The Impact of Workload on Decision-Making: Evidence from Patent Examination

Qing Huang* Ge Yin †

December 2, 2024

Abstract

This study investigates the effect of workload on individual decision-making in the context of patent examination in China from 2000 to 2011. Higher workloads increase approval rates, adding 1.5% to the total approved patents in our sample. Further analysis of patent quality shows that moderate workloads balance Type I (approving unqualified patents) and Type II errors (rejecting qualified patents), maintaining decision quality, but excessive workloads sharply increase Type I errors, reducing quality. Examiners adapt by reducing examination time and search efforts while enhancing knowledge accumulation as workloads rise. These findings provide insights into strategies for optimal workload management.

Key Words: workload; patent examiners; decision-making; optimal work assignment

JEL code: D91; D90; M54

*Huang: School of Agricultural Economics and Rural Development, Renmin University of China. Email: qhuang@ruc.edu.cn

†Yin: Institute of International Economy, Academy of China Open Economy Studies, University of International Business and Economics. Email: yinge@uibe.edu.cn. Corresponding author.

1 Introduction

In this article, we examine the role of workload—an integral work environmental factor—in shaping individual decision-making. Workload pressures are a widespread challenge, with over one-third of workers globally regularly working more than 48 hours per week in 2021 (International Labour Organization, 2022). In regions and industries where long hours are common, maintaining a healthy work-life balance becomes difficult, affecting both physical and mental well-being and often resulting in stress, reduced efficiency, and errors (Xu et al., 2022). Understanding how people adjust their decisions under varying workloads and in response to different incentives has significant implications, both theoretically and practically. Practically, assessing how workload impacts decision-making is essential for optimizing worker schedules, improving productivity, and reducing welfare losses in overburdened work settings (Chan, 2018). Theoretically, it deepens our understanding of decision-making under constraints, providing insights into how cognitive and physical limitations influence decision quality.

How the workload impacts individual decision-making is an important question, however, significant empirical challenges make it difficult to address. Task-level data that records each worker's decision comprehensively for a given task is scarce, and evaluating decision quality requires knowledge of ex-post outcomes, further exacerbating data limitations. Existing studies often address this issue by focusing on healthcare—a sector known for its high-pressure environment—to examine the effects of workload on service time (Kc and Terwiesch, 2009; He et al., 2012; Freeman et al., 2017; Kc et al., 2020; Shurtz et al., 2022; Jin et al., 2023). Additionally, such analyses are complicated by the lack of exogenous shocks to workload. Typically, both supply and demand adjust together with workload fluctuations; increases in workload often lead to corresponding workforce expansions, making it difficult to isolate the true effect of workload alone.

This article furthers the literature by providing a credible empirical evaluation of the effect of workload on individual decision-making in the context of patent examination. Using

comprehensive data on patent applications in China from 2000 to 2011, our findings show that increased workloads significantly raise the likelihood of a patent being approved. However, approved patent quality remains stable as long as workload increases are moderate, indicating that decision-making quality is not affected under reasonable workload levels. While examiners spend less time per application as their workload grows, a knowledge spillover effect from handling multiple tasks becomes evident. The results suggest that workload influences the likelihood of Type I and Type II errors differently: when workloads remain moderate, the magnitudes of increase in Type I errors (approving unqualified patents) and decrease in Type II errors (rejecting qualified patents) offset each other, maintaining decision quality. However, when the workload becomes excessive, a sharp rise in Type I errors dominates, negatively impacting decision-making quality.

The patent examination process offers a useful setting for studying the impact of workload on individual decision-making. First, examiners are required to conduct thorough, independent reviews of each patent application, which involves a deep understanding of the invention, searching for prior patents, and comparing the application with existing technologies. Moreover, patent data is meticulously recorded at the task level, allowing us to observe detailed information on each application, including the examiner's decision, search effort, and both the ex-ante and ex-post quality of the patent application. Second, from 2000 to 2011, examiners in China faced a dramatic surge in workload. The average number of patent applications per examiner rose from 3.54 in 2000 to 33.58 in 2011, driven by a substantial increase in patent filings rather than a reduction in staffing. The number of examiners remained sluggish due to China's "Bianzhi" system—a regulatory framework that restricts employee quotas in the public sector. This system limited the State Intellectual Property Office's (SIPO) ability to expand its workforce despite rising examination demand. Third, patent applications are randomly assigned to examiners within art units, ensuring that examiners cannot select cases based on their complexity or anticipated workload. This random assignment, combined with the relatively exogenous increase in workload, enables

us to estimate the causal effect of workload on examiner decisions by analyzing the same examiners' choices over different years under varying workloads.

We begin by examining the impact of workload on examiners' approval decisions. We segment examiner workloads into six categories: 1-50, 51-100, 101-150, 151-200, 201-300, and 300+. Our findings show that increased workloads significantly raise the likelihood of a patent being approved. For instance, an application reviewed by an examiner handling 150 cases has a 1.5% higher chance of approval compared to the same examiner handling fewer than 50 cases. This difference equates to a notable 2.3% increase relative to the overall average approval rate of 64.5%. The workload's effect on approval decisions continues to increase but at a slower rate once it exceeds 100 applications, suggesting a threshold effect. With 56.53% of applications falling into categories where examiners face workloads above 100, the impact of this workload dynamic is substantial. Overall, as a simple back-of-the-envelope calculation, the increasing workload leads to examiners approving 7,606 more patents compared to a scenario where all examiners handle a workload of fewer than 50, conditional on all controls. This accounts for 1.5% of the total approved patents (505,673) in our sample from 2000 to 2011.

As approval rates for patent applications rise with increasing workload, a critical question emerges: Are examiners approving unqualified applications that do not meet established standards— an increase in Type I errors, or are they approving qualified applications that might have been rejected under a low workload environment—a decrease in Type II errors? Both errors can raise approval rates but impact the quality of finally approved patents differently. An increase in Type I errors, where unqualified patents are approved, threatens the integrity of the patent system. Conversely, a decrease in Type II errors, where qualified patent applications are correctly approved, could turn out to maintain or even improve the quality of approved patents. To explore these dynamics, we examine how examiner workload affects the quality of approved patents and the likelihood of re-examination requests from initially rejected applications.

For the quality of approved patents, we use the likelihood of patent renewal for over three years as an indicator of a patent's value.[1] Our analysis reveals a nonlinear response: patent quality remains stable within moderate workload ranges (below 200), but declines by 3% in higher workload brackets (above 200). For initially rejected applications, we measure the patent application quality by the likelihood of applying for re-examination after an initial rejection. Under SIPO regulations, patent applicants can request a re-examination within three months of rejection, a process that is both time-consuming and costly. We hypothesize that higher-quality applications are more likely to pursue this option, reflecting their intrinsic value and the applicant's determination to secure approval. We observe a decrease in re-examination requests under heavier workloads, suggesting a reduction in Type II errors. Collectively, these findings indicate that while moderate workloads balance an increase in Type I errors with a decrease in Type II errors, thereby maintaining overall patent quality, excessive workloads result in a sharp rise in Type I errors without a corresponding reduction in Type II errors. In other words, moderate increases in workload can sustain patent quality, but excessively high workloads severely impair decision-making quality.

