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(Live and) Work from Anywhere:

Geographic Flexibility and Productivity Effects at the United States Patent Office

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An emerging form of remote work allows employees to *work from anywhere*, so the worker can be physically detached from the firm location. While traditional “work-from-home (WFH)” programs offer the worker temporal flexibility, “work-from-anywhere (WFA)” programs offer *both* temporal and geographic flexibility. We study the effects of WFA on productivity at the United States Patent and Trademark Office (USPTO) and exploit a natural experiment in which the implementation of WFA was driven by negotiations between managers and the patent examiners’ union, leading to exogeneity in the timing of individual examiners’ transition to WFA. Additionally, an employee could become a WFA worker only after first becoming a WFH worker, allowing us to compare their productivity while in the WFA and WFH programs. WFA resulted in a 4.4% increase in output compared to when the worker was on WFH, without affecting the incidence of rework. We also find a positive correlation between work output and the transition from being an in-office worker to a WFH worker. We report several results related to mechanisms, notably that WFA examiners relocate to locations with lower costs of living. We also study how flexibility affects the location choice of WFA workers and report correlations between tenure/career stage and the decision to relocate to locations such as Eastern Texas (where patent law firms are concentrated) and Florida. We additionally employ micro-data on geographic peers, an exogenous mandate to use IT, and proxies for examiner effort to shed further light on mechanisms.

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Introduction

The rich literature on nonstandard work (Ashford et al. 2007, Bidwell et al. 2013, Cappelli and Keller 2013, Pfeffer and Baron 1988) has documented increased variation over time in the degree of physical attachment of workers to the firm, that is, the extent to which workers are *physically proximate* to the organization. One form of nonstandard work that is becoming increasingly common is remote work, in which an employee is allowed to work outside of the office, either part or full time. Despite a few high-profile retreats from remote work by companies like Yahoo and IBM (*Wall Street Journal* 2013, *Wall Street Journal* 2017), many organizations such as Amazon, Apple, American Express, and Glassdoor offer remote work programs to employees.²

Demand for remote work and other flexible work arrangements is high; in its State of the American Workplace survey, Gallup (2017, p. 5) noted that it “consistently has found that flexible scheduling and work-from-home opportunities play a major role in an employee’s decision to take or leave a job.” Bidwell et al (2013) document literature showing how employees and advocacy groups have leveraged technological advancements to advocate for flexible work hours and telecommuting. The value that employees place on remote work arrangements is driven in large part by the costs of commuting, childcare, and eldercare faced by a population increasingly comprised of dual-career families (Council of Economic Advisers 2010).³

To date, research on remote work, including the recent Bloom et al (2015) study, has focused largely on the effects of *working from home* (WFH), in which the employee may conceivably still live within commuting distance of the office. In recent years, however, another form of remote work—*working from anywhere* (WFA)—has begun to emerge. Here, workers are no longer required to live in the same geographic location as the firm, and while the choice of geography for the worker may be constrained to a single country, employees are otherwise free to choose their location. Organizations with WFA policies include Akamai,

² Source: <https://www.glassdoor.com/blog/companies-that-let-you-work-remotely/> (website accessed on April 15, 2019).

³ Another survey finds “74% of employees say they would quit their jobs to work for an organization that would allow them to work remotely more often, even if their salary stayed the same” (Softchoice 2017, p. 3; https://m.softchoice.com/web/newsite/documents/research/SoftchoiceResearchStudy_CollaborationUnleashed.pdf). A contemporaneous benefits survey reports that 40% of surveyed firms indicated that offering more flexible work arrangements was one of their most effective recruiting strategies (Society for Human Resource Management 2017). In this survey, 62% of firms reported allowing some type of remote work/telecommuting.

Github, NASA, and DataStax, among others.⁴ However to the best of our knowledge, there is no research on the productivity effects of WFA, which is substantially different from WFH in the nature of the flexibility and, thus, control (Evans et al. 2004) that it provides to individual workers. WFA is also mechanistically different from WFH in how it might influence employee productivity. Previous research on WFH has identified benefits to employee performance via mechanisms such as reduced commute times and fewer sick days (Bloom et al. 2015), which can be attributed to increased *temporal flexibility* (Evans, et al. 2004). Yet, WFA goes further by eliminating the traditional link between the geography of home and work location, resulting in *geographic flexibility*, in which a worker can remain employed at a firm without needing to live within commuting distance of the firm's office location. In the case of WFA, employers cede to workers the control of the geography in which they choose to live, *in addition* to ceding the temporal control afforded by WFH (Evans et al. 2004).

This additional geographic flexibility, along with the general increase in both worker demand for and employer provision of WFA policies, leads us to our main research question: How does the geographic flexibility provided by WFA affect individual worker productivity? Bloom et al. (2015) present robust evidence from a Chinese travel agency showing positive effects of a WFH regime on individual productivity. We ask whether the productivity gains observed in Bloom et al.'s (2015) WFH setting persist in a WFA setting. We also attempt to unpack unique mechanisms through which WFA can affect worker productivity and study the locational choices made by workers who are awarded geographic flexibility.

Our setting, the United States Patent and Trademark Office (USPTO), and in particular, the job of patent examiner, is in many ways the ideal setting for our research questions. First, our setting allows us to exploit a natural experiment related to the implementation of a WFA policy. The bureaucratic processes governing the implementation of WFA at the USPTO allow us to mitigate endogeneity concerns related to worker selection into the WFA policy. More specifically, the implementation of WFA was driven by

⁴<https://hqhr.hq.nasa.gov/anywhere.html>, <https://www.fatherly.com/love-money/work-money/akamai-50-best-places-for-new-dads-to-work-for-in-2016/>, <https://www.flexjobs.com/blog/post/top-companies-work-from-anywhere-remote-jobs/> and <https://www.glassdoor.com/blog/companies-work-from-anywhere-jobs/> (websites accessed on April 15, 2019).

negotiations between USPTO managers and the union of patent examiners, leading to a monthly enrollment quota that created exogeneity in the *timing* of individual examiners' transition to WFA. Second, the role of a patent examiner is relatively independent. Third, examiners in our sample had spent at least two years in the USPTO office and additional time in a traditional WFH program before taking on a WFA assignment. These conditions help us in two ways. First, the independent nature of the task performed by patent examiners and the mandate to spend two years in the office help us (at least partially) control for adverse effects of remote work (e.g., effects of coordination losses and reduced learning effects from colocated peers) that might lead to confounding concerns in a more general setting. Second, given that all WFA employees in our study first transition from being an "in-office worker" to a "WFH worker" before further transitioning into a "WFA worker", we are able to isolate a productivity effect of geographic flexibility awarded by WFA vis-à-vis WFH. In other words, our setting allows us to conduct a robust comparison of productivity under the WFA and WFH regimes. These conditions not only present a clean empirical setting, but also serve as important boundary conditions to our findings and suggest a future research agenda.

To preview, we exploit this bureaucratic policy-induced variation and employ examiner fixed effects, finding that examiners enjoy an increase in work output of 4.4% when in the WFA program compared to the baseline of when the worker was in the WFH program, with no significant increase in the amount of rework. Separately, we also provide evidence of a positive correlation between work output and the transition from being an in-office worker to a WFH worker.

We also exploit institutional details of our setting to construct a preliminary "fingerprint" of the mechanisms through which geographic flexibility affects productivity. We document how geographic flexibility informs the location choice of WFA workers, finding that WFA examiners tend to relocate to lower cost-of-living locations, effectively increasing their real income holding nominal salaries constant. We also present correlational results showing that while early- and mid-career workers are likely to choose locations based on future career concerns, workers with greater tenure are more likely to choose "retirement-friendly" destinations such as Florida.

We also examined work practices associated with enhanced productivity for the sample of WFA examiners. Geocoded examiner location data revealed clusters of relocated examiners, so we explored the productivity impacts of geographic proximity to other WFA examiners. We find no effect from proximity to other examiners in general, but we do find a positive correlation between individual productivity and the number of examiners in the same art unit (i.e., work units based on a technological classification) located within 25 miles of the focal examiner. Taken together, these findings provide preliminary evidence that geographically clustered WFA examiners may benefit more from learning from each other than from social embeddedness in general. We also exploit a bureaucratic mandate requiring WFA employees to utilize IT tools for online coordination and find that mandating this practice does result in an increase in productivity for WFA employees whose work needs to be certified by a supervisor. Finally, we test whether measures related to examiner effort and leniency change when an employee transitions to WFA: We find no evidence of increased leniency or reduced effort, as measured by examiner-added citations.

Our findings make an original contribution to the literature on remote work. While prior literature has documented robust productivity effects of working from *home* (e.g., Bloom et al. 2015), our study goes a step beyond in documenting the productivity effects of working from *anywhere*, where the worker has geographic flexibility to relocate away from the original work location. Our results also contribute to the literatures on nonstandard work and physical detachment (Ashford, et al. 2007, Bidwell et al. 2013, Cappelli and Keller 2013), the literature on productivity effects of granting workers more perceived autonomy (Stern 2004, Gambardella, Panico, and Valentini 2015), and research on the effects of nonpecuniary incentives (Sauermann and Cohen 2010, Kryscynski 2011).

Working from Anywhere and Geographic Flexibility

In this paper, we examine the productivity effects of a work-from-anywhere (WFA) policy that grants workers geographic flexibility (the flexibility to choose a geographic location in which to live and work). Economics research on nonpecuniary incentives such as geographic flexibility predicts a “negative trade-off between wages and ‘positive’ job attributes, attributes like status or flexibility in hours of work” (Lazear and Shaw 2007, p. 102-103). Indeed, empirical research demonstrates at least some willingness to exchange wages

for nonmonetary benefits (Stern, 2004). Mas and Pallais (2017) find that, on average, workers are willing to accept 8% lower wages in exchange for a remote work option, suggesting that remote work policies are perceived as a valuable nonpecuniary benefit by employees. However, in some cases (such as the USPTO), the firm does not decrease wages for employees choosing a WFA regime. The implication of this practice is that the benefits to the firm of introducing WFA would need to at least match the costs of doing so in order for WFA to be sustainable. Examining the effects of WFA on employee productivity is one way to assess the net impact of these costs and benefits.

Evans, Kunda, and Barley (2004, p. 2) define flexibility in the employment relationship as “ceding control to workers over the circumstances of their work by enabling them to vary those circumstances to address personal and family needs and uncertainties.” Work-from-home (WFH) policies are an increasingly common means of granting temporal flexibility to employees, among other practices that give employees more control over the hours in which they complete their work (e.g., Briscoe 2007). Working from anywhere is a logical next step beyond WFH along a spectrum of employee detachment from a traditional, full-time, in-office work experience (Cappelli and Keller 2013). In addition to granting employees the *temporal flexibility* enjoyed under a WFH regime, WFA also gives employees *geographic flexibility*. With its additional benefits, WFA mitigates the locational disadvantage (to workers) of the traditional employment contract, enabling employees to enjoy the flexibility granted by nonstandard employment without having to undertake the market-entry activities and employment uncertainty faced by freelancers and contractors (Evans et al 2004).

The temporal flexibility afforded by WFA (and WFH) policies has been related to a number of benefits, such as increased employee autonomy, motivation, and decreased work-life conflict. But, temporal and geographic flexibility potentially increase the cost of coordination and information sharing among employees, leading to reduced opportunities to learn from coworkers and reduced social embeddedness in the organization. Benefits can potentially accrue to both employee (in the form of enhanced quality of life) and employer (to the extent that enhanced employee outcomes result in performance improvements). Similarly, costs may also be incurred by both employee (in the form of isolation and increased family-work conflict) and employer (with potential reductions in employee learning, coordination, and organizational identification,

among others). In the remainder of this section, we examine in more detail the benefits and costs associated with temporal and geographic flexibility.

Benefits of Flexibility

The benefits of temporal flexibility to employees have been well-documented in the research on family-friendly work policies (such as flexible work hours) and WFH policies, with particular emphasis on improvements in work-life balance and reductions in work-family conflict. Improvements in work-life balance related to temporal flexibility in the form of teleworking appear to stem from time gained from not having to commute to the office and higher quality of work surroundings. Bloom et al. (2015) found evidence that telework led to a 13% performance increase, of which 9% was due to fewer breaks and less sick days, and 4% was due to a “quieter and more convenient” work environment (p.165).

