workforce: Does subordinate contract frame induce leniency in superiors' target-setting decisions?* Working paper, Utah State University, University of Wisconsin – Madison, and University of Wisconsin – Whitewater.

Matos, K., E. Galinsky, and J. T. Bond. 2016. *National study of employers*. Available at: https://www.shrm.org/hr-today/trends-and-forecasting/research-and-surveys/Documents/National%20Study%20of%20Employers.pdf

Merchant, K. A. 1985. Organizational controls and discretionary program decision making: A field study. *Accounting, Organizations and Society* 10 (1): 67−85.

Merkley, K., R. Michaely, and J. Pacelli. 2020. Cultural diversity on Wall Street: Evidence from consensus earnings forecasts. *Journal of Accounting and Economics* 70 (1): 101330.

Napier, B. J., and G. R. Ferris. 1993. Distance in organizations. *Human Resource Management Review* 3 (4): 321−357.

Nekrasov, A., S. H. Teoh, and S. Wu. 2021. Visuals and attention to earnings news on twitter. *Review of Accounting Studies* (forthcoming).
Neufeld, D. J., Z. Wan., and Y. Fang. 2010. Remote leadership, communication effectiveness and leader performance. *Group Decision and Negotiation* 19: 227−246.
Newton, C. 2020. Mark Zuckerberg on taking his massive workforce remote. *theverge.com* (May 21).
Osterman, P. 1995. Work/family programs and the employment relationship. *Administrative Science Quarterly* 40 (4): 683−698.
Raffiee, J., and F. Teodoridis. 2020. *Does the political ideology of patent examiners matter? An empirical investigation.* Working paper, University of Southern California.
Righi, C., and T. Simcoe. 2019. Patent examiner specialization. *Research Policy* 48 (1): 137−148.
Rothbard, N. P., K. W. Phillips, and T. L. Dumas. 2005. Managing multiple roles: Work-family policies and individuals' desires for segmentation. *Organization Science* 16 (3): 243−258.
Sampat, B., and H. L. Williams. 2019. How do patents affect follow-on innovation? Evidence from the Human Genome. *American Economic Review* 109 (1): 203−236.
Shu, T., X. Tian, and X. Zhan. 2021. Patent quality, firm value, and investor underreaction: Evidence from patent examiner busyness. *Journal of Financial Economics* (forthcoming).
Tabakovic, H., and T. G. Wollmann. 2018. *From revolving doors to regulatory capture? Evidence from patent examiners.* Working paper, Harvard University and University of Chicago.
U.S. Department of Commerce (DOC). 2015. USPTO needs to strengthen patent quality assurance practices. Washington, DC: DOC.
U.S. Government Accountability Office (GAO). 2016. Patent office should define quality, reassess incentives, and improve clarity. Washington, DC: GAO.

APPENDIX A
Selected Example - Patent Examination Document

1. Notice of Allowance Documents - Patent Application No. 13/208,413

Notice of Allowability	**Application No.** 13/208,413	**Applicant(s)** MOQVIST, PÄR	
	Examiner PETER SOLINSKY JR	**Art Unit** 2463	**AIA (First Inventor to File) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--
All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *Request for Reconsideration filed 05/08/2014*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on______.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are *1-24*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   Certified copies:
   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.
   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)
1. ☒ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☒ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/PETER SOLINSKY JR/ Examiner, Art Unit 2463	/MARK RINEHART/ Supervisory Patent Examiner, Art Unit 2463

U.S. Patent and Trademark Office
PTOL-37 (Rev. 08-13) **Notice of Allowability** Part of Paper No./Mail Date 20140610

APPENDIX A (Continued)

2. Notice of Allowance Documents - Patent Application No. 13/208,413

Application/Control Number: 13/208,413 Page 3
Art Unit: 2463

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to PETER SOLINSKY JR whose telephone number is (571)270-7216. The examiner can normally be reached on Monday through Thursday 6:30 am to 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark H. Rinehart can be reached on (571) 272-3632. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

This appendix provides an example of a publicly available patent document on Public PAIR reviewed by both junior and primary examiners. The highlighted boxes show junior and primary examiners examining a particular patent application.