This interpretation of our results is verified by a test of balance. We find no evidence of any systematic relationship between the examiner workload and pre-determined application and applicant characteristics. We also show that the estimated effects are very close to those of our main specification under a series of regression-model specifications and context-relevant exclusions of data. For example, we find similar results when considering examiners who have continuously worked for 5 years or considering filing seasonality of the applications, suggesting that our findings is not driven by examiner dynamics or the selection of applications at different times of the year.

We then investigate the underlying mechanisms. We explore the roles of expedited exam-

[1]This is one of the most commonly used measures of patent quality (Pakes et al., 1989; Lanjouw et al., 1998), as patentees are required to pay a renewal fee annually to maintain patent rights. In this study, we use an ex-post quality indicator because ex-ante measures can be observed by examiners and may influence their decisions. We do not use citations as a quality indicator because, in China, applicants are not required to include backward citations, which are typically marked by examiners.

ination, reduced search efforts, and enhanced knowledge accumulation. We find a significant reduction in examination time as workload increases, with examination times shortened by up to four months in the 151-200 and 300+ workload brackets compared to the baseline group of 1-50, representing a 17.5% decrease from the average time of 22.8 months. This suggests that higher workloads pressure examiners to accelerate their review processes to handle the growing number of applications. The faster pace of examinations leads to notable changes in search behavior. Specifically, as workloads intensify, we observe a marked decline in the number of new backward citations, defined as patents that were neither previously cited nor examined by the same examiner, indicating a reduction in the exploration of new knowledge. This decline is especially pronounced in higher workload brackets and aligns with the rise in Type I errors (approving unqualified patents) under higher workload conditions. However, our findings also highlight some benefits of increased workloads, such as fostering knowledge accumulation. As workload increases, there is a notable rise in citations of patents previously cited or examined by the same examiner, which is linked to a reduction in Type II errors.

Our heterogeneous analysis shows that the impact of workload varies across different types of applications, applicants, and examiners. Lower-quality (predetermined) patent applications exhibit higher approval rates and lower renewal rates under high-workload conditions, while high-quality (predetermined) applications remain largely unaffected. In contrast, only high-quality applications respond to increased workloads by applying for re-examination after an initial rejection. These findings align with our interpretation of workload's impact on decision quality: low-quality patents experience a rise in Type I errors (approving unqualified patents), while high-quality patents benefit from a decrease in Type II errors (rejecting qualified patents). Examiners' responses to workload also differ by applicant type, with university applications receiving more lenient treatment. Furthermore, workload significantly affects senior examiners, increasing their approval rates, while junior examiners are less impacted by workload changes.

Our findings contribute to the growing body of research on how workload influences

economic behavior (Schultz et al., 1998, 1999). Previous studies have examined the impact of workload on service operations, processing times (Kc and Terwiesch, 2009; Berry Jaeker and Tucker, 2017), medical decision-making (Kuntz et al., 2015; Hoe, 2022), service time distributions (Bavafa and Jónasson, 2024), and service configuration decisions (Freeman et al., 2017; Kim et al., 2015). Various mechanisms behind these effects have been identified, such as task batching, prioritizing shorter or simpler tasks, and initiating tasks early (Ibanez and Toffel, 2020; Kc et al., 2020; Batt and Terwiesch, 2017). However, most existing literature on workload focuses on hospital settings. Two exceptions study the effects of workload on operational risk (Xu et al., 2022) and on sales and delivery speed in restaurants (Tan and Netessine, 2014). Our study broadens this scope by focusing on patent examiners, who are not subject to piece-rate wage systems and make binary decisions that can be evaluated ex-post for quality. We contribute to the literature by exploring which types of errors are induced or reduced by high workloads and the underlying reasons, providing insights into optimal workload design.

Of further relevance to the present study is the literature that has studied the relationship between the work environment and worker performance. While traditional models of production often treat labor as a mechanical input, recent empirical studies have explored how various work environment factors affect performance, including flexible or irregular hours (Bloom et al., 2015), workers' preferences for workplace arrangements (Moen et al., 2016; Mas and Pallais, 2017), and peer interactions (Mas and Moretti, 2009; Silver, 2021; Brune et al., 2022). Additionally, several studies emphasize the importance of effective worker scheduling to enhance productivity, with strategies to prevent slacking (Chan, 2018) and reduce task juggling (Coviello et al., 2015, 2014). In this study, we show that workload is a key environmental factor that significantly impacts worker performance. Our findings suggest that maintaining workloads at a moderate level is essential for optimizing efficiency. These insights offer valuable implications for designing optimal work assignments and improving worker productivity management.

This article is also related to the emerging body of literature on patent examination quality, an area highlighted by the seminal work of Cockburn et al. (2003), which underscored the lack of systematic attention paid to the patent rights examination process and revealed significant heterogeneity in patent examiner decisions. Subsequent studies have explored the determinants of this heterogeneity, focusing on variables such as examiner experience (Lemley and Sampat, 2012), allocated time (Frakes and Wasserman, 2017; Shu et al., 2022; Frakes and Wasserman, 2023), the under-utilization of examiner expertise (Lei and Wright, 2017), worker procrastination (Frakes and Wasserman, 2020, 2024), and obfuscation (Figueroa and Lemus, 2024), which all influence approving behaviors and the precision of patent reviews. While existing research predominantly focused on inter-examiner heterogeneity, our study introduces a previously underexplored factor—the examiner workload.[2] By identifying how workload affects examiner decisions, this study suggests that a significant portion of patent rights arises directly from the understaffing of patent offices. We provide insights that could inform policy adjustments to improve the efficiency and reliability of patent examinations (Wei et al., 2017; Fang et al., 2021).