Work-life balance is generally believed to increase (and work-family conflict to decrease) when employees are able to work from home (Gajendran and Harrison 2007), though some negative impacts have been noted in the areas of work-life boundary maintenance (Kossek, Lautsch, and Eaton 2006) and family-to-work conflict (Golden, Veiga and Simsek 2006). Improved work-life balance is one way employers can increase the intrinsic motivation of employees (particularly employees whose identity and motives are closely tied to family), helping maintain a balance between work and personal life (Akerlof and Kranton 2005; Sauermaun and Cohen 2010). Additionally, the degree of scheduling flexibility and autonomy of a teleworker has been shown to positively moderate the relationship between telecommuting and work-family conflict (Golden, Veiga and Simsek 2006), suggesting that employees granted higher degrees of telework may also benefit from receiving higher amounts of autonomy and scheduling flexibility in order to minimize work-family conflict and maximize productivity.

One study suggests that just the *availability* of temporal flexibility can improve employee outcomes to the benefit of both employer and employee. Kossek, Lautsch, and Eaton (2006) find a relationship between perceived psychological control over their jobs and reduced turnover intentions, family-work conflict, and depression. Importantly, the *perception* of flexibility was sufficient in this case for the employee to experience increased psychological control; the employee did not need to actually utilize the available temporal flexibility.

The implication is that perceived control is one mechanism that drives positive work outcomes. This perception of control over one's work is similar to the construct of autonomy, which has been related to increased motivation on the job (e.g., Hackman and Oldham 1976, Ryan and Deci 2000). Research on remote work has previously linked temporal flexibility (in the form of WFH) to increased perceptions of job autonomy (Belanger 1999, Gajendran and Harrison 2007).

Geographic flexibility adds a further layer of potential benefits to employees, as the ability to relocate beyond the environs of the home office may enable employees to take advantage of a lower cost of living. Moretti (2013) deflates nominal wages using a location-specific cost-of-living index and finds that the difference between the wage of college graduates and high school graduates in the U.S. is lower in real terms than in nominal terms; at least 22% of the documented increase in college premium is accounted for by spatial differences in the cost of living. Given the opportunity to relocate anywhere in the U.S., the worker might choose to move to a part of the country in which the cost of living is lower, thus allowing the worker to enjoy greater real income, holding nominal income constant—especially when the employer is based in an urban area with a relatively high cost of living.

If allowed geographic flexibility, employees may also choose to move closer to friends and family. There is a nascent literature that looks at revealed preferences of scientists, engineers, and entrepreneurs to choose work that is close to home (Dahl and Sorenson 2010a 2010b). Using panel data on the Danish population, Dahl and Sorenson (2010a) estimate a strong revealed preference of scientists and engineers to live close to family and friends. In another paper, they note that “one commonly cited reason for why people do not move more often is that they value being near family and friends, or at least the more frequent and more extended interactions that propinquity allows” (Dahl and Sorenson 2010b, p. 637). A related concept in economics is the construct of psychic costs of migration (Sjaastad 1962, Schwartz 1973). These studies suggest that the provision of geographic flexibility should benefit employees in ways that are *incremental to the benefits of temporal flexibility*. While temporal flexibility allows employees to spend more time with immediate family, geographic flexibility enables employees to relocate closer to extended family and other social networks.

Costs of Flexibility

The detachment from the workplace that occurs as the result of an employee's pursuit of temporal and geographic flexibility yields challenges as well as benefits. Working remotely makes coordination with coworkers more difficult and reduces opportunities for both learning from and socially interacting with coworkers. We address these costs as applying to policies for both temporal and geographic flexibility (i.e., WFH and WFA). We expect that adding geographic flexibility to temporal flexibility would result in a higher level of these costs, but there is, to our knowledge, no empirical evidence comparing these conditions. (We partially address this gap in our analysis later in the paper.)

The organization of workers into a firm has been viewed as a system to coordinate effort and communicate knowledge across multiple intrafirm actors (Srikanth and Puranam 2014, Grant 1996, Thompson 1967). Altering the spatial distribution of employees changes the means of coordination, limiting the ability of workers to rely on tacit coordination mechanisms (Srikanth and Puranam 2014), and potentially leading to increased coordination costs via difficulties in knowledge sharing (Cramton 2001, Gibson and Gibbs 2006). Building on Lawrence and Lorsch (1967), Grant (1996) viewed coordination as necessary to reduce intraorganizational goal conflicts. Thompson (1967) outlines three different types of interdependence, to discuss how coordination between organizational actors depends on the interdependence regime in the focal firm. The loosest of these interdependence regimes is *pooled interdependence*, in which coordination is achieved by standardization, that is, the establishment of routines or rules that constrains each worker's actions rather than the mutual planning and adjustment among workers required in higher interdependence contexts (Thompson 1967). Work that is characterized by pooled interdependence is arguably most suited to the implementation of geographic flexibility as compared to work requiring tighter day-to-day coordination between coworkers.⁵

⁵ In the second type of interdependence, which Thompson (1967) describes as sequential interdependence, worker A must act before worker B can act. The third form of interdependence can be labeled as reciprocal interdependence, referring to the situation in which the outputs of each become the inputs for the others. With sequential interdependence, coordination is achieved by planning, that is, the establishment of schedules for the interdependent workers, by which their actions are governed. For reciprocal interdependence, coordination is achieved by mutual adjustment, that is, the transmission of new information and feedback between interdependent workers, during the process of action.

Another possible negative effect of geographic flexibility is a reduced opportunity to learn from colocated workers. Organizations are sites of intensive learning, which is interpersonal, local, and variegated (Argote 1999, Edmondson 2002, Grant 1996). Remote workers must learn how to navigate temporal and geographic boundaries with coworkers, in addition to the social and political boundaries normally encountered in organizations, in order to learn and maintain a common set of practices (Orlikowski 2002). Research on learning strongly suggests that colocation results in knowledge spillovers among workers (Allen 1977, Jaffe et al. 1993, Singh and Marx 2013, Choudhury 2015 2017, Catalini 2017). This literature dates back to Allen (1977), who reported an exponential decline in communication between workers based on the physical distance that separated them. Colocation has been shown to help workers explicitly seek from their peers the knowledge needed to perform their tasks; this knowledge might be either codified or tacit (Polanyi 1966, Dasgupta and David 1994). Colocation may also help novice workers vicariously learn from experienced peers through transfer mechanisms, including demonstration and personal instruction, and by provision of expert services, such as advice and consultation (Coleman, Katz, and Menzel 1957, Greenwood et al. 2017, Myers 2018, Thornton and Thompson 2001).

Social embeddedness is an important precursor for learning at work (Brown and Duguid 1991) and for thriving at work more generally (Spreitzer et al. 2005). Conversely, social and professional isolation is a cost of temporal and geographic flexibility that is well documented in the research on remote work (e.g., Cooper and Kurland 2002, Golden, Veiga, and Dino 2008). Physical isolation can result in a loss of organizational identification (Bartel, Wrzesniewski, and Wiesenfeld 2012). Recent work has noted that the isolating effect of flexible work policies may impact both those choosing to work remotely and those remaining in the (considerably depopulated) office (Rockmann and Pratt 2015). Managers and organizations can help mitigate the costs of isolation for remote employees through the provision of structures that facilitate social interaction among remote employees, ground rules for the use of information technology tools (to facilitate communication), and clear performance evaluations (Makarius and Larson 2017).

Research Context and Exploratory Fieldwork

Because of the truly nascent stage of WFA research (Edmondson and McManus 2007), we undertook some preliminary qualitative, inductive work to identify potential mechanisms underlying the productivity effect of switching to a WFA regime. This exploratory work included 22 interviews with various USPTO managers, patent examiners, and POPA (labor union) leaders (details in Appendix A). These interviews were semi-structured and conducted in person, with average duration of 60 minutes. Additionally, we gathered online reviews posted by current and former patent examiners on the review site Glassdoor.com, which we describe later in this section. We will refer to this preliminary qualitative exploratory phase as our “fieldwork” for the remainder of the paper. In this section, we introduce the USPTO context, the job of patent examiner, and some of the preliminary insights we received from this qualitative exploration (which informed our subsequent hypothesis development and quantitative analysis).

The USPTO is a federal government agency with the authority to evaluate patent and trademark applications. The agency employs about 13,000 people, including slightly more than 8,000 patent examiners. The USPTO is headquartered in Alexandria, Virginia, with satellite offices in Detroit, Michigan; Denver, Colorado; San Jose, California; and Dallas, Texas. Patent examination comprises roughly 90% of the USPTO’s work; in 2015, the USPTO received 629,647 patent applications and granted 325,979 patents spanning a wide range of industries and technologies (Choudhury et al. 2017).

A patent application specifies a set of “claims” that defines the invention the applicant wishes to protect. Applications are assigned to examiners based on the required area of technical expertise (software, chemicals, mechanical, etc.). Examiners are organized into nine “technology centers,” each made up of smaller “art units.” Within a given art unit, a supervisory patent examiner (SPE) assigns each new patent application to a specific patent examiner (Lemley and Sampat 2012). The examiner is then responsible for reviewing the claims and moving the application through the examination process, with minimal supervisory oversight. Examiners must determine whether patent claims in applications meet criteria of “novelty” and “nonobviousness” in order to be patentable. In order to determine the validity of claims in an application, the patent examiner uses several proprietary search tools to review the body of publicly available work (called “prior art,” it includes existing patents, published patent applications, academic and trade journal articles, and

other publications). In order to determine “novelty,” the examiner must determine that the claims within the application are not already wholly addressed by another single patent or published work. For the criterion of “nonobviousness,” the examiner must determine whether there are parts of existing patents that could easily (or “obviously”) be combined to result in the invention claimed in the application (Frakes and Wasserman 2017).

Once the examiner has (to her knowledge) exhausted the existing prior art, she issues a “first office action,” (FOA) which can be an “allowance,” accepting all claims as patentable or, more commonly, a “nonfinal rejection,” which indicates that some or all claims are not patentable, and gives the basis for such rejection. Applicants can respond by withdrawing, narrowing, clarifying, or providing further evidence to support rejected claims. The examiner then reviews the response, accepts additional claims as applicable, and issues another office action. This process continues until the examiner believes that no further response will change the outcome of an application, at which point she issues a “final action.” Upon receiving a final action, the applicant has the choice of abandoning all remaining rejected claims, appealing the action to a board of appeal, or restarting the application process by paying an additional \$1,200 fee to initiate a “request for continued examination” (RCE). The RCE restarts the entire examination process, but is carried out by the same examiner and takes into account all prior communication. There is no limit on the number of RCEs an applicant may file, and approximately one-third of all applicants file at least one RCE, though few file more than three. Our field interviews indicate that applicants often choose to file an RCE because the examiner and the assignee do not agree on the interpretation of the text related to claims and which prior art should be considered in examining the claims.

Patent examiners are typically highly educated, holding undergraduate degrees in science and engineering, and some holding advanced degrees in technical fields. New employees are hired at a specific grade level (in line with hiring and employee ranking procedures at all federal agencies) based on their experience and skills. At the USPTO, examiners are hired at the civil servant “grade levels” GS-5, GS-7, GS-9, GS-11, GS-12, GS-13, GS-14, or GS-15, with pay and responsibilities increasing with each grade. During labor negotiations, examiners are represented by the USPTO’s union, the Patent Office Professional

Association (POPA). Examiners advance up to GS-13 automatically, based largely on tenure. Upon reaching GS-13, an examiner can enter a signatory review program in which the examiner's work is evaluated. Upon passing this review, the examiner is designated a partial signatory (PS) and can sign nonfinal office actions. After six months of PS status, examiners are eligible for a second-round work review. Upon passing this review, the examiner attains full signatory (FS) status, indicating that the examiner can sign all decisions (including first office actions and final office actions). Attaining FS status automatically results in a promotion to at least GS-14 grade; therefore, the transition to grade GS-14 or higher indicates transition to FS status, a point that becomes relevant in our analysis of coordination effects.

The USPTO measures examiner productivity using the number of actions completed by an examiner within a given period of time in relation to an expected productivity level, which is determined based on examiner grade level (a proxy for experience) and the examiner-specific case mix—examiners in more nuanced or complex fields are granted more time to examine a given application. First office actions are weighted more heavily than subsequent rulings in the count of total actions completed. The expected time to complete an action drops as examiner grade and seniority increase, with the highest-level examiner receiving approximately half the time of the lowest-ranked examiner to do the same work. Following the USPTO's measures, we take the number of actions in a given period as the measure of examiner production. We consider the number of RCEs in a given period to serve as a measure of rework. While we recognize that this is an imperfect measure (an inventor is well within rights to doggedly pursue a patent claim via an unlimited number of RCEs, regardless of the accuracy and quality of the examiner's ruling), an RCE mechanically leads to rework, as the examiner must search prior art again to write the next decision. Furthermore, our field interviews with USPTO personnel indicated that, on balance, a greater number of RCEs for a given examiner is likely to indicate a greater need for rework.