APPENDIX B
Description of Variables

Variable	Description	Source
Complex Tech	An indicator variable that equals one if a patent has either the highest, above-quartile, or above-tercile expectancy, and zero otherwise. Expectancy is the expected number of hours allocated to review one patent application;	FOIA
Days to FOAM	The number of days from the application filing date to the FOAM date;	Public PAIR
Examiner Backward Citation	The total number of examiner-added citations used in office actions for a given patent application;	Public PAIR
Forward Citation	The number of forward citations received by a focal patent;	Kogan et al.'s (2017) website
High RCE	An indicator variable that equals one if a Technology Center that an examiner belongs to has an above-median propensity of requests for continued examination (RCEs), and zero otherwise;	Public PAIR
Junior Busyness	The natural logarithm of the number of patents that each junior examiner reviews in the FOAM year;	Public PAIR, Patentsview
Junior Minority	An indicator variable that equals one if a junior examiner is ethnic minority, and zero otherwise;	Oxford Dictionary of American Family names, Ancestry.com, and Forebears.io
Junior Female	An indicator variable that equals one if a junior examiner for a given patent application is female, and zero otherwise;	FOIA, Patentsview, genderize.io
Junior Grade	An ordinal variable classifying junior examiners' GS-level ranging from one to 15, where 15 corresponds to GS-15;	FOIA, Patentsview
Junior Tenure	The number of years a junior examiner for a given patent application has worked as of the FOAM year;	FOIA, Patentsview
Junior WFH	An indicator variable that equals one if a junior examiner for a given application works from home as of the FOAM date, and zero otherwise;	FOIA, Public PAIR, Patentsview
Patent Value	The natural logarithm of one plus the dollar value of a patent (deflated to 1982 million dollars using the consumer price index) estimated based on the stock price response to news about patents;	Kogan et al.'s (2017) website
Primary Female	An indicator variable that equals one if a primary examiner for a given patent application is female, and zero otherwise;	FOIA, Patentsview, genderize.io
Primary Minority	An indicator variable that equals one if a junior examiner is ethnic minority, and zero otherwise;	Oxford Dictionary of American Family names, Ancestry.com, and Forebears.io
Primary Grade	An ordinal variable classifying primary examiners' GS-level ranging from one to 15, where 15 corresponds to GS-15;	FOIA, Patentsview
Primary Prior Patents	The natural logarithm of the number of prior patents on which each primary examiner supervised a junior examiner before the FOAM date;	FOIA, Patentsview

Primary Span of Control	The natural logarithm of the number of junior examiners that each primary examiner supervises in the FOAM month;	FOIA, Public PAIR, Patentsview
Primary Tenure	The number of years a primary examiner for a given patent application has worked as of the FOAM year;	FOIA, Patentsview
Primary WFH	An indicator variable that equals one if a primary examiner for a given application works from home as of the FOAM date, and zero otherwise;	FOIA, Public PAIR, Patentsview
RCE	An indicator variable equal to one if an applicant files an RCE on an application, and zero otherwise;	Public PAIR
# *Claims*	The number of patent claims in an application;	Patentsview
# *Figures*	The number of figures in an application; and	Patentsview
# *Words in Claims*	The number of words in patent claims.	Patentsview