The remainder of the article is structured as follows. Section 2 describes the institutional background of the patent examination process. Section 3 introduces the data source and Section 4 presents our empirical strategy. Section 5 establishes the main results on the effect of workload on approval rate and patent quality, and Section 6 conducts the robustness checks on our baseline results. Section 7 explores potential mechanisms underlying the effect

[2]The closest research to our work is a study by Kim and Oh (2017), which examines the effects of increased examination workloads on the patent examination process in Korea from 1999 to 2009. However, our approach differs from theirs in several key aspects. Firstly, we leverage the exogenous shock of the surge in Chinese patent applications to assess workload effects, whereas they use the lagged workloads of individual examiners as an instrumental variable. Secondly, we identify a nonlinear effect of workload on examiner decisions, suggesting that the impact of workload varies at different levels, whereas their analysis treats workload as a continuous variable without considering potential non-linearities. Thirdly, our findings indicate that high workloads lead examiners to expedite the decision-making process, as evidenced by reduced examination durations; their study, on the other hand, does not provide evidence regarding changes in examination speed. Lastly, we measure workload based on the number of in-progress applications an examiner handles, offering a direct view of their active caseload, while they assess workload through the total number of ongoing claims for which an examiner conducts prior art searches, which may not fully capture the immediate pressures faced by examiners.

of workload on examiner decisions. Section 8 summarizes our conclusions and discusses the implications of our findings.

2 Institutional Background

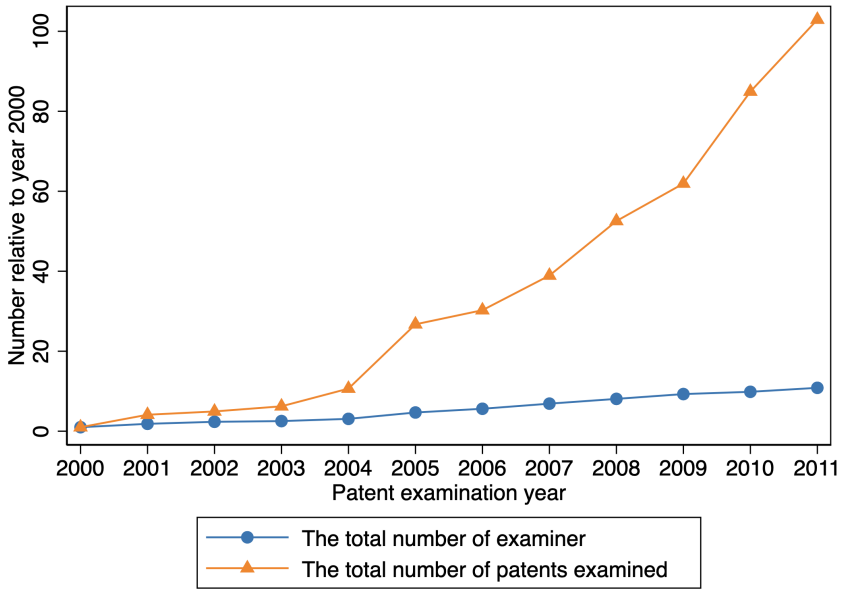
In this section, we introduce the institutional background of our study. We begin by highlighting the escalating workload of patent examiners, which is driven by the burgeoning demand for patent examinations amidst the constrained supply of available examiners. Additionally, we provide an overview of the patent examination process, which is crucial for understanding the decision-making frameworks of patent examiners.

2.1 The Increasing Workload of Examiners

The workload of patent examiners is driven by two main factors: the volume of patent applications—reflecting examination demand—and the number of available examiners—indicating examination capacity. In China, a growing imbalance between examination demand and examination capacity has led to a significant increase in examiners' workloads. On one hand, the number of patent applications at China's State Intellectual Property Office (SIPO) has grown exponentially, from just 83,045 in 1995 to over 2.3 million by 2014, with an average annual growth rate of 19%. In 2011, China surpassed the United States to become the world leader in patent filings (Wei et al., 2017). This sharp rise is also illustrated in Figure A1 in the Appendix, which highlights the increasing demand for patent examination. On the other hand, the growth of examiners has not kept pace with the surge in applications. As shown in Figure 1, there is a widening gap between the soaring number of patent applications and the relatively stagnant growth in examiner headcount from 2000 to 2011. Compared to the dramatic rise in application volume (from 1,844 in 2000 to 189,794 in 2011, a 103-fold increase), the growth in the number of examiners has been modest (from 521 in 2000 to 5,652 in 2011, an 11-fold increase), resulting in a significant rise in the average

workload per examiner. The average number of patents examined per examiner increased sharply from 3.54 in 2000 to 33.58 in 2011.

Figure 1: The Number of Patent Applications and Examiners Between 2000 and 2011



Notes: This Figure shows the trends in the number of patent examiners and patents examined annually between 2000 and 2011. The counts are normalized to the examination year 2000, with the base values being 521 examiners and 1,844 patents examined. We limit the sample to applications submitted by applicants based in China, that must be requested for examination no more than three years following the filing date. Data source: State Intellectual Property Office (SIPO) of China.

2.2 The Sluggish Supply of Examiners: The "Bianzhi" System

For the constraints on staffing levels for patent examiners in China, it is essential to understand the "Bianzhi" system, a regulatory framework that controls employee quotas in public sectors. The "Bianzhi" system, established in 1949 and restructured by central authorities through the creation of the Central Establishment Commission and Office in 1991, prescribes the official positions across public sectors including government, government-affiliated institutions, SOEs, etc. This system, a relic of the planned economy era, is characterized by meticulous planning, resulting in slow responsiveness to the evolving needs of public service providers (Ang, 2012).

Patent examiners at SIPO are directly impacted by this system, with recruitment stringently managed by the Central Establishment Office. The "Bianzhi" is categorized into two main types: administrative "Bianzhi", reserved for civil servants, and public personnel ("Shiye" "Bianzhi"), applicable to other public employees like technical workers and educators. Patent examiners fall under a strict subtype of the "Shiye Bianzhi" category, known as Type I "Shiye Bianzhi". This sub-category is as rigid as its administrative counterpart and is fully funded by the state. This inflexible control over position quotas leads to a predetermined and often insufficient number of positions that do not meet actual service demands. The discrepancy between the "Bianzhi" size and the actual need for the staffing level allows for some flexibility, such as hiring contract employees. For instance, in the 2010s, SIPO initiated the establishment of examination centers in local areas and began employing contract examiners. This adjustment has guided our decision to limit our analysis to data prior to 2011.

In summary, the examination system at SIPO is significantly understaffed, primarily due to the restrictive "Bianzhi" system. This system imposes rigid controls and fails to align staffing levels with actual needs. The significant gap between the sluggish number of examiners and the rapid increase in patent applications manifests as an escalating workload of the examiners which we take advantage of to understand its impact on decision-making.

2.3 The Patent Examination Process

The patent examination process is structured and carried out in two primary stages: the preliminary examination phase and the substantive examination phase.

The preliminary examination process [3] In the preliminary examination stage, the primary focus is on the formal aspects of the patent application. Substantive issues are typically not explored in depth unless there are evident substantive concerns. If the preliminary examination reveals no need for corrections, and the applicant has requested a substantive

[3]The complete patent examination process is illustrated in Figure A2 in the Appendix.

examination, the application progresses to the next stage.