The process of patent examination is largely an individual exercise, but with some supervisory constraints. At lower grade levels, patent examiners are typically newer and less experienced in their fields and, therefore, must obtain approval on their actions from either their assigned SPE or a senior patent examiner. However, given the independent nature of the task, even for junior examiners, there is relatively

little coordination that needs to be managed between the examiner and his or her supervisor (Lemley and Sampat 2012, Choudhury et al. 2018).

Our fieldwork also reveals the importance of learning from peers for examiners to perform their task. The most important knowledge examiners have to learn from experienced peers relates to *how to construct the prior art search string*. Patent lawyers representing firms filing patents often engage in strategic behavior in framing the language comprising the patent claims, in order to secure the broadest possible claims.⁶ Our field interviews revealed that to counter this strategic behavior, experienced patent examiners often add keywords to their searches that encompass language beyond the text of the patent claims being examined. The knowledge needed for this search strategy is relatively tacit, and patent examiners often ask colocated colleagues for advice in framing a search string. Our interviews also revealed that novice examiners engage in vicarious learning on framing search strings by observing experienced examiners.

To further enrich our understanding of the examiners' perspective on their jobs, we gathered qualitative data from 258 online employee reviews at Glassdoor.com. Online reviews are believed to be biased toward polar extremes (Koh, Hu, and Clemons 2010), and reviewers may be biased by the content of previous reviews (Chen and Lurie 2013, Ma, et al. 2013). Yet, examining online reviews does suggest themes in a particular job that are important to employees as they evaluate their positions (Dabirian, Kietzmann, and Diba 2017). Further, the quantitative ratings given in these reviews did not appear to be skewed (details in Appendix B). The reviews contained a number of consistent themes. Temporal and geographic flexibility are both cited as highly valuable aspects of the examiner job that enable a desirable level of work-life balance. Furthermore, there are frequent mentions of the independent (low-interdependence) nature of the job, giving further confirmation that our research context is one of low, pooled interdependence. The job is also described as highly routine and repetitive, suggesting that routineness is a further scope condition of our findings. There is extensive discussion of the emphasis placed on meeting performance targets for actions, to the point where workers engage in unpaid overtime work to meet targets. This theme further supports our

⁶ This phenomenon has been discussed in prior literature (Choudhury et al. 2018); for a theoretical discussion, see Anton and Yao 2004).

use of the number of total actions as a valid measure of employee productivity in this context. Finally, it is interesting to see that while reviewers enjoy the autonomy inherent in temporal and geographic flexibility, they also note a high level of monitoring by technologies put in place in recent years to track employee time on the job. (Details in Appendix C.)

Remote work programs at the USPTO

The USPTO experimented with more than one remote work program. At one end, there was a true WFA program called “Telework Enhancement Act Pilot Program (TEAPP),” which allowed eligible examiners to live and work at any location in the U.S.; on the other end, the USPTO implemented remote work programs such as the “Patents Hoteling Program (PHP)” that offered examiners less autonomy on location choice. Below we describe institutional details related to all the remote work programs at the USPTO. The bulk of our empirical analysis focuses on the TEAPP program, which we will refer to as “WFA.”

We will focus on these two prominent telework programs at USPTO: WFA (i.e., TEAPP) and WFH (i.e., PHP). The USPTO introduced the voluntary PHP in January 2006 with an initial cohort of 500 patent examiners. PHP provides eligible employees with equipment and remote access to systems and allows them to work from home up to four days per week. When they report to the office, they reserve desk space through an online system. PHP is a classic work-from-home program that offers temporal flexibility, but less geographic flexibility than WFA. Initially, eligibility for the program was limited to those at the GS-14 level and above, but it was later lowered to GS-12. In addition, participants must have worked at the USPTO for at least two years and demonstrated “satisfactory performance.” Eventually, the PHP program grew to include two subprograms: (1) the “PHP within 50 miles” program (i.e., those examiners who lived within the 50-mile radius of the USPTO headquarters in Alexandria and reported to the USPTO headquarters at least once per week); and (2) the “PHP greater than 50 miles” program (i.e., those examiners who lived at least 50 miles from headquarters but were still required to report to the USPTO headquarters at least once a week).

In December 2010, President Barack Obama signed the Telework Enhancement Act, which set standard rules and regulations for remote work at federal government agencies. In early 2011, the USPTO

began planning to pilot a WFA program (i.e., TEAPP), allowing employees to work anywhere in the contiguous U.S. (greater than 50 miles from the USPTO) and travel to headquarters periodically at their own expense. In other words, WFA awarded eligible patent examiners geographic flexibility. Importantly for our purposes, the USPTO did not adjust wages for employees opting to participate in either the WFH or WFA programs; this helps us test the net impact on firm productivity of the WFA benefit in the absence of any offsetting reduction in wages.

Employees were eligible to participate in WFA if they: (1) were already enrolled in the “PHP greater than 50 miles” program; (2) had access to the Internet and USPTO systems; (3) agreed to change their “duty station” (i.e., home office) to a location greater than 50 miles from USPTO headquarters; and (4) waived their rights to travel reimbursement for required trips back to headquarters. The USPTO capped the number of trips that teleworking employees would need to make to headquarters at 12 days and/or five trips during a fiscal year. The USPTO also provides WFA workers with online communication tools such as Microsoft Lync, WebEx webinar services, and Cisco Voice over Internet Protocol (VoIP). On January 30, 2012, the USPTO officially launched the WFA program. On June 24, 2013, the USPTO (in negotiation with POA) amended the WFA agreement to include the following: “the above tools (instant messaging, document/desktop sharing, virtual meeting, video communication, and a presence indicator) would be mandatory for...full-time teleworkers,” noting that “the purpose of requiring the use of these tools was to encourage collaboration” (National Academy of Public Administration, 2015, p. 70).⁷ Employees who had been located in the Alexandria headquarters for at least two years were eligible for the “PHP greater than 50 miles” program. Therefore, we know that employees transferred to WFA during its initial ramp-up had already achieved a baseline level of task-specific human capital and had benefited from significant learning effects while being colocated with experienced examiners in Alexandria. The combination of this baseline level of learning with the low levels of coordination required for examiners in general yield a setting in which we expect minimal negative effects from increased learning and coordination costs under WFA.

⁷ Source: <http://www.laipla.net/wp-content/uploads/2015/08/NAPAtelework2015.pdf> (website accessed on March 6, 2019).

Hypotheses: WFA and Productivity

We begin with an attempt to replicate Bloom et al.'s (2015) findings of a productivity increase under a remote work regime. We do this to extend the Bloom et al. (2015) findings to our higher-skilled context that additionally offers workers geographic flexibility (not offered in the Bloom et al. context). It seems likely that the benefits identified in Bloom et al. (2015) would be mirrored in our context. WFA employees at the USPTO have no mandated commute time (assuming they work at home) other than the occasional trip to headquarters in Alexandria. Because of the independent nature of the work, examiners can also enjoy more flexible working hours.⁸ So, it is safe to assume that WFA at the USPTO offers employees increased temporal and geographic flexibility well above that available to employees who were working in the office. Like Bloom et al. (2015), we expect to see that an implementation of WFA results in increased work output.

Generally, while the increased perceived autonomy awarded by WFA could positively affect work output, WFA could result in higher rework due to both increased coordination costs and fewer opportunities to learn from colocated peers. However, we argue that *in our setting* neither of these things are likely to affect rework, especially for patent examiners with a baseline level of task-specific human capital. First, experienced patent examiners are not likely to suffer negative learning effects due to lack of colocation with peers. As prior research (Katila and Ahuja 2002, Rosenkopf and McGrath 2011, Argote and Miron-Spektor 2011) has shown, learning by doing is accrued through the experience of performing a task repeatedly. Given their preexisting tenure of at least two years at USPTO headquarters and the routine nature of patent examination, experienced patent examiners are likely to have already developed the requisite absorptive capacity (Cohen and Levinthal 1990) and task-specific human capital to perform tasks such as a prior art search.

Second, as described earlier, patent examiners carry out their tasks (researching, searching for prior art, writing decisions, and communicating with applicants) independently, and there are relatively few requirements to coordinate with peers. In this pooled-interdependence setting, patent examiners reach out to peers mainly to seek advice on relevant prior art. Experienced examiners could continue to leverage their

⁸ In the case of the USPTO, employees working in Alexandria may be allowed some flexibility in work hours (under the U.S. government employees' flex time policy (<https://www.opm.gov/policy-data-oversight/pay-leave/work-schedules/fact-sheets/alternative-flexible-work-schedules/>)).

intraorganizational social ties even after migrating to a WFA program, and our field interviews yielded examples of experienced WFA examiners calling peers (who might be based in Alexandria or elsewhere) and sharing computer screens on the videoconferencing calling tool WebEx to ask: (1) “Do you have a search for me?” (that is, have you searched this topic previously and, if so, could you share the results?); or (2) “Can you take a look at my drawings and suggest prior art?” In summary, experienced examiners have already developed firm- and task-specific human capital and have the technological means to reach out and seek advice from prior colocated colleagues. Given this, we anticipate that, on balance, even as the amount of output increases, the amount of rework will *not* increase after such employees move to a WFA regime, though there may be variance between workers with different levels of coordination requirements and technology use. We hypothesize:

HYPOTHESIS 1a. For workers in a pooled-interdependence (low-coordination) setting who have a baseline level of learning and task-specific human capital, the granting of geographic flexibility through a work-from-anywhere regime leads to an increase in output.

HYPOTHESIS 1b. For workers in a pooled-interdependence (low-coordination) setting who have a baseline level of learning and task-specific human capital, the granting of geographic flexibility through a work-from-anywhere regime does not lead to an increase in rework.

Having proposed a positive overall relationship between WFA and productivity, we then examine the relationship between the degree of geographic flexibility granted to a remote worker and the increase in productivity, in a pooled-interdependence setting. Granting a greater degree of scheduling flexibility and autonomy to a teleworker positively moderates the relationship between telecommuting and work-family conflict (Golden, Veiga, and Simsek 2006) and the relationship between degree of telecommuting and job satisfaction (Golden and Veiga 2005); it also positively affects employee task performance and citizenship behavior as rated by managers (Gajendran, Harrison, and Delaney-Klinger 2015). As summarized earlier, the USPTO offered two versions of remote programs: a classic work-from-home program that offers temporal flexibility and a work-from-anywhere program that offers both temporal and geographic flexibility to workers. As our field interviews suggested, in the case of WFA, a greater degree of geographic flexibility led to less

frequent trips back to the USPTO headquarters, lower costs of traveling and booking hotels for a weekend stay around Alexandria, and lower costs of living, all resulting in greater perceived control over their jobs, and thus greater autonomy. Given this, we hypothesize that remote work (i.e., WFA) offering both geographic and temporal flexibility has greater productivity benefits compared to remote work (i.e., WFH) offering temporal flexibility alone:

HYPOTHESIS 2. For workers in a pooled-interdependence (low-coordination) setting who have a baseline level of learning and task-specific human capital, WFA is associated with greater increases in productivity compared to WFH.

Data

This paper draws on multiple sources of data. We begin with a unique administrative dataset obtained from the USPTO for the years 2007 to 2015 that reports, annually, all patent examiners on the USPTO payroll, their general schedule (GS) pay level, and a benchmark measure of productivity used for promotion decisions (as a function of the “United States Patent Classification” or USPC class of their examined patents). We link this data to a separate administrative dataset, again obtained from the USPTO, that identifies which examiners are enrolled in each remote work program, their current home office location, and when they began remote work. From here, we link the combined examiner datasets to publicly available USPTO data on applications and transactions (such as RCEs) to quantify examiner-level output and rework.

Examiner Personnel Data

The first dataset used for this study is an annual record of all patent examiners active at the USPTO from 2007 to 2015, with 9,210 unique examiners over these eight years, inclusive. This data also provides the GS (grade level) of every USPTO examiner, data that is otherwise not public. As described earlier, the grade level of an examiner is of particular importance: it serves as a natural hierarchy for promotions, it is mechanically correlated with tenure and experience, and higher-grade examiners have increasing levels of autonomy in their workflows. Hence, controlling for grade level is important to account for unobservable task-specific human capital of examiners (Gibbons and Waldman 2004).