FIGURE 1
The Percentage of Supervisory Examiners Working from Home by Year

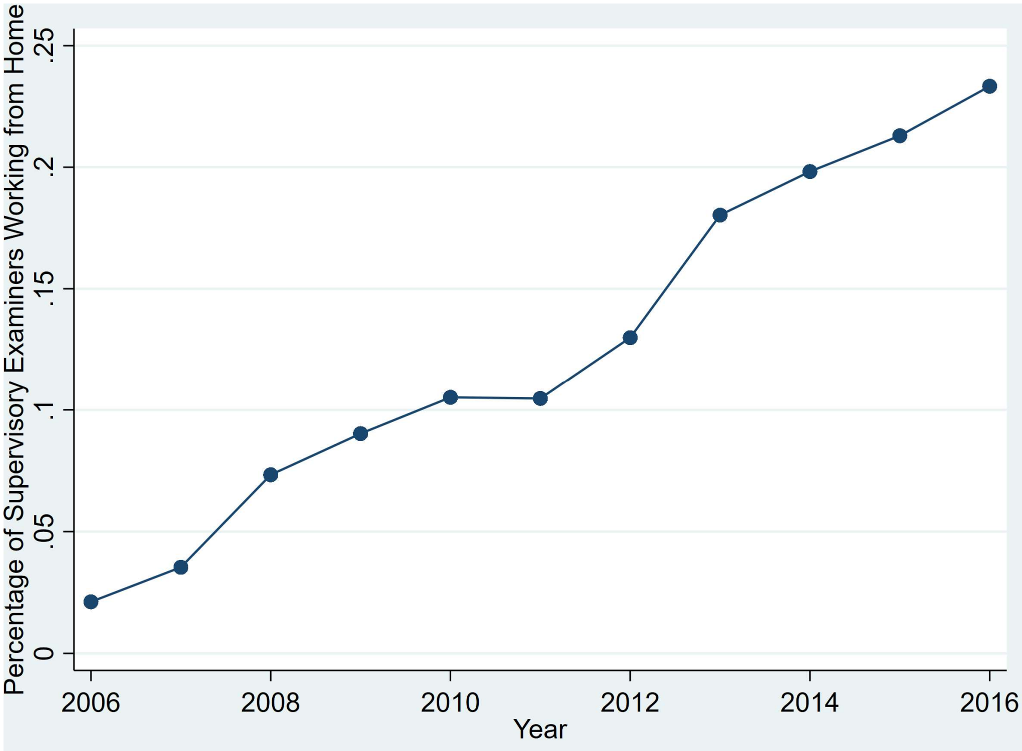

Figure 1 illustrates observation points capturing the percentage of supervisory (primary) examiners working from home across time points divided into spans of one year for the sample used in my analyses.

TABLE 1
Sample Selection Procedure

Description	**Table**	**Observations**
(i) Utility patent applications that examiners complete the FOAM from 2006 to 2016:		4,127,558
Exclude patent applications that are not granted:		(1,252,044)
Exclude patents examined by primary examiners only:		(1,948,448)
Exclude patents not matched with the data set obtained via FOIA:		(461,779)
Exclude patents examined by junior examiners who were working from home as of the FOAM date:		(80,519)
Require non-missing data for variables representing examiner characteristics:		(222,185)
(ii) Final Sample before limiting the sample to patent value and forward citations	Tables 7 and 10	162,563
Require non-missing data for variables representing patent value and forward citations:		(102,535)
(iii) Final Sample for tests of patent value and forward citations: (ii) – (a)	Tables 3, 4, 5, 6, and 11	60,028

Table 1 presents my sample selection procedure.

TABLE 2
Sample

Panel A. Summary Statistics

Measures	N	Mean	Median	Q1	Q3	Std. Dev.
Primary WFH	60,028	0.115	0.000	0.000	0.000	0.318
Patent Value	60,028	1.537	1.466	0.487	2.329	1.152
Primary Span of Control	60,028	9.051	7.000	3.000	13.000	7.510
Primary Prior Patents	60,028	88.571	63.000	30.000	116.00	88.026
Primary Female	60,028	0.124	0.000	0.000	0.000	0.329
Primary Minority	60,028	0.225	0.000	0.000	0.000	0.418
Primary Tenure	60,028	15.424	14.000	9.000	21.000	7.450
Primary Grade	60,028	14.634	15.000	14.000	15.000	0.531
Junior Female	60,028	0.251	0.000	0.000	1.000	0.433
Junior Minority	60,028	0.299	0.000	0.000	1.000	0.458
Junior Tenure	60,028	2.687	2.000	1.000	4.000	2.269
Junior Grade	60,028	10.576	11.000	9.000	12.000	1.962
Junior Busyness	60,028	34.985	31.000	20.000	46.000	20.797
Forward Citations	60,028	6.564	2.000	0.000	6.000	17.122
Days to FOAM	162,563	720.48	717.00	480.00	947.00	333.43

Panel B. Sample Composition by Year (by the FOAM Year)

	Patent Value					
	N	**Mean**	**Median**	**Q1**	**Q3**	**Std. Dev.**
2006	4,772	1.665	1.584	0.459	2.573	1.260
2007	6,109	1.674	1.574	0.512	2.538	1.252
2008	7,446	1.579	1.516	0.443	2.396	1.195
2009	7,225	1.488	1.411	0.446	2.303	1.124
2010	5,839	1.498	1.433	0.507	2.251	1.099
2011	6,114	1.441	1.361	0.374	2.191	1.097
2012	5,798	1.481	1.408	0.520	2.237	1.093
2013	5,879	1.488	1.455	0.474	2.240	1.110
2014	4,374	1.538	1.534	0.546	2.297	1.538
2015	4,076	1.534	1.490	0.597	2.312	1.534
2016	2,396	1.549	1.466	0.640	2.408	1.549
Total	60,028	1.537	1.466	0.487	2.329	1.152