The substantive examination process In the substantive examination phase, patent applications are randomly assigned to individual examiners within an art unit. This system mirrors the process in the United States Patent and Trademark Office (USPTO). This phase involves a thorough review of the patent, with particular attention to the patent claims that define the scope of protection sought by the applicant. The examination assesses whether the claims meet the legal standards for novelty, utility, and non-obviousness. This phase is intensive and time-consuming, requiring a deep understanding of the invention and an extensive comparison with existing technologies. Examiners independently conduct a global search for prior art, often without any applicant-provided references. This phase includes multiple rounds of review and response, forming the crux of the examination process.

The substantive examination phase concludes with the final decision on the patent application.[4] This stage is typically lengthy, often extending over 2-3 years or more from the start of the examination to the final determination. During this time, the examiner must review the patent while managing several other applications that are either in progress or awaiting examination. The simultaneous handling of multiple cases contributes significantly to the workload, especially given the ongoing surge in patent filings.

The motivation structure of examiners Examiners at SIPO are employed under a "Shiye Bianzhi" salaried arrangement, which means that their compensation is not tied to the number of patents processed, and they do not receive a performance-based bonus. This structure ensures that examiners are not financially motivated to speed up or slow down the examination process. They are required to examine all assigned patent applications, without self-motivation to conclude more cases which inevitably entails processing times shortening. This arrangement is crucial, as it prevents examiners from manipulating examination durations for personal financial gain. However, examiners still face pressure from supervisors and applicants to avoid unnecessary delays, to ensure a consistent and reasonable pace of

[4]If the applicant fails to respond to the examiner's questions within three months, the application is considered withdrawn.

examination.

3 Data

3.1 Data Source

We obtain our data from the State Intellectual Property Office (SIPO), which maintains comprehensive records of all published applications of invention patents,[5] including those approved and rejected. We have access to patent applications filed from 1995 to 2012, and the data was last updated on December 31, 2020. Our data is on the patent application level, including standard variables, such as the patent ID, applicant, filing date, approval date (if approved), expiry date (if approved), technological classification, claim counts, patent family size, etc, as well as information about the examination process, such as examination date, rejection date, the examiner who handles the patent application, whether the applicant asks for a re-examination request after rejection and the final decision of SIPO.

Our analysis sample is constructed as follows: First, we include only those applications submitted by applicants based in China. Second, we exclude patent filings that did not initiate the substantive examination process, which in China starts only after the applicant has paid the substantive examination fee and must be requested no more than three years following the filing date. We then calculate the workload of the substantive examiner for each patent application. Lastly, we confine our sample to patents filed and examined between 2000 and 2011. We limit our study to this period because of several considerations: workloads prior to 2000 may include patents filed before 1995 that are not covered in our data, potentially leading to an underestimation of workloads. Similarly, considering the workload post-2012 without including patents filed after 2012 would also underestimate the workload.

[5]China's invention patent is a counterpart of the US's utility patent. China has three types of patents, invention, utility model, and design. Only invention patents undergo a substantive examination process, the latter two types of patents undergo only a preliminary examination. Preliminary examination primarily checks for formal requirements and basic eligibility without a deep review of novelty or inventiveness. In this paper, we explore the workload of substantive examiners, thus only keeping invention patents in the sample.

Additionally, regional examination centers were established post-2011, significantly altering the examiner landscape in SIPO. Examiners at these centers are not recruited under the "Shiye Bianzhi" system and can be employed flexibly. In our dataset, all examiners are based in Beijing and review patents from across the country. All patents in our analysis reached a final disposition by December 31, 2020, either approved or rejected.

3.2 Measurement and Summary Statistics

In this article, the key independent variable of interest is the workload of the substantive examiner handling the focal patent application, measured by the number of applications the examiner processes over the 12 months following the start of the examination of the focal patent application. We use a 12-month window because the average time for the first-round review typically spans about a year. Examiners generally conduct the initial review within 6 months, and applicants take approximately 4 months to submit their replies, cumulatively spanning about one year.[6]

For the outcome variables, we first consider the approval dummy, which reflects the examiner's final decision. In our sample, approximately 64.5% of patents were approved. For these approved patents, we assess their quality by whether they were renewed for over three years, a commonly used measure of patent value (Pakes et al., 1989; Lanjouw et al., 1998).[7] The renewal of a patent for over three years indicates that the patent holder perceives the private value of the patent to outweigh the renewal costs, serving as a self-revealed quality indicator. Nearly 79.6% of approved patents in our sample were renewed for over three years.

[6]We use a 12-month rolling window rather than a calendar year to ensure the workload measure is application-specific. If we used a calendar year, the workload would be the same for all applications assigned to the examiner, regardless of whether they were assigned at the beginning or end of the year. This approach would overlook the reality that an examiner's workload can vary significantly between the beginning and end of a year. Additionally, using a calendar year would introduce variation only from comparing the same examiner across different years, potentially introducing confounders at the examiner-year level that could affect the results.

[7]In this study, we use an ex-post quality indicator to assess the accuracy of the examiner's approval decision, as ex-ante indicators can be observed by examiners and may influence their decisions, such as claim counts and patent family size. Although citation is another potential ex-post measure of patent quality, backward citations are typically marked by examiners rather than applicants in China for institutional reasons, making them one of the examiner's decisions.

For initially rejected applications, we assess the quality of the examiner's decision by the likelihood of a re-examination request, as opting for re-examination suggests the applicant believes the patent deserved approval, implying the examiner may have made an incorrect decision. In the following, we interpret the impact of workload on examiners' Type I and II errors based on these outcomes.

We measure examination time as the period from the disposition (the start of the substantive examination phase) to the decision date to assess the examiner's time input in the review process. To evaluate the examiner's fresh search efforts, we count the number of patents in the backward citation list that were neither previously cited nor examined by the examiner. To quantify knowledge accumulation, we use two metrics: the number of patents in the backward citation list that were either previously cited or examined by the examiner, and a binary variable indicating whether any patents in the backward citation list were either previously cited or examined. These variables suggest that examiners benefit from the cases they have handled, becoming more knowledgeable about the evolving technology in their field, which may help them make more precise decisions regarding the approval of the focal patent application.

Additionally, we control for several pre-determined characteristics of patent applications, including the number of claims, the number of inventors, whether the applicant has previously applied for any patents, the type of applicant (individual, firm, or research institute), and the year gap between the filing and the examination date of the application. Table 1 provides summary statistics on these key variables.