We also utilize a second unique USPTO-provided personnel dataset specifically focused on remote workers. This second dataset includes examiner identifiers, as well as the remote work program(s) in which

the examiner enrolled: WFA, and PHP (<50 miles and >50 miles combined). Figure 1 shows the growth in remote working across the remote work programs from 2007 to 2015; WFA appears to gain an increasing share of the teleworking population as examiners substitute away from PHP programs. The examiner-specific start date for each specific telework program is also available to us, allowing us to track an examiner across programs. This data also identifies the city and state of a teleworking examiner (as of August 2016), which is important for spatial analyses (to be described later).

[Figure 1 here]

USPTO Patent Data

Data on patents and patent application-level transactions were collected from a combination of two publicly available datasets: USPTO's Public PAIR (Patent Application Information Retrieval) dataset and PatentsView. Application data collected includes the name of the examiner assigned to a patent, the examiner's art unit, and the USPC classification of the application. For each patent, we then collect data on all transactions executed by an examiner, focusing on two specific metrics of productivity: total actions (measure of output) and RCEs.⁹ Total actions is a measure of aggregate output delivered by an examiner, and aligns with the PTO's internal performance measure of expectancies. The second measure, RCEs, or requests for continued examination, are a measure of *rework*.

Spatial Data

City and state data on the most recent location of teleworking patent examiners was obtained through the USPTO administrative dataset on teleworkers. This data was then geocoded using commercially available GIS tools, and measures of the spatial concentration of WFA examiners were calculated.

⁹ We assume here that shirking—another possible negative outcome associated with increased autonomy—is reflected in the productivity measure, given that we are using an objective measure of productivity. Concerns about shirking were addressed at the USPTO in a contemporaneous time frame, with claims of “examiner fraud” and “attendance abuse” made by *The Washington Post* (2014, 2016), based on critical findings from the U.S. Department of Commerce's Office of the Inspector General. However, all of these findings related to either (1) overreporting of hours worked or (2) shifts in the timing of work completed, such as backloading at the end of a calendar quarter, which raised concerns about the accuracy and quality of work completed. USPTO Office Director Michelle K. Lee told lawmakers that she and her team “do not tolerate any kind of attendance abuse” (*Washington Post*, 2016). Our measure of productivity is only output dependent, so overreporting of time worked would not affect this measure. Second, our measure of rework—while not a perfect proxy for quality—should capture any substantial degradation in work quality due to backloading or other timing shifts. In robustness checks available upon request, we also employ month fixed effects to test our causal results, and results remain robust.

Identification Strategy: Natural Experiment

To provide robust econometric estimates related to how the implementation of WFA affected output and rework, we exploit a natural experiment within the USPTO. As outlined earlier, the implementation of WFA was driven by negotiations between USPTO management and the union of patent examiners. Specifically, these negotiations resulted in a monthly quota for eligible examiners transitioning to WFA in the first 24 months of program implementation. Our field interviews indicated that the monthly quotas were oversubscribed, and eligible examiners, in many cases, had to wait for several months to transition into the WFA program. While it is likely that observable and unobservable factors determine whether or not examiners transition into WFA, we circumvent these concerns by focusing on the sample of examiners who selected to transition into the WFA program over the first 24 months and exploit variation in *when* (i.e., which month) the examiner could transition into WFA, variation that is exogenous given the monthly quotas determined by USPTO management and the union (POPA). Below we provide further details of how the implementation of the WFA program lends itself to a natural experiment.

As a result of the negotiations conducted between USPTO management and POPA, the USPTO planned to enroll participants in the WFA program in phases. Additionally, and importantly for the purpose of identification, there was an exogenous quota imposed for eligible examiners enrolling in the WFA program. The number of slots was decided by a committee comprising management and union members. If a slot was not available, the prospective enrollee was placed on a waiting list. Our field interviews indicated that “all slots allocated for the first several months were exhausted,” implying that even if an examiner was eligible for WFA, he or she would have had to wait an unknown length of time before transitioning to WFA. As such, the timing of an eligible examiner’s transition to WFA was relatively exogenous. Our field interviews indicated that prior tenure, experience, or performance were *not* considered in allocating slots to eligible examiners.

To validate our natural experiment and the insights generated by the field interviews, we test whether the variation in WFA transition time was truly exogenous by regressing the time it took an eligible examiner to transition to WFA on observable measures of past performance. As our main results analyze productivity

(and include a measure of the expected work as a control), we regress “months to WFA” on measures of total examiner-level output, rework, and expectancy (a measure of expected output in the previous year). Results from these analyses are reported later in the paper: We find no evidence of selection on prior performance (or other observables), validating our principal identification strategy.

Estimation and Results

We focus on utilizing the natural experiment and limit our sample to examiners who enrolled in WFA in either 2012 or 2013. Within this sample, we exploit bureaucratic process-induced variation in enrollment dates to identify the effect of receiving WFA *earlier* than another examiner. As both examiners in this exercise must be eligible and have selected into the program, we avoid the traditional identification issues that arise from self-selection—all examiners in our sample can be thought of as treated, varying only in the amount of time they have had to wait to be exposed to the treatment (WFA). Moving forward, we refer to this sample as the “WFA sample.” The WFA sample comprises 831 examiners (out of the 9,210 examiners). Tables 1a and 1b report summary statistics for the full sample and the WFA sample, respectively.

[Tables 1a and 1b here]

Causal Estimation of the Effect of WFA on Productivity

Hypotheses 1a and 1b state that for workers in a pooled-interdependence (low-coordination) setting who have a baseline level of learning and task-specific human capital, the granting of geographic flexibility through a work-from-anywhere regime leads to an increase in output and does not lead to an increase in rework. We utilize the natural experiment described above and employ the following examiner month-level specification to test these hypotheses:

$$Output_{it} = \alpha_i + \beta_{it} * WFA + \xi_{it} + \gamma_t + \lambda_i + \epsilon_i$$

where WFA is a binary indicator that turns on (and stays on) when an examiner enrolls in WFA during the 2012 to 2013 timeframe. As described earlier, we use two different measures of individual-level output: We measure individual output using total actions and measure individual rework using the number of RCEs. ξ_{it} is a vector of controls that includes examiner month-specific grade level and examiner month-specific expectancy, while γ_t is a full set of time (month) fixed effects and λ_i is an optional set of examiner fixed

effects. Standard errors are clustered at the art unit level to account for concerns regarding intra-art unit correlation of error terms, particularly as they relate to unobserved routines. Columns 1-4 of Table 2 provide the focal set of results evaluating the effect of WFA on productivity.

[Table 2 here]

Columns 1 and 2 report results relevant to output. Specifically, column 1 identifies the effect of WFA on the total number of actions completed by each examiner in a given month, with column 2 including a set of examiner fixed effects to identify the effect not just within the sample of examiners transitioning to WFA in 2012 and 2013, but *also* within each examiner. There is a positive, highly significant effect of WFA on overall output, roughly corresponding to a 4.42% increase in the total number of actions on a mean of 12.97 per month. Columns 3 and 4 present results indicating that WFA does not increase the amount of RCEs, or rework, an examiner engages (with or without examiner fixed effects). In summary, Hypotheses 1a and 1b are both supported. It is important to note that since workers had to first transition into the WFH program prior to transitioning to the WFA program, the baseline level of productivity here is productivity of the examiner while on the WFH program. We now turn attention to further comparing productivity on these two remote work programs as well as comparing productivity on WFA and WFH to ‘in-office’ productivity.

Comparison of WFA and WFH

Hypothesis 2 states that for workers in a pooled-interdependence (low-coordination) setting who have a baseline level of learning and task-specific human capital, WFA (which offers both geographic and temporal flexibility) is associated with greater increases in productivity compared to WFH (which offers temporal flexibility alone). To recap, the USPTO experimented with a series of remote work programs. There was a WFA program (i.e., TEAPP) that allowed eligible examiners to live and work at any location in the U.S., and the USPTO implemented remote work programs such as PHP that offered examiners less autonomy on location choice and were akin to WFH programs. Given that the bureaucratic assignment to remote work is valid only for WFA, we can no longer rely on the natural experiment in this setting, and we estimate the specification below within the full sample of existing examiners across all months (576,267 examiner-months from 2007-2015):

$$Output_{it} = \alpha_i + \beta_{1it} * WFA + \beta_{2it} * PHP_{<50} + \beta_{3it} * PHP_{>50} + \xi_{it} + \gamma_t + \lambda_i + \epsilon_i$$

where WFA , $PHP_{<50}$, and $PHP_{>50}$ are indicator variables for when an examiner enrolled in either of the three programs, indicators that remain on until the examiner switches programs. As before, ξ_{it} is a vector of controls that includes examiner month-specific grade level and examiner month-specific expectancy, while γ_t is a full set of time (year) fixed effects and λ_i is a set of examiner fixed effects, which are of particular importance in this exercise as they allow us to track examiners as they switch from program to program. As before, standard errors are clustered at the art unit level. Table 3 provides results from this estimation exercise:

[Table 3 about here.]

Column 2 reports the most restrictive specification with examiner fixed effects. As this model includes examiner fixed effects, we note that the coefficients are semi-additive: WFA captures the effect of remote work above and beyond PHP (>50 miles), as examiners must enroll in the latter before being eligible for the former. Hence, in this model, all telework programs increase productivity, with PHP (>50 miles) having the lowest effect, while PHP (<50 miles) has roughly twice the impact as PHP(>50 miles). The impact of WFA, when interpreted additively with PHP (>50 miles), is far above and beyond the other remote work programs. It is important to note that we interpret these results in the context of one another rather than as causal estimates; the full sample regressions illuminate the relative differences between the remote work programs rather than the absolute improvements themselves.

Evidence on Mechanisms: Fingerprint of Geographic Flexibility

We now turn to establishing a fingerprint for mechanisms through which geographic flexibility can affect productivity. We first examine whether WFA examiners relocate to counties that lower their cost of living and, in effect, increase their real income. While real estate cost reduction for employers is fairly obvious (and described earlier in the context of the USPTO), we now examine whether employees benefit from telework programs by selecting into lower cost-of-living areas. Utilizing previously described county-level cost-of-living data, we estimate the effects of telework on an examiner's current home cost-of-living index relative to

Alexandria, Virginia, within both the full sample and the sample of examiners transitioning to WFA in 2012-2013. We estimate:

$$Cost_of_Living_Reduction_{it}$$

$$= \alpha_i + \beta_{1it} * WFA + \beta_{2it} * PHP_{<50} + \beta_{3it} * PHP_{>50} + \xi_{it} + \gamma_t + \lambda_i + \epsilon_i$$

where $Cost_of_living_reduction_{it}$ is an examiner-specific measure of the reduction in the county cost-of-living index relative to Alexandria, while WFA , $PHP_{<50}$, and $PHP_{>50}$ are indicator variables defined as before. This model similarly includes controls for year, grade level, and expectancy, but does not include examiner fixed effects, as those would absorb all time-invariant, examiner-specific variation in cost-of-living reductions. Column 1 of Table 4 reports results from regressions utilizing the full sample of examiners.¹⁰ We find evidence of substantial cost reductions associated with PHP (>50 miles) and WFA, on the order of two standard deviations in the distribution of cost reductions across all teleworking examiners. As expected, PHP (<50 miles) does not show evidence of cost reductions, as those examiners must live in and around Alexandria. The results remain robust in the WFA sample (column 2).

[Table 4 here]

We next study WFA workers' geographic locational choices. As part of our examination of the data on WFA examiner location (Figure 2), we noticed there were clusters of examiners in a number of major metropolitan areas, including New York, Chicago, San Francisco, Los Angeles, Seattle, and Minneapolis, among others. These clusters can be expected given the concentration of population in these metropolitan areas. However, it also became clear there was a cluster of examiners in Eastern Texas, and another cluster along both of the Florida coasts. These clusters cannot be explained easily by population alone; however, further discussion with patent scholars¹¹ and USPTO staff yielded some interesting insights.

[Figure 2 here]

¹⁰ As reported in Table 1a, this sample has 576,274 examiner-month-level observations. We dropped a few observations, corresponding to examiners without worker location data.

¹¹ We are indebted to Iain Cockburn and Tim Simcoe for their advice on the development of this section of the paper.