TABLE 2 (Continued)

Panel C. Sample Composition by Technology

	Patent Value					
	N	**Mean**	**Median**	**Q1**	**Q3**	**Std. Dev.**
Biotechnology and Organic Fields	3,051	2.332	2.246	1.351	3.326	1.289
Chemical and Materials Engineering	5,148	1.535	1.512	0.339	2.339	1.199
Computer Architecture Software and Information Security	8,035	1.715	1.659	0.936	2.414	1.051
Computer Networks, Multiplex, Cable, and Cryptography/Security	8,847	1.541	1.498	0.605	2.354	1.096
Communications	7,759	1.251	1.017	0.157	2.098	1.134
Semiconductors, Electrical and Optical Systems, and Components	13,233	1.168	0.965	0.189	1.875	1.036
Transportation, Electronic Commerce, and National Security	5,863	1.738	1.730	0.490	2.579	1.250
Mechanical Engineering, Manufacturing, and Products	8,092	1.788	1.842	1.005	2.477	1.053
Total	60,028	1.537	1.466	0.487	2.329	1.152

Panel A reports the summary statistics on the variables used in my analyses. For variables *Primary Span of Control*, *Primary Prior Patents*, and *Junior Busyness*, I present raw values before taking the log. Panels B and C present the sample composition by the FOAM year and technology, respectively.

TABLE 3
Effects on Patent Value

	DV: *Patent Value*			
	(1)	(2)	(3)	(4)
Primary WFH	-0.044** (-2.02)	-0.044** (-2.06)	-0.057** (-2.57)	-0.059*** (-2.68)
Art Unit FEs	Yes	Yes	No	No
Junior Examiner FEs	No	No	Yes	Yes
Technology Subclass × Year FEs	Yes	Yes	Yes	Yes
Junior Examiner Tenure FEs	No	Yes	No	Yes
Junior Examiner Grade FEs	No	Yes	No	Yes
Observations	55,323	55,323	55,187	55,187
ADJ R^2	0.200	0.200	0.227	0.227

Table 3 reports the estimation results of Model (1) using OLS regression. The dependent variable is *Patent Value*, defined as the natural logarithm of one plus the dollar value of a patent estimated based on the stock price response to news about patents, a measure proposed by Kogan et al. (2017). Column (1) report results with Art-Unit-level and subclass-by-year-level fixed effects. Column (2) report results with Art-Unit-level, subclass-by-year-level, junior-examiner-tenure-level, and junior-examiner-grade-level fixed effects. Column (3) report results with junior-examiner-level and subclass-by-year-level fixed effects. Column (4) report results with junior-examiner-level, subclass-by-year-level, junior-examiner-tenure-level, and junior-examiner-grade-level fixed effects. All *t*-statistics (in parentheses) are based on standard errors clustered at the primary examiner level. ***, **, and * denote two-tailed statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 4
Robustness Tests

Panel A. Inclusion of Control Variables

	DV: ***Patent Value***			
	(1)	**(2)**	**(3)**	**(4)**
Primary WFH	-0.054**	-0.055**	-0.062***	-0.065***
	(-2.33)	(-2.37)	(-2.64)	(-2.75)
Primary Span of Control	-0.001	-0.002	-0.001	-0.002
	(-0.19)	(-0.25)	(-0.17)	(-0.20)
Primary Prior Patents	0.024***	0.017	0.016	0.008
	(3.36)	(1.38)	(1.58)	(0.54)
Primary Female	-0.003	-0.002	-0.005	-0.006
	(-0.10)	(-0.08)	(-0.18)	(-0.20)
Primary Minority	-0.011	-0.010	0.037	0.039
	(-0.54)	(-0.51)	(1.50)	(1.56)
Primary Tenure	-0.003**	-0.003**	-0.003**	-0.003**
	(-2.07)	(-2.04)	(-2.09)	(-2.21)
Primary Grade	0.001	0.001	0.012	0.011
	(0.05)	(0.04)	(0.76)	(0.73)
Junior Busyness	-0.025**	-0.023*	-0.035**	-0.033**
	(-2.14)	(-1.86)	(-2.36)	(-2.20)
Junior Female	-0.003	-0.004		
	(-0.20)	(-0.22)		
Junior Minority	0.005	0.006		
	(0.30)	(0.40)		
Art Unit FEs	Yes	Yes	No	No
Junior Examiner FEs	No	No	Yes	Yes
Technology Subclass × Year FEs	Yes	Yes	Yes	Yes
Junior Examiner Tenure FEs	No	Yes	No	Yes
Junior Examiner Grade FEs	No	Yes	No	Yes
Observations	55,323	55,323	55,187	55,187
ADJ R^2	0.200	0.200	0.227	0.228