Table 1: Summary Statistics

	N	Mean	SD	Min	Max
Independent Variable					
Examiner workload	784,004	133.292	99.941	1	1163
Examiner workload category variable	784,004	2.959	1.447	0	1
Examiner workload=[1,50], frequency	134,204				
Examiner workload=[51,100], frequency	206,604				
Examiner workload=[101,150], frequency	186,366				
Examiner workload=[151,200], frequency	113,096				
Examiner workload=[201,300], frequency	101,338				
Examiner workload=300+, frequency	42,396				
Dependent Variable					
Whether the patent is approved (1) or not (0)	784,004	0.645	0.479	0	1
Whether the patent is renewed for over three years (1) or not (0)	505,673	0.796	0.403	0	1
Whether an initially rejected patent is re-examined (1) or not (0)	282,143	.031	0.173	0	1
Examination time, months	505,600	21.302	9.712	1	149
The number of patents in the backward citation list that were neither previously cited nor previously examined by the examiner before	344,079	3.694	1.886	0	21
The number of patents in the backward citation list that were either previously cited or previously examined by the examiner	344,079	0.073	0.391	0	15
Whether any patents in the backward citation list were either previously cited or previously examined by the examiner (1) or not (0)	344,079	0.049	0.217	0	1
Control Variable					
Number of claims	784,004	6.282	4.181	1	50
Repeat applicant = 1	784,004	0.675	0.468	0	1
Individual applicant = 1	784,004	0.208	0.406	0	1
Firm applicant =1	784,004	0.394	0.489	0	1
Multiple-individuals applicant = 1	784,004	0.018	0.132	0	1
The year gap between the filing and the disposition, years	784,004	1.060	0.856	0	4

Notes: This table presents the summary statistics of key variables used in this article. We limit the sample to applications submitted by applicants based in China, that must be requested for examination no more than three years following the filing date. The disposition date marks the beginning of the Substantive Examination Phase. Data source: State Intellectual Property Office (SIPO) of China.

4 Empirical Strategy

To estimate the impact of workload on examiner decisions, we estimate the following equation by ordinary least squares.

$$Y_{ieky} = \alpha + \sum_{b=2}^{6} \beta_b D_{ieky}^{b} + X_{ieky} + P_{ey} + \lambda_e + \eta_{ky} + \epsilon_{ieky} \tag{1}$$

where the dependent variable Y_{ieky} represents the outcome of interest for patent application i in technology field k (IPC-code), reviewed by examiner e in the examination year y, i.e., whether the application is ultimately approved, or whether the patent is renewed continuously for over three years. The main independent variable, the examiner's workload D, is specific to each application i, hence the subscript $ieky$. The workload is determined by counting the total number of patent applications that the examiner begins to review sub-

stantively within a 12-month window, starting from the month the substantive examination of patent application i is initiated. Examiner workload is segmented into six categories: 1-50, 51-100, 101-150, 151-200, 201-300, 300+. The variable D^b_{iey} is assigned a value of 1 if the examiner's workload falls within group b, and 0 otherwise, with the 1-50 group serving as the reference category. β_b is the coefficient of interest, which measures the effect of the examiner's workload on the outcome variable relative to the baseline workload of 1-50.

We include a set of fixed effects. The examiner fixed effects, λ_e, absorb the effect of any time-invariant examiner characteristics that could be correlated with patent approval decisions. Consequently, the variation used to identify β_b stems from comparing different applications managed by the same examiner under different workloads. The technology field—examination year fixed effects, η_{ky}, control for technology-specific time trends in the outcome variables. In addition, we control for a set of pre-determined patent characteristics at the application level, X_{ieky}, because patent examination outcomes may coincide with these features. For example, a surge in the filing of low-quality patents can simultaneously escalate the workload for examiners and decrease the likelihood of patent approval. Finally, we control for the experience of examiner e in the examination year y, P_{ey}, categorized into two-year intervals as suggested by Frakes and Wasserman (2017), which captures the idea that examiner experience might be associated with patent office decisions. We cluster the standard errors at the examiner level, accounting for within-examiner serial correlations. The identification assumption for estimating Equation 1 is that after controlling for these fixed effects and control variables, the examiner workloads are exogenous to application-level outcomes. Given that the surge in examiner workload primarily stems from an increase in the supply of patent applications and patent applications are randomly assigned to examiners within art units, it is unlikely that examiners can choose their workloads endogenously. The increase in workload, driven by changes in the examination demand of examiners, provides the necessary variation to identify the impact of workload. The setting helps mitigate concerns that examiners might select applications based on their complexity or anticipated

workload demands.

5 Baseline Results

In this section, we present our findings on the impact of workload on examiner decisions. First, we conduct a balance check to validate the identification assumption. We then analyze how examiner workload impacts the probability of patent approval. Finally, we evaluate how workload influences decision quality. On one hand, the increased workload may lead examiners to approve low-quality patents or those that do not meet the required standards. On the other hand, it may reduce the likelihood of rejecting patents that should have been approved. By examining these effects, we distinguish between Type I errors—approving patents that should have been rejected—and Type II errors—rejecting patents that deserved approval—while investigating the reasons behind changes in the approval rate.

5.1 Balance Check

Our identification strategy relies on two main points. First, patent applications are randomly assigned to individual examiners within an art unit during the substantive examination phase, ensuring that neither applicant nor application characteristics influence the assignment of an application to an examiner. This justifies the need to control for technology-field×examine-year fixed effects. Second, the main variation in workload increases stems from institutional factors: a dramatic rise in patent applications alongside a relatively slow growth in the number of examiners. To ensure that the variation comes solely from the examination demand side and to rule out changes in examiner supply, we compare the same examiner under different workloads by including the examiner fixed effects. Therefore, we argue that any observed differences in applications should vanish if conditional on fixed effects based on examiner and technology-field×examine-year. Table 2 presents a balance check for the assignment of patent applications to examiners according to their workload. Our analysis

shows no systematic differences in workload across various pre-determined characteristics of patent applications and applicants once fixed effects are applied. Columns (1) and (2) indicate that application characteristics (e.g., claim count and inventor count) do not predict whether an examiner with a high workload is assigned. Columns (3) to (6) show that applicant characteristics, such as new or repeat status and applicant type, also do not predict assignment to a busier examiner. This approach helps mitigate potential biases in our study by confirming that examiners do not choose applications based on applications' complexity or anticipated workload.