First, the Eastern District of Texas—during the years preceding and during our timeframe—was one of the (and in some years, the) most active venues for patent litigation in the U.S.¹² This concentration of litigation was driven by a relatively loose legal standard for the location of patent lawsuits combined with a relatively high propensity of this particular District Court to find in favor of plaintiffs in patent infringement cases. Another result of this concentration of litigation was a proliferation of patent attorneys in this District. Our fieldwork also suggested that becoming a patent attorney is a common career progression for a patent examiner, especially for early- and mid-career examiners, so it is plausible that such patent examiners might choose to locate in an area in which there is significant potential for future employment as a patent attorney. Indeed, results reported in column 2 of Table 5 indicate that for the sample of WFA examiners, geographic proximity to Marshall in the Eastern District of Texas is correlated to an indicator for being an early- or mid-career patent examiner. Here we employ a dummy to indicate whether or not the examiner is GS14 or above, a measure of later-career patent examiners.

Next, we posited that a common reason for relocation to the coastal areas of Florida is seeking alternate living arrangements when workers are close to retirement. We asked whether it was possible that more senior patent examiners were relocating to Florida at a higher-than-average rate, possibly as a first step toward retirement. The first column of Table 5 indicates a positive and statistically significant correlation between tenure at the USPTO and the probability of choosing to live in Florida.

[Table 5 about here].

While these results begin to paint a picture of geographic location choices under a WFA regime, it is important to note that they do not capture the full range of decision-making criteria. For example, a worker may choose to relocate to a given location due to proximity to family (elderly parents, for example) or to return to a location where they have more friends and family (e.g., Dahl and Sorenson 2010a 2010b). We

¹² A May 2017 U.S. Supreme Court ruling significantly limiting jurisdictional choice for patent litigation resulted in a significant decline in patent applications in Eastern Texas by late 2017. While this ruling does not affect our findings, it provides an interesting exogenous shock that could be used in future research to explore further the question of patent examiner location choice.

expect there are a number of further relocation decision criteria not captured in the current analysis. Future research on the worker perspective would further refine this initial fingerprint.

Work Practices that Enhance Productivity of WFA Workers

We conducted supplementary analyses to study productivity effects of work practices within the USPTO that might be correlated with work output of examiners, while on the WFA program. While an exhaustive examination of all relevant work practices is beyond the scope of the paper, our analysis is motivated by a work practices that we could observe and where we could measure productivity effects.

Geographically Proximate Peers

We study productivity effects of having geographically proximate peers. We postulate that WFA workers might experience disproportionate gains to productivity when they are geographically proximate to other WFA workers. Recognizing that the transfer of knowledge and, thus, learning reflects the social context in which the worker is situated (Brown and Duguid 2001), it seems likely that increased geographic proximity of professional peers would result in enhanced knowledge transfer, learning, and ultimately, productivity (Singh and Marx 2013, Choudhury 2015, Catalini 2017). Furthermore, proximity of coworkers could mitigate the sense of professional isolation often experienced by remote workers (Golden, Veiga, and Dino 2008).

We can utilize data on the location of a WFA examiner to identify the effect, if any, that collocated peers have on one’s productivity—namely total output and the addition of examiner-added citations. Limiting our sample to examiners outside the Alexandria commuting zone (those examiners at least 50 miles away from Alexandria),¹³ we estimate the effect of WFA along with terms that capture both the count of all examiners within a close radius of the focal examiner (25 miles) and examiners within the same art unit (also within 25 miles) as well. Specifically, we utilize our causal sample and model:

$$Output_{it} = \alpha_i + \beta_{1it} * WFA + \beta_{2it} * AllExaminers_{<25\ miles} + \beta_{3it} * SameArtUnitExaminers_{<25\ miles} + \xi_{it} + \gamma_t + \epsilon_i$$

¹³ Examiner locations are coded at the city level. In order to account for variation in the distance from the centroid of the city to the possible examiner home location, we were functionally limited to just shy of 60 miles. Manual validation confirmed that this threshold was necessary to avoid including all examiners within the 50-mile commuting zone around Alexandria.

where ξ_{it} is a vector of controls that includes examiner month-specific grade level and examiner month-specific expectancy, while γ_t is a full set of time (month) fixed effects. While we do not provide within-examiner estimates in this exercise (as examiner location is fixed over time in our data), we reiterate the use of the natural experiment as providing identification. Table 6 provides results from this estimation exercise.

[Table 6 about here.]

All columns point to a positive impact of WFA on output, with magnitudes broadly consistent with our main estimates. Focusing on the third column, we note that as the number of nearby (within 25 miles) examiners within the same art unit increases, productivity increases. More specifically, an additional nearby same-art-unit examiner yields an increase in productivity that is roughly 1.5 times the main WFA effect. Notably, an increase in general (not art unit-specific) teleworking examiners yields essentially zero effect on productivity.

Coordination Effects Measured Using IT Usage

Next, we postulate that the use of IT tools will enhance the productivity of WFA workers, especially WFA workers with a greater need for coordination. Research on remote work has indicated that the use of IT tools that foster situational awareness of the task helps in coordinating geographically dispersed workers (Malhotra and Majchrzak 2014). IT tools that are directed toward synchronous communication could arguably aid situational awareness and productivity of remote workers. We exploit institutional details of our setting to test this proposition.

As per a USPTO directive in June 2013, all teleworking patent examiners were mandated to utilize USPTO IT tools (e.g., logging into the USPTO virtual private network (VPN) and using USPTO messaging services). This provides us with the ability to measure the impact of IT on productivity for a sample of WFA examiners. Presumably, mandated IT usage could reduce coordination costs, particularly for those examiners with a higher need to coordinate (assistant examiners without signatory authority had to coordinate with their supervisors. Limiting to our causal sample first, and further limiting to those examiners enrolled in WFA prior to June 2013, we estimate the following model:

$$Output_{it} = \alpha_i + \beta_{1it} * IT + \beta_{2it} * IT * Examiner\ needing\ supervision + \xi_{it} + \lambda_i + \epsilon_i$$

where ξ_{it} is a vector of controls that includes examiner month-specific grade level and examiner month-specific expectancy and λ_i is a set of examiner fixed effects. Table 7 provides results from this estimation exercise. Column 1 reports results for total actions, where the IT mandate improved output by 3% (off a mean of 12.9) exclusively for those examiners without signatory authority, that is, examiners who while they do the work on their own, have to coordinate with their supervisors to get their work checked. Column 2 reports results for RCEs, where we find no significant impact of the IT policy.

[Table 7 about here.]

Robustness Checks

To test for concerns around time trends and reversion of performance to the mean posttreatment (due to reciprocity or other unobserved mechanisms), we plot month-specific fixed effect coefficients in Figure 3 and find no evidence of reversion to mean posttreatment. This analysis was also repeated for a longer time window, and results remain robust. Given the point estimate of the month prior to treatment revealed in Figure 3, we additionally drop the two months prior to treatment from our regression analysis, and all results remain robust. Further, in order to validate our natural experiment, we look for evidence of selection in the time-to-WFA variation for those employees enrolling in WFA in 2012 or 2013. We estimate a model to determine whether previous performance, expected performance (expectancy), or rework is correlated with how soon an examiner receives WFA. In order to do so, we limit our sample to those examiners who obtained WFA in 2012 or 2013 and estimate variations on the following model:

$$Months_i = \alpha_i + \beta_{1i} * X_{it, < 2012} + \xi_{it} + \epsilon_i$$

Where $Months_i$ is an examiner-specific measure of the number of months (0-23) it took an eligible examiner to actually get in the program. X refers to total actions, total RCEs, or expectancy; hence, $X_{it, < 2012}$ refers to an examiner's annual prior performance, rework, or expected performance. ξ_{it} is a set of controls for an examiner's GS at the month level. Table 8 presents results from these regressions. We find no evidence of previous performance, expected performance, or rework being correlated with the amount of time it took an examiner to transition to WFA, validating our identification strategy. We also conduct a placebo treatment test, explained and reported in Figure 4.

[Figure 3, Table 8 and Figure 4 here]

A potential concern is that examiners, upon transitioning to WFA, may scale back or distort effort relative to the quality of their work prior to being a WFA worker. For instance, while examiners may increase overall output, it is *ex ante* unclear whether leniency and/or effort change. In the following exercise, we check for evidence of either of these distortions in our sample of examiners transitioning to WFA in 2012-2013, by estimating effects on first office actions, application rejections, and examiner-added citations, which we use as a proxy for effort. We estimate the following model, as before:

$$Output_{it} = \alpha_i + \beta_{it} * WFA + \xi_{it} + \gamma_t + \lambda_i + \epsilon_i$$

where *Output* is defined as the count of first office actions, the count of rejections, and the count of examiner-added citations (at the examiner month level), utilizing the same controls as before (examiner, year, grade level, expectancy). Table 9 reports results from this exercise.

[Table 9 here]

Considering columns 1 and 2, we find that the increase in first office actions is matched by a proportional increase in rejections. We interpret this as evidence that examiners are no more or less lenient upon transitioning to WFA. Column 3 reports results for examiner-added citations—we are unable to distinguish from the null here; there appears to be no reduction in examiner-added citations for those examiners transitioning to WFA.

Welfare Estimates

Using our estimates of a 4.4% increase in examiner-level production (for experienced examiners) with no increase in the amount of rework (or RCEs), we can make a back-of-the-envelope calculation of the net profit increase at the USPTO under two assumptions. First, we assume that the 4.4% increase in total actions reasonably corresponds to a 4.4% increase in the number of patents examined, which we argue is plausible. Using the 4.4% increase in patent examination output, we can estimate that USPTO profit increases two ways, one simple and one more nuanced. One, we assume the number of examiners remains fixed and that pendency (i.e., number of outstanding patent examinations) is not a concern to the USPTO and simply estimate a 4.4% increase on \$3 billion in annual fees collected (USPTO 2017), with no increase in costs for

patent examinations, for a total increase of \$132 million. A second, more realistic estimate would also consider the USPTO's continuing concerns with pendency, which have caused the USPTO to increase hiring substantially over the past few years (United States Government Accountability Office 2008). The productivity improvements from WFA could reduce the need for new hires in addition to improving output (and, hence, fees collected), so above and beyond the \$132 million increase in fee revenue, we estimate a 4.4% reduction in FTE and the subsequent fixed hiring and variable wage costs. As the PTO hired 780 additional examiners each year with an average salary of roughly \$80,000 and hiring costs of roughly \$20,000 (Choudhury et al. 2017), we estimate a one-time reduction of \$0.7 million and a continuing annual cost savings of \$2.75 million. In addition, we provide evidence of the effectiveness of WFA for the USPTO based on survey and qualitative evidence. In 2013, due in part to the agency's remote work options, the USPTO was ranked highest on the "Best Places to Work in the Federal Government" survey.¹⁴ Environmental benefits also accrue from the program; in 2015, the agency estimated that its remote workers avoided driving 84 million miles, thereby reducing emissions by more than 44,000 tons. Finally, in 2015, the USPTO estimated that it saved \$38.2 million in real estate avoidance costs due to remote workers freeing up office space at headquarters.¹⁵

Finally, one particular feature specific to our setting is that the USPTO also helps set the rate of U.S. innovation, standing as one last bottleneck in the traditional innovation process. A 4.4% increase in patent grants could lead to innovation spillovers that amount to a total of \$1.3 billion. We arrive at this estimate through back-of-the-envelope calculations. Choudhury et al. (2017) indicate that the average number of patent grants from 2009 to 2012 was 211,973 patents per year; this figure, taken into consideration with our estimated 4.4% increase in production, would lead to roughly 9,326 more patents being granted every year. Prior literature also indicates that the mean value for patents granted to U.S. patentees was \$78,168 in 1992 dollars (Bessen 2008). The author also estimates the median value of a patent to a U.S. assignee to be \$7,175 in 1992 dollars. We convert the mean and median values of a patent to a U.S. assignee to 2018 dollars and

¹⁴ Source: <https://www.uspto.gov/about-us/news-updates/us-patent-and-trademark-office-ranks-1-best-places-work-federal-government>

¹⁵ Source: <https://www.uspto.gov/sites/default/files/documents/TeleworkAnnualReport2015-508.pdf>

estimate that a 4.4% increase in production of patents at the USPTO creates \$120 million value for the U.S. economy (considering the median value of a patent in 2018 dollars) and \$1.3 billion value for the U.S. economy (considering the mean value of a patent in 2018 dollars).