TABLE 4 (continued)

Panel B. Inclusion of Firm Fixed Effects

	DV: *Patent Value*			
	(1)	**(2)**	**(3)**	**(4)**
Primary WFH	-0.047*** (-3.39)	-0.025** (-2.46)	-0.033*** (-2.88)	-0.024** (-2.15)
Junior Examiner FEs	Yes	Yes	Yes	Yes
Firm FEs	Yes	No	No	No
Firm × Year FEs	No	Yes	Yes	Yes
Technology Subclass × Year FEs	No	No	Yes	Yes
Junior Examiner Tenure FEs	No	No	No	Yes
Junior Examiner Grade FEs	No	No	No	Yes
Observations	59,519	57,736	52,825	52,825
ADJ R^2	0.854	0.858	0.860	0.861

Panel C. Entropy Balancing

	DV: *Patent Value*			
	(1)	**(2)**	**(3)**	**(4)**
Primary WFH	-0.083*** (-3.05)	-0.084*** (-3.12)	-0.102*** (-2.87)	-0.108*** (-3.05)
Art Unit FEs	Yes	Yes	No	No
Junior Examiner FEs	No	No	Yes	Yes
Technology Subclass × Year FEs	Yes	Yes	Yes	Yes
Junior Examiner Tenure FEs	No	Yes	No	Yes
Junior Examiner Grade FEs	No	Yes	No	Yes
Observations	55,323	55,323	55,187	55,187
ADJ R^2	0.443	0.444	0.503	0.504

Panel A presents the estimation results of Model (1) with additional controls. *Primary Span of Control* is the natural logarithm of the number of junior examiners that each primary examiner supervises in the FOAM month. *Primary Prior Patents* is the natural logarithm of the number of prior patents on which each primary examiner supervised a junior examiner before the FOAM date. *Primary Female* (*Junior Female*) is an indicator variable that equals one if a primary (junior) examiner for a given patent application is female, and zero otherwise. *Primary Minority* (*Junior Minority*) is an indicator variable that equals one if a junior examiner is ethnic minority, and zero otherwise. *Primary Tenure* (*Junior Tenure*) is the number of years a primary examiner for a given patent application has worked as of the FOAM year. *Primary Grade* (*Junior Grade*) is an ordinal variable classifying primary (junior) examiners' GS-level ranging from one to 15, where 15 corresponds to GS-15. *Junior Busyness* is the natural logarithm of the number of patents that each junior examiner reviews in the FOAM year. Panel B presents the estimation results of Model (1) with firm-fixed effects. Panel C presents the estimation results of Model (1) using entropy balancing weights. All *t*-statistics (in parentheses) are based on standard errors clustered at the primary examiner level. ***, **, and * denote two-tailed statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 5
Cross-Sectional Tests: Moderating Effects of Technological Complexity