Table 2: Balance Check on Patents Assignment to Examiners' Workload

	(1)	(2)	(3)	(4)	(5)	(6)
	Pre-determined Characteristics of Patent Applications					
	# claims (in log)	# inventors (in log)	Repeat applicant = 1	Individual applicant = 1	Firm applicant = 1	Research institute applicant = 1
Workload=[51,100]	-0.008*	-0.002	0.001	0.002	0.000	0.001
	(0.004)	(0.004)	(0.003)	(0.002)	(0.003)	(0.003)
Workload=[101,150]	-0.008*	0.002	0.001	-0.001	0.002	0.001
	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)
Workload=[151,200]	-0.001	-0.004	0.000	0.001	0.005	-0.004
	(0.006)	(0.006)	(0.004)	(0.003)	(0.004)	(0.004)
Workload=[201,300]	-0.005	-0.006	0.004	0.000	0.008*	-0.008*
	(0.007)	(0.007)	(0.004)	(0.004)	(0.005)	(0.005)
Workload=300+	-0.006	-0.007	0.004	0.002	0.006	-0.008
	(0.010)	(0.011)	(0.006)	(0.007)	(0.006)	(0.007)
Mean of Dep. Var.	1.605	0.913	0.675	0.208	0.394	0.342
FE	Examiner, IPC-code×Examine-year					
N	783,406	783,406	783,406	783,406	783,406	783,406
adj. R2	0.079	0.131	0.068	0.169	0.113	0.160

Notes: This table presents the association between pre-determined patent characteristics and examiner workload. Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. All regressions control for the year gap between the filing and the disposition of the application. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

5.2 The Impact of Workload on Approval Decision

We examine the impact of examiner workload on the likelihood of a patent being approved, which constitutes the direct and final decision by the examiner. Table 3 presents the results

from Equation 1 across different specifications. The baseline model incorporates examiner and IPC code×examine year fixed effects, progressively integrating metrics of initial quality and examiner experience into the regression analyses. The dependent variable in these models is a binary indicator that denotes whether the patent application was ultimately approved.

We highlight two main findings. Firstly, an increase in examiner workload results in a higher probability of a patent being approved. For example, an application reviewed by the examiner managing 150 ongoing applications is 1.5% more likely to be approved than when the examiner is handling only 50 applications. Considering the average approval rate of 64.5%, this translates into a 2.3% increase in the likelihood of patent approval. Secondly, the impact of workload on approval decisions becomes more pronounced when the number of applications under review exceeds 100. There is a significant increase when moving from under 100 to above 100, followed by a more gradual rise as the workload increases from above 100 to above 200 and 300. This pattern suggests a threshold effect, where the influence of examiner workload becomes evident beyond a certain point and grows at a slower rate as workload continues to rise. With 56.53% of applications being reviewed by examiners handling over 100 cases, this effect is non-negligible. Overall, as a simple back-of-the-envelope calculation, the increasing workload leads to examiners approving 7,606 more patents compared to a scenario where all examiners handle a workload of fewer than 50, conditional on all controls. This accounts for 1.5% of the total approved patents (505,673) in our sample from 2000 to 2011.

5.3 The Impact of Workload on Decision Quality

As patent application approval rates increase under higher workloads, two distinct outcomes may emerge. Firstly, high workloads may pressure examiners to approve patents that fail to meet required standards. This results in an increase in Type I errors—essentially, approving patents that should have been rejected. Secondly, the increased workload may lead examiners to recognize and approve patents that might have been rejected in a less busy

Table 3: The Impact of Examiner Workload on Approval Decision

	(1)	(2)	(3)	(4)
	Dep. Var. = The likelihood of patent approval			
workload=[51,100]	0.010***	0.005	0.010***	0.003
	(0.003)	(0.003)	(0.003)	(0.003)
workload=[101,150]	0.024***	0.016***	0.023***	0.012***
	(0.004)	(0.004)	(0.004)	(0.004)
workload=[151,200]	0.035***	0.024***	0.032***	0.018***
	(0.005)	(0.005)	(0.005)	(0.005)
workload=[201,300]	0.037***	0.025***	0.034***	0.018***
	(0.006)	(0.006)	(0.006)	(0.006)
workload=300+	0.040***	0.029***	0.037***	0.021**
	(0.009)	(0.009)	(0.008)	(0.008)
FE	Examiner, IPC-code×Examine-year			
Initial quality	N	N	Y	Y
Examiner Experience	N	Y	N	Y
N	783,406	783,406	783,406	783,406
adj. R2	0.141	0.141	0.178	0.178

Notes: This table presents the effect of examiner workload on the patent approval rate. Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is a binary indicator where 1 denotes a patent approval. Examiner experience is categorized into two-year intervals. The initial quality includes a set of variables: the logarithm of the number of claims, whether the applicant has previously applied for a patent, the type of applicant (individual, joint by individuals, or corporate), the geographical origin of the patent (province), and the duration (in years) between the filing and the disposition of the application. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

work environment. This thereby reduces Type II errors—missing patents that deserved approval. An increase in Type I errors, where unqualified patents are wrongfully approved, could degrade the overall quality of the approved patents. Conversely, a reduction in Type II errors, where deserving patents are correctly recognized and approved, could preserve and potentially improve the quality of approved patents. Thus, distinguishing between these two types of errors is vital for evaluating how examiner workload impacts the patent system.

To distinguish between Type I and Type II errors, we begin by analyzing the relationship between examiner workload and the quality of approved patents. Should a higher approval rate under a high workload signify an increase in Type I errors, we would expect to see

a decline in the quality of approved patents. Conversely, if a higher approval rate reflects a decrease in Type II errors, the quality of patents might remain stable or even improve as the examiner's workload increases. We use the probability of patent renewal over three years as a key indicator of patent value. The results are shown in Table 4. We observe that the impact of workload on the quality of approved patents varies across different workload categories. Specifically, for intermediate workload categories—ranging from 51-100, 101-150, and 151-200—the quality of the approved patent remains relatively stable when compared to the baseline group of 1-50. However, for higher workload brackets, particularly from 200-300 and above, there is a marked decrease in the probability of renewal, with a drop of 3% relative to the baseline. This nonlinear response suggests that the detrimental effects on patent quality are not immediate but become pronounced once a certain workload threshold is exceeded.

Our findings about the nonlinear effect of workload on the quality of approved patents shed light on the margins of Type I and Type II errors. While both an increase in Type I errors (approving unqualified patents) and a decrease in Type II errors (rejecting qualified patents) contribute to a higher approval rate, their impacts on the quality of approved patents differ. An increase in Type I errors results in a deterioration of patent quality, whereas a decrease in Type II errors tends to improve it. Thus, our analysis reveals that moderate workloads (below 200) coincide with an increase in Type I errors and a decrease in Type II errors, together fostering a higher approval rate while maintaining stable patent quality. However, under conditions of high workload (above 200), while the significant rise in Type I errors is associated with both higher approval rate and reduced patent quality, the change in Type II errors remains unclear. It is possible that Type II errors also decrease with increased workload, which could further complicate the quality outcomes of approved patents under high workload conditions. We next aim to directly assess the impact of workload on Type II errors to better understand these relationships.