Discussion

We study the relationship between geographic flexibility granted through a work-from-anywhere (WFA) program and worker productivity in a highly skilled work context. Our choice of setting presents us with two important empirical opportunities. First, the presence of a natural experiment originating from a bureaucratic policy allows us to mitigate the impact of endogeneity of selection into a WFA regime. Second, the dual mandate—to first spend two years in the office with other coworkers and then spend time in a traditional WFH program prior to becoming a WFA worker—allows us to compare the productivity effects of WFH and WFA. We find robust productivity effects, with a 4.4% increase in work output under WFA in comparison to WFH, and no effect on additional rework. We provide evidence on mechanisms: notably that WFA examiners relocate to lower cost-of-living locations. We also study the choice of geographic location made by WFA workers and find interesting differences based on worker tenure and career stage: There is a correlation of early- and mid-career examiners moving to the Eastern District of Texas (a location that exhibits a concentration of patent law firms), and we find a correlation between tenure at the USPTO and the likelihood of moving to a “retirement friendly” location such as Florida. We also study conditions under which productivity of WFA workers is further enhanced. We find evidence that employees located near other examiners from the same art unit experience productivity increases well above those of examiners located near examiners from other art units (or not located near other examiners), suggesting that geographically clustered WFA examiners from the same art unit may learn from each other. Mandating IT usage also appears to relax coordination constraints (and, thus, increase productivity) for employees requiring supervisory approval of work. A back-of-the-envelope calculation suggests that the increase in patents granted due to higher examiner productivity could result in \$1.3 billion of added value to the U.S. economy in the best-case scenario.

This paper makes contributions to research in the areas of nonstandard work and remote work. Our conceptualizing of *geographic flexibility* where the worker can decide to *work from anywhere*, distinguishes our study from prior research on remote work and working from home. As Gajendran and Harrison (2007) state, working from home offers the worker temporal flexibility and flexibility in choosing working conditions. In contrast, working from anywhere affords all of the benefits of working from home, plus the flexibility to relocate to a geographic location different from the employer's. As a result, while the work-from-home (WFH) literature, notably Bloom et al. (2015), focuses on productivity-enhancing mechanisms such as fewer work breaks, sick days, and the benefits of a quieter work environment, our focus on geographic flexibility points to mechanisms such as the benefits of moving to a lower cost-of-living location, the degree of geographic flexibility (i.e., comparison of WFA to WFH) and the effect of geographic proximity to other WFA workers.. In studying geographic flexibility, we also contribute to the literature on nonstandard work and physical detachment. While Ashford, George, and Blatt (2007) characterize physical detachment within nonstandard work, as “work from home” and “work at client sites,” we push the frontier further by theorizing about geographic flexibility and work from anywhere. As we examine a transition to WFA with no change in compensation practices, and also look at the combination of employee choices and employer outcomes under WFA, we begin to address calls for a systems perspective on nonstandard work arrangements (Bidwell et al, 2013).

We also contribute to the literature on nonpecuniary incentives (Sauer mann and Cohen 2010, Kryscynski 2011, Gambardella et al. 2015, Stern 2004). Our study suggests that the firm can create value through the addition of a nonpecuniary incentive such as WFA without decreasing wages in the process, contradicting the underlying assumption of hedonic models of compensation, as predicted by Lazear and Shaw (2007). Our results are also relevant to the literature on worker perceived autonomy; as described earlier, prior literature has conceptualized worker autonomy with respect to individual decision making on project choice (Stern 2004, Gambardella et al. 2015) and more broadly as “performing organizational practices without explicit direction or approval from others” (Wiedner and Mantere 2018, p. 4). In contrast,

we theorize and provide evidence on how geographic flexibility (i.e., granting the worker freedom to choose the work location) affects productivity.

We also present a nuanced result related to the degree of geographic flexibility. More specifically, we find that a “middling” amount of geographic flexibility (i.e., $PHP > 50$) is worse than very little flexibility (i.e., $PHP < 50$) or a very strong case of geographic flexibility (i.e., WFA), evinced by the relative comparison of work output reported in Table 4. This finding has practical implications for managers, suggesting that if a company hopes to see the motivational benefits of increased perceived autonomy through the provision of a WFA regime, it needs to “cut the umbilical cord,” giving employees true autonomy, rather than a piecemeal granting of autonomy.

Our results additionally contribute to the literature on geographic proximity of knowledge workers and learning (Allen 1977, Jaffe et al. 1993, Singh and Marx 2013, Choudhury 2015 2017, Catalini 2017). Catalini (2017) identifies beneficial effects of colocation on search and execution costs among potential collaborators. We complement these findings by shedding light on an additional effect of colocation, showing that geographic colocation with other WFA examiners in the same art unit is correlated to productivity. Our findings are consistent with past research showing that learning relates to access and exposure to the experience of others (Allen 1977, Darr et al. 1995) and to one’s own ability to gain hands-on experience (Katila and Ahuja 2002, Rosenkopf and McGrath 2011, Argote and Miron-Spektor 2011, Myers 2018). Our results suggest that remote workers might informally create “remote communities of practice.” This proposition could be studied further in future research and would contribute to the literature on communities of practice (Brown and Duguid 1991).

Our study has several limitations. Similar to Bloom et al. (2015), our study is focused on a single organization and, in this sense, follows the tradition of insider econometrics (Bartel et al. 2004). Additionally, it is plausible that in other settings where workers have greater dependence on coworkers and supervisors to accomplish their tasks, increased coordination costs might offset the gains from higher productivity. Future work should validate our findings in other settings that exhibit other forms of interdependence and/or where the task is more or less routine compared to patent examination. Building on Krzyscynski (2011), we posit that

nonpecuniary incentives such as WFA can and should be firm specific. For instance, a firm could choose to provide a WFA option to experienced employees if the tasks performed by knowledge workers in the firm exhibit properties of pooled interdependence. However, WFA may not create value for other firms with stronger (i.e., reciprocal or sequential) interdependence regimes, and future research could examine this proposition.

Our results showing that differences in tenure and grade level at the USPTO are correlated to the worker's choice of geographic location open up avenues for future research. Our correlational finding that early- and mid-career workers are more likely to choose geographic locations such as Eastern Texas (with its concentration of patent law firms) suggests future work could study whether geographic flexibility and WFA could have *career-enhancing* benefits for early- and mid-career workers, by enabling them to move to locations beneficial for future career prospects. Our correlational finding that higher-tenured workers are more likely to choose a geographic location such as Florida (which is arguably better suited as a preretirement destination) suggests that future work can explore whether WFA could have *career-extending* benefits, motivating workers closer to retirement to remain in the workforce and be productive.

It is important to note that our research contributes to a very active managerial debate on the effectiveness of WFA. In February 2013, then-CEO Marissa Mayer famously rescinded the remote work program at Yahoo! with the following words drafted in a company memo: "Some of the best decisions and insights come from hallway and cafeteria discussions, meeting new people, and impromptu team meetings. Speed and quality are often sacrificed when we work from home. We need to be one Yahoo!, and that starts with physically being together."¹⁶ Yet, along with these highly visible retreats from WFA regimes, other employers continue (typically with less fanfare) to increase WFA opportunities and more generally support the concept of remote work. Akamai's "Akamai Anywhere" WFA policy is one such example.¹⁷ In promoting

¹⁶ Source: <http://allthingsd.com/20130222/physically-together-heres-the-internal-yahoo-no-work-from-home-memo-which-extends-beyond-remote-workers/>

¹⁷ <https://www.benefitnews.com/news/benefits-professional-of-the-year-creates-a-balance-for-akamai-employees>

the agency's WFA policy, NASA's Chief Technology Officer noted that "The potential exists for the size of an employee's office to expand from a 12' by 12' room to virtually everywhere."¹⁸

A series of empirical studies around WFA could help resolve this debate. It is plausible that the gains from WFA are restricted to firms and settings where workers are approaching diminishing returns in learning from peers and/or are relatively less dependent on coworkers and supervisors to accomplish their tasks. Hence, it would be interesting to replicate our study in a setting of designers, software developers, and other contexts with varying degrees of worker interdependence. Future research could also study the duration of physical collocation that leads to new hires "coming up to speed" in terms of learning tacit knowledge needed to perform the task and not experiencing increases in rework after moving to a WFA program. Similarly, it could be beneficial to pursue further study of the conditions (if any) under which workers could benefit from learning from other remote workers and knowledge spillovers among WFA workers. For example, it has been suggested that "innovation spaces," such as coworking spaces and incubators, are becoming a source of considerable knowledge transfer that promotes innovation and collaboration.¹⁹ This argument suggests that there could be an optimal policy of WFA that allows employees to work from anywhere while interacting to some degree with professional peers in a *physical* collaborative setting close to their chosen geography. These workers may experience increased benefits to productivity from knowledge spillovers in their home geography; this, however, is an empirical question requiring further exploration.

Thinking beyond the immediate debate around WFA and firm productivity, we believe that future research on WFA could also help inform managerial decision making in newer forms of organizing knowledge workers. A number of firms, primarily in the software and technology fields (such as Mozilla and Art & Logic), are structured as virtual organizations in which WFA is the dominant form of work.²⁰ At the same time, the rise of online platforms such as upwork.com—which match potential workers and employers for short-term contract-based jobs—has resulted in a significant increase in alternative work arrangements

¹⁸ Source: <https://www.nasa.gov/content/work-from-anywhere-how-to-land-that-bigger-office>

¹⁹ Source: https://www.brookings.edu/wp-content/uploads/2017/04/cs_20170404_innovation_spaces_pdf.pdf

²⁰ Source: <https://www.flexjobs.com/blog/post/25-virtual-companies-that-thrive-on-remote-work/>

(Katz and Krueger 2016), often informally referred to as the “gig economy.”²¹ With these technologies further enabling WFA, it seems likely that researchers and firms will continue to explore the conditions under which geographic flexibility can contribute positively to the productivity of “gig workers.” Additionally, the notion of geographic flexibility introduced in this study might have career-enhancing and career-extending effects: Notably, future research should study whether and when firms can extend productivity from aging workers by giving them autonomy to relocate to “retirement friendly” destinations. Geographic flexibility may serve as another form of nonstandard work arrangement which can help older workers remain active in the workforce longer (Bidwell, et al 2013).

As technology continues to enable richer communication and collaboration among virtual coworkers and as major business centers continue to become more populous and congested, there is a strong need to develop our understanding of how the granting of geographic flexibility via policies such as WFA affect productivity. To the best of our knowledge, our study represents the first set of robust econometric results on the productivity effects of working from anywhere and makes a contribution to the literature on remote work, nonstandard work, and physical detachment, nonpecuniary incentives, autonomy, and worker collocation. In conclusion, our study is a step in the direction of resolving the ongoing debate about remote work policies, studying physical detachment of workers and understanding whether and under what conditions firms should implement work-from-anywhere policies for their workers.