Panel A. Technology Fields by Technological Complexity

	Expectancy (hours)	Technology Fields (Examples)
Simple Technologies	14.3	Purses, Wallets, and Protective Covers; Trunks and Hand-Carried Luggage; Flexible Bags
↑	15.8	Cutlery; Woodturning; Coopering; Work Holders
	16.9	Tent, Canopy, Umbrella, or Cane; Flexible or Portable Closure, Partition, or Panel
	17.5	Boring or Penetrating the Earth; Railway Wheels and Axles; Mining or In Situ Disintegration of Hard Material
	18.2	Internal-Combustion Engines; Surgery Tools
	19.7	Sugar, Starch, and Carbohydrates; Metal Treatment
	20.5	Radiant Energy; Wave Transmission Lines and Networks
	21.9	Concentrating Evaporators; Mineral Oils; Distillation; Gas Separation
	22.4	Batteries (Thermoelectric and PhotoElectric); Chemistry (Electrical and Wave Energy)
	23.6	Recorders; Incremental Printing of Symbolic Information; Television (Sound Signal, Noise Inversion)
	24.4	Semiconductor Cleaning; Chemical Bleaching, Oxidation, or Reduction
	25.9	Drug, Bio-Affecting, and Body Treating Compositions; Molecular Biology and Microbiology
	26.3	Kinesitherapy; Television (Motion Picture Film Scanner, Mechanical Optical Scanning, Motion Detection)
	27.5	Data Processing (Vehicles, Navigation, and Relative Location)
	28.2	Multiplex Communications (Data Assembly or Formatting, Internet Protocol, Emulated Lan)
↓	28.9	Image Analysis (Vehicle or Traffic Control, Motion or Velocity Measuring, Radiography, Blood Cells, Neural Networks)
Complex Technologies	31.6	Data Processing (Database and File Management, Data Structures, Digital Audio Data Processing System); Computer Graphics Processing; Operator Interface Processing; Selective Visual Display Systems

Panel B. Summary Statistics

Measure	N	Mean	Median	Min.	Q1	Q3	Max.	Std. Dev.
Expectancy (Hours)	60,028	25.036	24.200	14.300	21.000	28.900	31.600	4.838

TABLE 5 (Continued)

Panel C. Regression Results

	DV: ***Patent Value***					
Complex Tech:	Highest Expectancy		Highest Quartile		Highest Tercile	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Primary WFH × Complex Tech	-0.113**	-0.114**	-0.119**	-0.120**	-0.096**	-0.097**
	(-2.20)	(-2.24)	(-2.40)	(-2.44)	(-1.97)	(-2.01)
Primary WFH	-0.024	-0.026	-0.020	-0.022	-0.025	-0.026
	(-1.00)	(-1.08)	(-0.79)	(-0.87)	(-0.97)	(-1.04)
Complex Tech	0.232***	0.233***	0.177***	0.178***	0.116***	0.117***
	(4.89)	(4.92)	(3.74)	(3.76)	(2.62)	(2.64)
Junior Examiner FEs	Yes	Yes	Yes	Yes	Yes	Yes
Technology Subclass × Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Junior Examiner Tenure FEs	No	Yes	No	Yes	No	Yes
Junior Examiner Grade FEs	No	Yes	No	Yes	No	Yes
Observations	55,187	55,187	55,187	55,187	55,187	55,187
ADJ R^2	0.228	0.228	0.228	0.228	0.227	0.228

Panel A presents examples of technology fields corresponding to expectancy, which is the number of expected hours allocated to review a patent application determined based on technological complexity of each patent. Panel B reports the summary statistics of expectancy (denoted in hours) in my sample. Panel C reports the estimation results of Model (2) using OLS regression. For Columns (1) and (2), *Complex Tech* is an indicator variable that equals one if a patent has the highest expectancy of 31.6 hours, and zero otherwise. For Columns (3) and (4), *Complex Tech* is an indicator variable that equals one if a patent is in the top quartile of expectancy, and zero otherwise. For Columns (5) and (6), *Complex Tech* is an indicator variable that equals one if a patent is in the top tercile of expectancy, and zero otherwise. All *t*-statistics (in parentheses) are based on standard errors clustered at the primary examiner level. ***, **, and * denote two-tailed statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 6
Cross-Sectional Tests: Moderating Effects of the Degree to which Tacit Knowledge is Required

Panel A. Summary Statistics

	RCE		*High RCE*
	N	**Mean**	
Computer Networks, Multiplex, Cable, and Cryptography/Security	8,847	0.564	1
Computer Architecture Software and Information Security	8,035	0.533	1
Communications	7,759	0.469	1
Chemical and Materials Engineering	5,148	0.443	1
Mechanical Engineering, Manufacturing, and Products	8,092	0.410	0
Transportation, Electronic Commerce, and National Security	5,863	0.352	0
Semiconductors, Electrical and Optical Systems, and Components	13,233	0.314	0
Biotechnology and Organic Fields	3,051	0.270	0
Total	60,028	0.426	