Type II errors occur when examiners fail to recognize and approve patents that meet the

Table 4: The Impact of Examiner Workload on Quality of Approved Patents

	(1)	(2)	(3)	(4)
	Dep. Var. = Approved patent quality			
workload=[51,100]	0.005*	0.006**	0.005*	0.003
	(0.003)	(0.003)	(0.003)	(0.003)
workload=[101,150]	0.006*	0.007**	0.005	0.001
	(0.003)	(0.004)	(0.003)	(0.003)
workload=[151,200]	0.003	0.005	-0.001	-0.005
	(0.004)	(0.004)	(0.004)	(0.004)
workload=[201,300]	0.002	0.004	-0.005	-0.010**
	(0.005)	(0.005)	(0.004)	(0.005)
workload=300+	-0.015**	-0.013**	-0.024***	-0.028***
	(0.007)	(0.007)	(0.006)	(0.006)
FE	Examiner, IPC-code×Examine-year			
Initial quality	N	N	Y	Y
Examiner Experience	N	Y	N	Y
N	505,433	505,433	505,433	505,433
adj. R2	0.029	0.029	0.091	0.091

Notes: This table presents the effect of examiner workload on the quality of approved patents. Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is a binary indicator where 1 denotes that the patent is renewed continuously for over three years, and 0 otherwise. Examiner experience is categorized into two-year intervals. The initial quality includes a set of variables: the logarithm of the number of claims, whether the applicant has previously applied for a patent, the type of applicant (individual, joint by individuals, or corporate), the geographical origin of the patent (province), and the duration (in years) between the filing and the disposition of the application. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

standards. As a result, we assess the quality of initially rejected applications to gauge the prevalence of these errors. We introduce an indicator of patent quality for initially rejected applications: the likelihood of applying for re-examination following an initial rejection. According to SIPO regulations, if a patent applicant disagrees with the examiner's decision to reject the patent application, he may request a review from the Patent Reexamination Board within three months of receiving the rejection notice. This review process culminates with the board issuing a decision and notifying the applicant. However, pursuing re-examination incurs significant costs, including the review fee, potential legal fees for hiring a patent agency, amending application documents, and time costs. We hypothesize that applications

of higher quality are more likely to seek re-examination upon initial rejection, suggesting their high intrinsic value.

Table 6 displays the impact of examiner workload on the likelihood of re-examination for initially rejected patent applications, serving as a proxy for rejection decision quality. We find a consistent decrease in the likelihood of re-examination as the examiner's workload intensifies. Specifically, applications initially rejected by examiners managing 51-100 applications show a 0.7% lower probability of seeking re-examination compared to those handling less than 1-50. Re-examination requests decrease as workload increases. Since we use the likelihood of applying for re-examination as an indicator of rejection decision quality, the declining tendency to seek re-examination under heavier workloads suggests a reduced occurrence of examiners' Type II errors, where qualified patent applications fail to be recognized and approved during the initial examination.

In summary, our study shows that while increased workload can help examiners more effectively identify qualified patent applications, it also leads to a rise in Type I errors. At moderate levels, the reduction in Type II errors offsets the increase in Type I errors, preserving the overall quality of approved patents. However, beyond a certain workload threshold, Type I errors escalate significantly, while Type II errors do not decline proportionally. This imbalance suggests that while modest increases in workload can maintain patent processing quality, excessive workloads disproportionately impair decision-making, ultimately compromising the integrity of outcomes. These findings complement the traditional assumption that increased workload always leads to compromised quality, such as the well-known quality-speed tradeoff (Kc and Terwiesch, 2009; Tan and Netessine, 2014). They provide a rationale for developing improved workload management strategies that focus on optimizing case allocation rather than uniformly limiting workloads.

Table 5: The Impact of Examiner Workload on Quality For Initially Rejected Applications

	(1)	(2)	(3)	(4)
	Dep. Var. = The likelihood of re-examination			
workload=[51,100]	-0.007***	-0.007***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[101,150]	-0.010***	-0.009***	-0.010***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[151,200]	-0.008***	-0.008***	-0.008***	-0.007***
	(0.002)	(0.003)	(0.002)	(0.003)
workload=[201,300]	-0.010***	-0.009***	-0.010***	-0.009***
	(0.003)	(0.003)	(0.003)	(0.003)
workload=300+	-0.012***	-0.012***	-0.012***	-0.011***
	(0.004)	(0.004)	(0.004)	(0.004)
FE	Examiner, IPC-code×Examine-year			
Initial quality	N	N	Y	Y
Examiner Experience	N	Y	N	Y
N	281,418	281,418	281,418	281,418
adj. R2	0.030	0.030	0.042	0.042

Notes: This table shows the effect of examiner workload on the likelihood of patent re-examination for initially rejected applications. Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is binary, indicating whether an initially rejected patent was re-examined (1) or not (0). Examiner experience is categorized into two-year intervals. The initial quality includes a set of variables: the logarithm of the number of claims, whether the applicant has previously applied for a patent, the type of applicant (individual, joint by individuals, or corporate), the geographical origin of the patent (province), and the duration (in years) between the filing and the disposition of the application. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

6 Robustness Checks

6.1 Examiner Dynamics

Examiner dynamics could potentially bias our results. First, examiners who work for less than one year may exit early, introducing a potential truncation issue in our workload calculation. We define workload as the number of cases an examiner handles within a 12-month window starting from the month a specific patent examination begins. This approach may yield lower calculated workloads for examiners with less than one year of experience. However, as examiner entrants make up only 7% of our sample, this truncation issue is minimal

Table 6: The Impact of Examiner Workload on Quality For Initially Rejected Applications

	(1)	(2)	(3)	(4)
	Dep. Var. = The likelihood of re-examination			
workload=[51,100]	-0.007***	-0.007***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[101,150]	-0.010***	-0.009***	-0.010***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[151,200]	-0.008***	-0.008***	-0.008***	-0.007***
	(0.002)	(0.003)	(0.002)	(0.003)
workload=[201,300]	-0.010***	-0.009***	-0.010***	-0.009***
	(0.003)	(0.003)	(0.003)	(0.003)
workload=300+	-0.012***	-0.012***	-0.012***	-0.011***
	(0.004)	(0.004)	(0.004)	(0.004)
FE	Examiner, IPC-code×Examine-year			
Initial quality	N	N	Y	Y
Examiner Experience	N	Y	N	Y
N	281,418	281,418	281,418	281,418
adj. R2	0.030	0.030	0.042	0.042

Notes: This table shows the effect of examiner workload on the likelihood of patent re-examination for initially rejected applications. Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is binary, indicating whether an initially rejected patent was re-examined (1) or not (0). Examiner experience is categorized into two-year intervals. The initial quality includes a set of variables: the logarithm of the number of claims, whether the applicant has previously applied for a patent, the type of applicant (individual, joint by individuals, or corporate), the geographical origin of the patent (province), and the duration (in years) between the filing and the disposition of the application. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

and unlikely to significantly bias our results. To further ensure robustness, we exclude all entrants (i.e., examiners with less than one year of experience) and present the results in Table A1. All estimates remain consistent with the baseline. Second, examiners may exit due to high workloads. For instance, if increased workloads prompt examiners who struggle with high pressure to leave, and this unobservable trait is correlated with approval decisions, our findings could be affected. Although we include examiner fixed effects to compare decisions made by the same examiner under different workloads over time, one concern is that examiners who persist in high-workload situations may inherently be better suited to handle pressure, potentially impacting our results. To address this, we limit our analysis to patent

applications managed by examiners who have worked continuously for at least five years. The results from this subset are consistent with our baseline findings (see Table A2).