²¹ Source: <https://assets.aspeninstitute.org/content/uploads/2017/02/Regional-and-Industry-Gig-Trends-2017.pdf>

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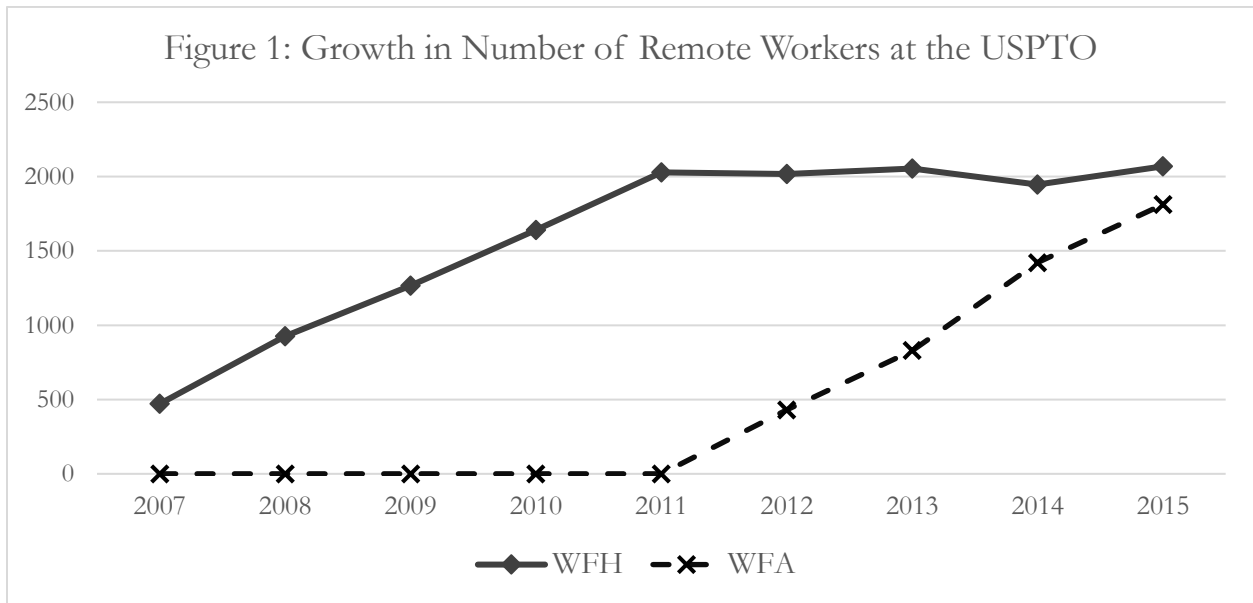
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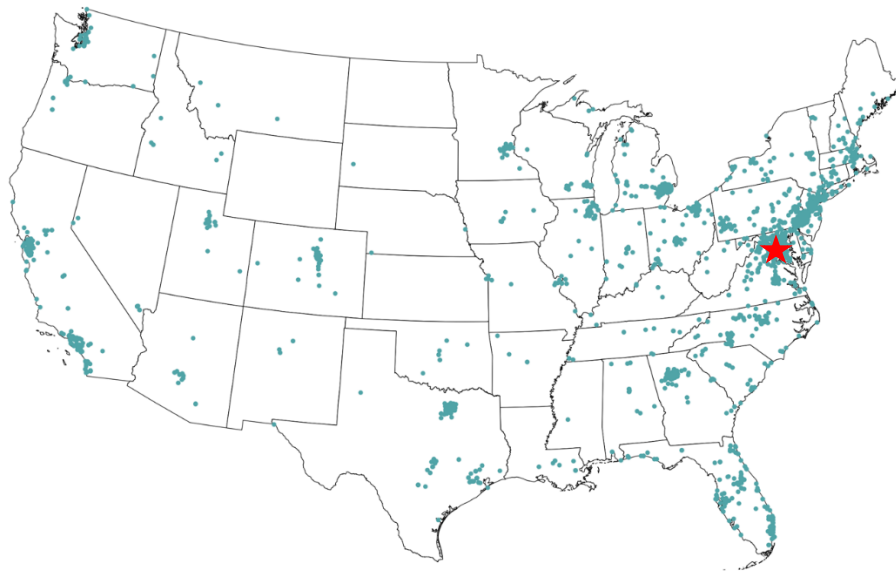
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Figure 1 Growth in Number of Remote Workers at the USPTO



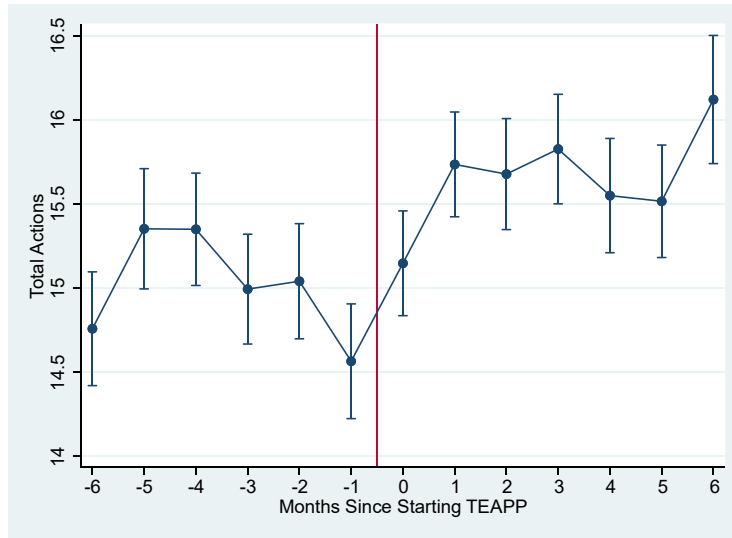
This figure illustrates the annual number of examiners enrolled in two remote work programs at the USPTO: WFA (TEAPP) and PHP.

Figure 2 WFA Examiner Locations



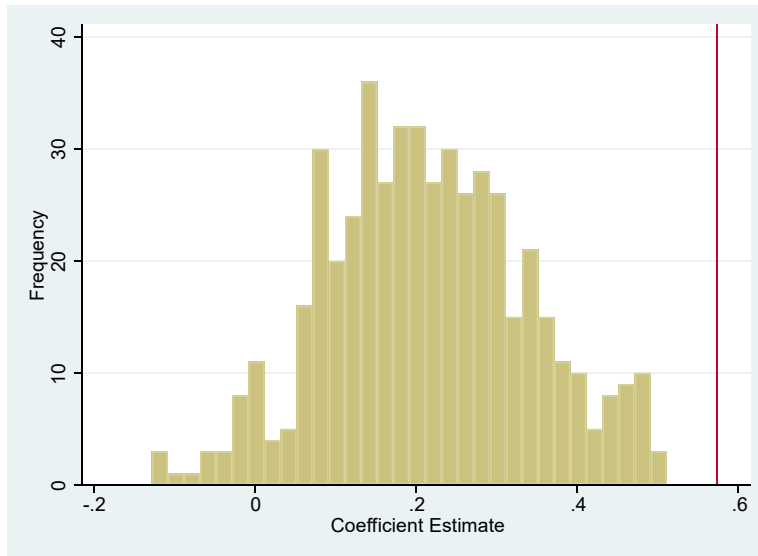
This figure illustrates the spatial distribution of WFA examiners at the USPTO as of August 2016. Each dot corresponds to a single unique examiner. Alexandria, Virginia (USPTO headquarters), is denoted by a red star.

Figure 3 Difference-in-Differences Graph for Treatment



This figure plots the month-specific fixed effect coefficients estimated from a regression of total actions on controls for examiner, expectancy, grade level, and year. Standard errors are clustered at the art unit level. Treatment (TEAPP) is indicated with the red vertical line.

Figure 4 Placebo Test



Notes. The analyses conducted here are as follows: There are 831 patent examiners in our dataset. For each of these examiners, we know the month they started participating in TEAPP. To perform one iteration of the placebo test, we shuffle the start month for all examiners—that is, we randomly assign, without replacement, when each examiner starts TEAPP. We merge these placebo treatments back into the panel dataset and recompute the work-from-anywhere dummy that indicates whether the current month t is greater than or equal to examiner i 's start month. We re-estimate the regression associated with Table 2 Column 2 with this new dummy variable (all other variables are the same), and we record the coefficient estimate associated with the synthetic treatment variable. We do this 500 times with different random shuffles of start date. Finally, we calculate a p-value by computing the proportion of the 500 iterations that yield coefficient estimates larger than what we find using the true data. None of the 500 estimates are greater than 0.574 ($p < 0.002$).

Table 1a Descriptive Statistics and Correlation Matrix: Full Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) Total Action	1.000	0.431	0.589	0.734	0.457	0.093	0.118	0.016	-0.242	0.023	0.032	0.291	0.261
(2) Total RCE		1.000	-0.074	0.260	0.239	0.098	-0.028	0.019	-0.006	-0.061	-0.010	0.082	-0.004
(3) FOA			1.000	0.433	0.177	-0.044	0.129	0.008	-0.247	0.078	0.040	0.168	0.246
(4) Reject				1.000	0.722	0.159	0.016	-0.022	-0.165	-0.055	0.016	0.111	0.064
(5) Examiner Cites					1.000	0.127	-0.097	0.001	-0.084	-0.123	-0.009	-0.076	-0.129
(6) WFA (TEAPP)						1.000	-0.325	-0.164	0.025	-0.456	0.029	0.143	0.053
(7) PHP (<50 miles)							1.000	-0.288	-0.031	0.642	0.006	0.383	0.357
(8) PHP (>50 miles)								1.000	0.014	-0.402	0.027	0.084	-0.024
(9) Mean Expectancy									1.000	-0.034	-0.074	0.027	-0.005
(10) Nearby Examiners										1.000	-0.038	0.183	0.220
(11) Distant Examiners											1.000	0.026	0.031
(12) GS												1.000	0.690
(13) Primary Examiner													1.000
Mean	11.375	1.347	4.306	6.500	15.238	0.076	0.198	0.070	23.183	1258.069	149.586	12.552	0.403
Std Dev	7.039	1.581	3.931	4.329	13.835	0.264	0.399	0.255	5.143	1131.381	362.223	1.919	0.490
Min	1	0	0	0	0	0	0	0	6.6	0	0	0	0
Max	167	18	160	58	208	1	1	1	31.6	2399	2263	15	1
n (non-missing)	576,274	576,274	576,274	477,305	477,305	576,274	576,274	576,274	576,274	322,155	322,155	576,274	576,274

Notes. Observations are at the examiner-month level. The full sample uses all examiners in our dataset, regardless of their remote work status. The “WFA causal sample” (reported in Table 1b) refers to examiners who transitioned to WFA in 2012 or 2013.

Table 1b Descriptive Statistics and Correlation Matrix: Causal (“WFA”) Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Total Action	1.000	0.444	0.575	0.760	0.478	0.205	-0.252	0.053	0.061	0.272	0.259
(2) Total RCE		1.000	-0.062	0.265	0.239	0.138	0.002	-0.011	-0.030	0.099	0.040
(3) FOA			1.000	0.453	0.194	-0.042	-0.267	0.077	0.092	0.126	0.195
(4) Reject				1.000	0.713	0.283	-0.168	0.019	0.024	0.188	0.148
(5) Examiner Cites					1.000	0.173	-0.072	-0.041	-0.031	0.018	-0.040
(6) WFA(TEAPP)						1.000	0.026	0.022	0.022	0.422	0.313
(7) Mean Expectancy							1.000	-0.105	-0.149	0.031	-0.005
(8) Nearby Examiners								1.000	0.492	0.085	0.095
(9) Distant Examiners									1.000	0.082	0.093
(10) GS										1.000	0.724
(11) Primary Examiner											1.000
Mean	12.974	1.643	4.642	7.293	16.886	0.474	23.346	14.326	168.366	12.904	0.439
Std Dev	7.246	1.736	3.891	4.589	14.458	0.499	4.915	59.638	510.943	1.404	0.496
Min	1	0	0	0	0	0	6.6	0	0	5	0
Max	76	16	66	45	174	1	31.6	600	2244	15	1
n (non-missing)	65,694	65,694	65,694	55,791	55,791	65,694	65,694	65,499	65,499	65,694	65,694

Notes. Observations are at the examiner-month level. This causal sample uses all examiners who transitioned to WFA in 2012 or 2013.

Table 2: Causal Estimates of WFA on Productivity

	(1)	(2)	(3)	(4)
Variables	Total Actions	Total Actions	Total RCEs	Total RCEs
WFA	0.509** (0.208)	0.574*** (0.131)	-0.0540 (0.0513)	0.00123 (0.0368)
Controls:				
Expectancy	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Grade Fixed Effects	Yes	Yes	Yes	Yes
Examiner Fixed Effects	No	Yes	No	Yes
Observations	65,694	65,694	65,694	65,694
Adjusted R-squared	0.358	0.553	0.143	0.279

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes. Standard errors appear in parenthesis and are clustered at the art unit level. Observations are at the examiner-month level and utilize the “WFA sample” of experienced examiners for columns (1) through (4)—a subset of the main dataset that is limited to examiners who transitioned to WFA in 2012 or 2013. WFA is an indicator variable that turns on for examiner-months that transitioned into the WFA (i.e. TEAPP) program. Controls are indicated in the table above and may include year fixed effects, grade level (GS) fixed effects, expectancy (a measure of expected effort/output on an examiner-month level), and examiner fixed effects. All columns utilize data from 2007-2015.

Table 3: Degree of Geographic Flexibility - WFA vs. WFH

Variables	(1) Total Actions	(2) Total Actions
PHP (<50 Miles)	1.339*** (0.114)	1.035*** (0.0952)
PHP (>50 Miles)	1.131*** (0.120)	0.487*** (0.0915)
WFA	1.792*** (0.119)	1.022*** (0.0999)
Controls:		
Expectancy	Yes	Yes
Year Fixed Effects	Yes	Yes
Grade Level Fixed Effects	Yes	Yes
Examiner Fixed Effects	No	Yes
Observations	576,267	576,267
Adjusted R-squared	0.354	0.562

* p<0.10, ** p<0.05, *** p<0.01

Notes. Standard errors appear in parenthesis and are clustered at the art unit level. Observations are at the examiner-month level and utilize the full sample of examiners. WFA is an indicator variable that turns on for examiner-months that transitioned into the TEAPP WFA program. PHP <50 and >50, respectively, are indicator variables that identify examiner-months that have transitioned into the two PHP programs. The two PHP programs are akin to a traditional work from home (WFH) program, with less geographic flexibility than a work from anywhere program (WFA). Controls are indicated in the table above and may include year fixed effects, grade level (GS) fixed effects, expectancy (a measure of expected effort/output on an examiner-month level), and examiner fixed effects).