Panel B. Mean Differences

Measure	***High RCE* = 1**		***High RCE* = 0**		**Mean Difference**
	N	Mean	N	Mean	
# Words in Claims	30,239	1,295.06	29,789	1,050.00	245.06***
# Claims	30,239	18.344	29,789	16.752	1.592***
# Figures	29,153	11.545	28,564	14.174	-2.629***

Panel C. Regression Results

	DV: *Patent Value*			
	(1)	**(2)**	**(3)**	**(4)**
Primary WFH × High RCE	-0.100**	-0.096**	-0.100**	-0.101**
	(-2.33)	(-2.42)	(-2.20)	(-2.24)
Primary WFH	0.012	0.008	-0.011	-0.012
	(0.40)	(0.29)	(-0.38)	(-0.43)
High RCE	0.214	0.220	0.216	0.218
	(1.54)	(1.60)	(1.30)	(1.33)
Junior Examiner FEs	Yes	Yes	Yes	Yes
Filing Year FEs	Yes	Yes	No	No
Technology Subclass FEs	No	Yes	No	No
Technology Subclass × Year FEs	No	No	Yes	Yes
Junior Examiner Tenure FEs	No	No	No	Yes
Junior Examiner Grade FEs	No	No	No	Yes
Observations	59,914	58,516	55,187	55,187
ADJ R^2	0.201	0.220	0.227	0.227

Panel A presents the average value of *RCE* (an indicator variable equal to one if an applicant files an RCE on an application, and zero otherwise) across Technology Centers. *High RCE* is an indicator variable that equals one if a Technology Center that an examiner belongs to has an above-median propensity of RCEs, and zero otherwise. Panel B presents the differences in variables representing characteristics of the application cross high- versus low-RCE Technology Centers. # *Words in Claims* is the number of words in patent claims in an application. # *Claims* is the number of patent claims in an application. # *Figures* is the number of figures in an application. Panel C reports the results of estimating Model (3). All *t*-statistics (in parentheses) are based on standard errors clustered at the primary examiner level. ***, **, and * denote two-tailed statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 7
Effects on Review Speed

	DV: Log(1+*Days to FOAM*)			
	(1)	(2)	(3)	(4)
Primary WFH	0.127*** (8.90)	0.126*** (8.95)	0.130*** (9.69)	0.033*** (6.96)
Junior Examiner FEs	Yes	Yes	Yes	Yes
Filing Year FEs	Yes	Yes	No	No
Technology Subclass FEs	No	Yes	No	No
Technology Subclass × Year FEs	No	No	Yes	Yes
Junior Examiner Tenure FEs	No	No	No	Yes
Junior Examiner Grade FEs	No	No	No	Yes
Observations	162,535	160,399	156,410	156,410
ADJ R^2	0.449	0.454	0.468	0.763

Table 7 reports results of estimating Model (4). The dependent variable is the natural logarithm of one plus *Days to FOAM*, defined as the number of days from the application filing date to the FOAM date. All *t*-statistics (in parentheses) are based on standard errors clustered at the primary examiner level. ***, **, and * denote two-tailed statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 8
Effects of Junior Examiners Working from Home when Primary Examiners Work at the Office

Panel A. Summary Statistics of Junior Examiners Working from Home

Measure	N	Mean	Median	Q1	Q3	Std. Dev.
Junior WFH	61,799	0.155	0.000	0.000	0.000	0.361

Panel B. Regression Results

	DV: *Patent Value*			
	(1)	(2)	(3)	(4)
Junior WFH	0.0002 (0.01)	-0.002 (-0.12)	-0.009 (-0.50)	-0.015 (-0.74)
Art Unit FEs	Yes	Yes	No	No
Primary Examiner FEs	No	No	Yes	Yes
Technology Subclass × Year FEs	Yes	Yes	Yes	Yes
Junior Examiner Tenure FEs	No	Yes	No	Yes
Junior Examiner Grade FEs	No	Yes	No	Yes
Observations	57,046	57,046	56,941	56,941
ADJ R^2	0.203	0.204	0.206	0.206