Table 4: Cost-of-Living Reduction

Variables	(1) Cost-of-Living Reduction	(2) Cost-of-Living Reduction
PHP (<50 Miles)	0.00335 (0.0429)	
PHP (>50 Miles)	18.57*** (0.607)	
WFA	18.54*** (0.541)	3.030*** (0.454)
Controls:		
Expectancy	Yes	Yes
Year Fixed Effects	Yes	Yes
Grade Level Fixed Effects	Yes	Yes
Examiner Fixed Effects	Yes	Yes
Observations	576,002	65,437
Adjusted R ²	0.828	0.761

* p<0.10, ** p<0.05, *** p<0.01

Notes. Standard errors are clustered at the art unit level. Column (1) reports results from a regression of Cost-of-Living Reductions, indexed to 0 for Alexandria on dummies for being in either PHP program and being in WFA. Column (1) utilizes the full sample of examiners. In order to align with our main results, column (2) reports results from the “causal sample” of examiners who transition to WFA in 2012 to 2013. Both columns limit samples to those locations with cost-of-living data and include controls for expectancy, year, and grade level, as well as examiner fixed effects. All columns utilize data from 2007-2015.

Table 5: Choice of Geographic Location by WFA Examiners

	(1)	(2)
Variables	In Florida	Near Marshall
Grade 14 and Above	-0.200 (0.164)	-0.417** (0.195)
Tenure (Years)	0.0489*** (0.0137)	0.000343 (0.0197)
Constant	-2.522*** (0.160)	-2.252*** (0.200)
Observations	2,064	2,064
Pseudo R-squared	0.008	0.006

*** p<0.01, ** p<0.05, * p<0.1

Notes. Table presents coefficient estimates from two logistic regressions. Standard errors appear in parentheses. Observations are at the examiner level. The sample is restricted to examiners participating in the WFA (i.e., TEAPP) program.

Table 6: Effects of Having Geographically Proximate Peers

Variables	(1) Total Actions	(2) Total Actions	(3) Total Actions
WFA	0.503* (0.240)	0.432* (0.226)	0.497* (0.239)
All Examiners (<25 miles)	-0.00965* (0.00478)		-0.0103* (0.00481)
Same Art Unit Examiners (<25 miles)		0.596** (0.252)	0.667** (0.269)
Controls:			
Expectancy	Yes		Yes
Year Fixed Effects	Yes		Yes
Grade Level Fixed Effects	Yes		Yes
Observations	58,691	58,691	58,691
Adjusted R ²	0.348	0.347	0.348

* p<0.10, ** p<0.05, *** p<0.01

Notes. Standard errors appear in parenthesis and are clustered at the county and grade level. Observations are at the examiner-month level and utilize the “WFA sample” of experienced examiners for columns (1) through (3) limited to those examiners outside the Alexandria commuting region. WFA is an indicator variable that turns on for examiner-months that have transitioned into the WFA (i.e., TEAPP) program. All Examiners (<25 miles) measures the number of remotely working examiners within a 25-mile radius of the focal examiner, and Same Art Unit Examiners (<25 miles) measures the number of examiners within the same art unit as the focal examiner, within 25 miles. Controls are indicated in the table above and may include year fixed effects, grade level (GS) fixed effects, and expectancy (a measure of expected effort/output on an examiner-month level). All columns utilize data from 2007-2015.

TABLE 7: IT Usage

Variables	(1) Total Actions	(2) Total RCEs
Examiner Needing Supervision	-1.119*** (0.291)	-0.0311 (0.0800)
Mandated IT	-0.291* (0.165)	-0.0169 (0.0547)
Mandated IT * Examiner Needing Supervision	0.920*** (0.260)	0.0659 (0.0735)
Controls:		
Expectancy	Yes	Yes
TEAPP Experience	Yes	Yes
Examiner Fixed Effects	Yes	Yes
Observations	19,255	19,255
Adjusted R ²	0.499	0.244

* p<0.10, ** p<0.05, *** p<0.01

Notes. Standard errors appear in parenthesis and are clustered at the art unit level. Observations are at the examiner-month level and are limited to those examiners on WFA before June 2013. Column (1) reports results from a regression of Total Actions, and column (2) reports results for Total RCEs. Mandated IT is an indicator variable that turns on post-June 2013, and ‘Examiner Needing Supervision’ is an indicator for whether an examiner does not have “Full Signatory” authority and hence the work, while conducted alone, needs to be certified by a supervisor. Both columns include Expectancy, Year, and Examiner Fixed Effects, the latter of which absorbs nontemporal variation in “Primary Examiner” status.

Table 8 Robustness: Selection into WFA

Variables	(1) Months to WFA	(2) Months to WFA	(3) Months to WFA
Total Action	0.00436 (0.00547)		
Expectancy		0.0867 (0.0627)	
Total RCE			0.0429 (0.0263)
Controls:			
Grade	Yes	Yes	Yes
Observations	2,771	2,771	2,771
Adjusted R-squared	0.002	0.003	0.003
* p<0.10, ** p<0.05, *** p<0.01			

Notes. All columns reflect regressions with the sample of examiners who received WFA in 2012 or 2013, limited to years prior to 2012 in order to observe pre-WFA performance. Observations are at the examiner year level, where columns (1)-(3) estimate models testing whether prior output, expectancy, and rework are associated with the time it takes for an examiner to transition to WFA, the key source of causal variation in this study. Standard errors appear in parenthesis and are clustered at the grade level.

Table 9 Robustness: Examiner Effort and Leniency

Variables	(1) FOAs	(2) Rejections	(3) Examiner-Added Citations
WFA	0.135* (0.0652)	0.194* (0.0902)	-0.242 (0.289)
Controls:			
Expectancy	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Grade Fixed Effects	Yes	Yes	Yes
Examiner Fixed Effects	Yes	Yes	Yes
Observations	55,791	55,791	55,791
Adjusted R ²	0.325	0.392	0.467

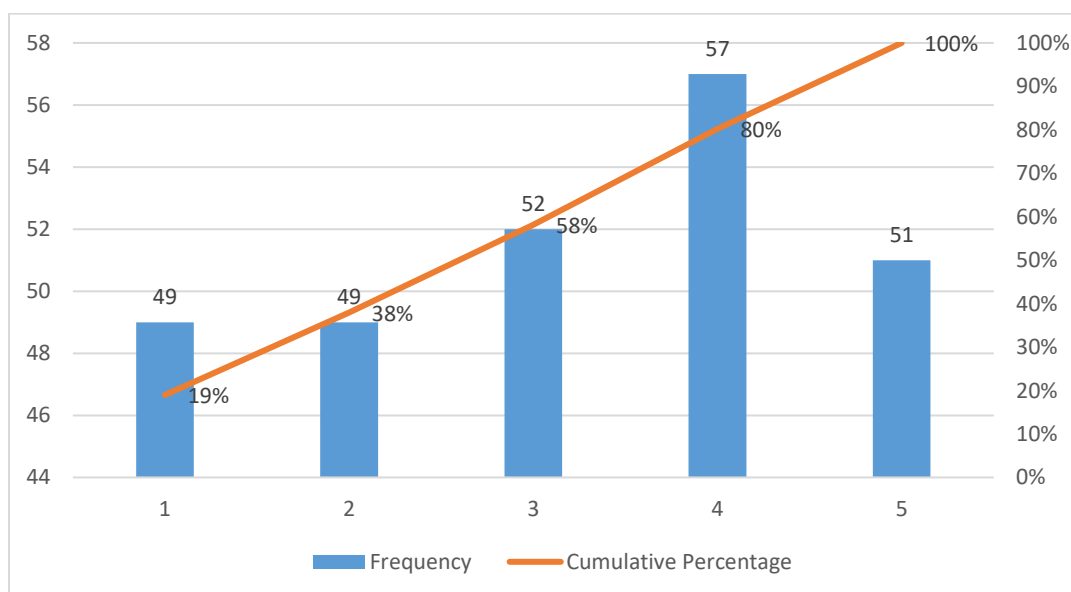
* p<0.10, ** p<0.05, *** p<0.01

Notes. Standard errors appear in parenthesis and are clustered at the art unit level. Observations are at the examiner-month level, where column (1) utilizes first office actions (FOAs) as an outcome variable, column (2) utilizes rejections as an outcome variable, and column (3) utilizes examiner-added citations as an outcome variable. All regressions reflect analyses on the “WFA sample,” limited to those with data on FOAs, rejections, and examiner-added citations. WFA is an indicator variable that turns on for examiner-months that have transitioned into the TEAPP WFA program. Controls are indicated in the table above, and include year fixed effects, grade level (GS) fixed effects, examine fixed effects, and expectancy (a measure of expected effort/output on an examiner-month level).

Appendix A: Details of Fieldwork Interviews

Individual(s) Interviewed	Number of Interviews Conducted
Commissioner for Patents	3
Deputy Commissioner for Patent Operations	2
Deputy Commissioner for Patent Policy	1
Deputy Commissioner for Patent Operations	1
Deputy Commissioner for Patent Administration	1
Patent Office Professional Association (POPA) Office Bearers	2
Manager, Production, Performance Appraisal Plan, Docket Management	1
Patent Model, Stats and Dashboard	1
Patent Examiners	4
Head of Remote Work Programs at USPTO	3
Deputy Chief Information Officer, USPTO	1
Chief Financial Officer, USPTO	1
Chief Administrative Officer, USPTO	1

Appendix B: Glassdoor.com Online Reviews: Ratings Frequency and Cumulative Percentage



Notes: n = 258. Ratings are on a scale from 1 (worst) to 5 (best).

Appendix C: Partial List of Key Themes from Glassdoor.com Reviews (n=258)

<u>Theme</u>	<u>Representative Quotes</u>
Temporal Flexibility	<p>“Flexibility, hoteling, free to take leave whenever.”</p> <p>“Stability and flexibility: working from home, schedule your own working hours.”</p> <p>“As long as you get your work done, nobody cares when you work.”</p>
Geographic Flexibility	<p>“Working from anywhere in the lower 48 states is amazing.”</p> <p>“The USPTO also has one of the best telework policies, allowing you to work all over the country; great benefits (work from home in any city in the continental U.S.).”</p> <p>“You can work from home anywhere in the U.S....Once you achieve signatory authority, you’d be hard pressed to find a much better job for overall freedom and quality of life.”</p>
Work-life Balance	<p>“The flexibility of the schedule is the real selling point. I am able to pick up my kids from school every day and be that parent who can attend field trips and help in the classroom.”</p> <p>“Since your work is mostly independent of others, it is easy to maintain work-life balance”</p> <p>“Ridiculously amazing family life. Easy to drop off/pick up kids from school EVERY DAY. Multiple family vacations per year. Easy to BBQ on weekdays!”</p>
Independent Nature of the Job	<p>“The job is essentially a solitary position, so there is no need to coordinate schedules. You can work your own schedule. As long as you hit your numbers (i.e., production and workflow), you are left alone.”</p> <p>“People who can maintain a pretty repetitive review process, can stay motivated in their routine, enjoy rarely interacting with other humans, are decisive, and work very quickly through their cases are most likely to thrive.”</p> <p>“BORING because it is isolated work with rarely any interaction, even in the hallway.”</p> <p>“Repetitive work on an individual basis. If you like working in teams, this is not the job for you.”</p> <p>“No team work required for this job.”</p>

<p>Emphasis on Meeting Output Targets</p>	<p>“Performance (i.e., the number of cases examined and docket management) is tracked every pay period and every quarter, thus making life super stressful.”</p> <p>“Very stressful work environment, production quota system very strict, supervisors too focused on production for bonus.”</p> <p>“Quality-driven people might struggle and need to work more voluntary overtime if they can’t handle production demands. Takes a lot of effort to recover production numbers if you’ve had a couple of biweeks with a low production.”</p>
<p>Low Skill variety/Monotony</p>	<p>“Patent examination can be very dull, especially if you are coming from more creative environments such as school, R&D, engineering.”</p> <p>“Over the long term, the job is monotonous.”</p>