Panel A reports the summary statistics of *Junior WFH*, defined as an indicator variable that equals one if a junior examiner for a given application works from home as of the FOAM date, and zero otherwise. Panel B reports the estimation results of regressing *Patent Value* on *Junior WFH* with various fixed effects. All *t*-statistics (in parentheses) are based on standard errors clustered at the primary examiner level. ***, **, and * denote two-tailed statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 9
Out-of-Sample Test: Quality of Patents Reviewed only by the Primary Examiner

	DV: *Patent Value*			
	(1)	**(2)**	**(3)**	**(4)**
Primary WFH	-0.319	-0.064	-0.041	-0.056
	(-0.93)	(-0.28)	(-0.18)	(-0.24)
Art Unit FEs	No	Yes	Yes	Yes
Gender FEs	No	No	Yes	Yes
Ethnic Minority FEs	No	No	Yes	Yes
Technology Subclass × Year FEs	Yes	Yes	Yes	Yes
Primary Examiner Tenure FEs	No	No	No	Yes
Primary Examiner Grade FEs	No	No	No	Yes
Observations	170,777	170,763	170,763	170,763
ADJ R^2	0.032	0.086	0.086	0.086

Table 9 reports the estimation results of regressing *Patent Value* on *Primary WFH* using a sample of patent applications examined only by a primary examiner used in the main sample. All *t*-statistics (in parentheses) are based on standard errors clustered at the primary examiner level. ***, **, and * denote two-tailed statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 10
Effects on Examiner Effort

Panel A. Summary Statistics

Measure	**N**	**Mean**	**Median**	**Q1**	**Q3**	**Std. Dev.**
Examiner Backward Citation	162,563	3.857	0.000	0.000	5.000	7.106

Panel B. Regression Results

	DV: Log(1+*Examiner Backward Citation*)			
	(1)	**(2)**	**(3)**	**(4)**
Primary WFH	0.033**	0.033**	0.026*	0.031**
	(2.02)	(2.10)	(1.87)	(2.16)
Junior Examiner FEs	Yes	Yes	Yes	Yes
Filing Year FEs	Yes	Yes	No	No
Technology Subclass FEs	No	Yes	No	No
Technology Subclass × Year FEs	No	No	Yes	Yes
Junior Examiner Tenure FEs	No	No	No	Yes
Junior Examiner Grade FEs	No	No	No	Yes
Observations	162,535	160,399	156,410	156,410
ADJ R^2	0.582	0.586	0.593	0.593

Panel A reports the summary statistics of *Examiner Backward Citation*, defined as the total number of examiner-added citations used in office actions for a given patent application. Panel B reports the estimation results of regressing the natural logarithm of one plus *Examiner Backward Citation* on *Primary WFH* with various fixed effects. All *t*-statistics (in parentheses) are based on standard errors clustered at the primary examiner level. ***, **, and * denote two-tailed statistical significance at the 1%, 5%, and 10% levels, respectively.

TABLE 11
Alternative Measure

	DV = Log(1+*Forward Citations*)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Primary WFH	-0.052***	-0.054***	-0.052**	-0.039	-0.172***	-0.057***	-0.059***	-0.044**
	(-2.60)	(-2.70)	(-2.17)	(-1.63)	(-6.09)	(-2.82)	(-2.94)	(-2.21)
Junior Examiner FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Filing Year FEs	Yes	Yes	No	No	No	Yes	No	No
Technology Subclass FEs	No	Yes	No	No	No	No	No	No
Technology Subclass × Year FEs	No	No	Yes	Yes	No	No	No	No
Junior Examiner Tenure FEs	No	No	No	Yes	No	No	No	Yes
Junior Examiner Grade FEs	No	No	No	Yes	No	No	No	Yes
Firm FEs	No	No	No	No	Yes	Yes	No	No
Firm × Year FEs	No	No	No	No	No	No	Yes	Yes
Observations	59,914	58,516	55,187	55,187	59,519	59,519	57,736	57,736
ADJ R^2	0.225	0.239	0.233	0.234	0.260	0.294	0.294	0.296

Table 11 reports results of estimating Model (1) by replacing *Patent Value* with the natural logarithm of one plus *Forward Citations*, defined as the number of forward citations received by a focal patent. All *t*-statistics (in parentheses) are based on standard errors clustered at the primary examiner level. ***, **, and * denote two-tailed statistical significance at the 1%, 5%, and 10% levels, respectively.