6.2 Filing Seasonality

As previously mentioned, we are comparing decisions made by the same examiner under varying workloads over time. One potential concern is the selection of applications at different times of the year. Low-quality patent applications might be hastily filed at the end of the year due to government top-down planning and directives on patenting (Sun et al., 2021). This can result in higher workloads and a lower average quality of applications during that period. To take this into consideration, we include filing month fixed effects, and the results, presented in Table A3, remain consistent with our baseline estimates.

6.3 Alternative Measures

To further test robustness, we use alternative measures to assess the quality of approval decisions. First, for approved patents, we employ a dummy variable indicating patent renewal beyond five years as an ex-post quality measure, replacing the three-year measure used in the baseline regression, see Table A4. Longer renewal periods indicate potentially greater patent quality. Consistent with our baseline findings, this analysis suggests that the quality of approved patents significantly deteriorates only when workloads become excessively high.

Second, for initially rejected applications, we examine their quality by the likelihood of requesting a re-examination. In our baseline analysis, we found that higher workloads reduce the likelihood of applicants requesting re-examination after an initial rejection. Moreover, if these re-examination requests succeed, it indicates that the examiner's initial rejection was overturned by the review committee, implying that the original decision was incorrect and the quality of these applications was indeed high. Table A5 shows that the likelihood of requesting re-examination and succeeding in it decreases as workload increases. This supports our baseline conclusion that higher workloads reduce Type II errors.

7 Mechanisms and Heterogeneity

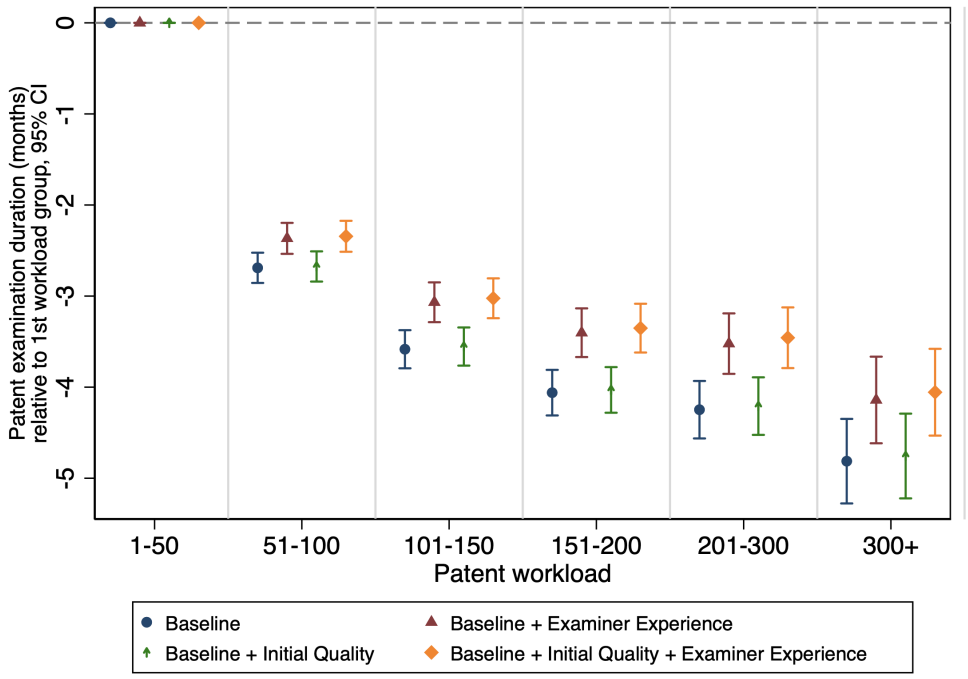
So far, our findings indicate that higher examiner workloads are associated with a greater likelihood of patent approval. Additionally, the impact on patent quality varies with the level of workload: it remains stable under moderate workload conditions but deteriorates as workload levels become excessive. In the following section, we aim to explore how workload impacts examiner behaviors. First, we focus on direct consequences induced by high workload such as expedited decisions, decreased search effort, and increased knowledge accumulation. Next, we study heterogeneity among the patents, applicants, and examiners.

7.1 Expedited Examination

We firstly explore whether examiners accelerate their decision-making processes in response to increasing workloads, particularly as they face the challenge of managing growing backlogs. Figure 2 illustrates the relationship between examiner workload and the patent examination time of all applications. We find that as the examiner workload increases, the duration of patent examinations decreases continuously. In the workload categories of 51-100 and 101-150, we observe a significant reduction in examination time of three months compared to the baseline group of 1-50. For higher categories, ranging from 151-200 through 300+, examination time is up to 4 months less than the baseline category. Considering that the average examination time is 22.8 months, this reduction corresponds to a 17.5% decrease. This pattern indicates that heavier workloads may compel examiners to expedite their review processes to manage the escalating number of applications.[8]

[8]One hypothesis posits that examiners may intensify their efforts towards the year's end or beginning. To test this, we regress the examination time on the examiner workload, segmented by examination quarter. The results are depicted in Figure A3 in the appendix. We find that the duration of patent examinations generally decreases as examiner workload increases, and this trend persists uniformly across all quarters. This demonstrates that the pressure to expedite reviews is constant throughout the year regardless of seasonal variations.

Figure 2: The Impact of Examiner Workload on Patent Examination Time



Notes: This figure illustrates the effect of examiner workload on the patent examination time for approved patents. Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is the duration between the disposition of the application (the beginning of the Substantive Examination Phase) and the approval date in months. Examiner experience is categorized into two-year intervals. The initial quality includes a set of variables: the logarithm of the number of claims, whether the applicant has previously applied for a patent, the type of applicant (individual, joint by individuals, or corporate), the geographical origin of the patent (province), and the duration (in years) between the filing and the disposition of the application. All specifications include examiner and IPC-code×Examine-year fixed effects. Standard errors are clustered at the examiner level. N= 774,474.

7.2 Reduced Search Effort

It is crucial to recognize that this accelerated pace can lead to consequences such as decreased search effort as workloads rise. Under such pressure of high workloads, examiners are likely to adopt heuristic strategies that simplify decision-making but can introduce cognitive biases (Kahneman, 2011). This simplification in processing and reliance on shortcuts, though practical for managing larger volumes of work, may adversely affect the quality of patent examinations. For instance, patents might be approved without fully adhering to the rigorous criteria typically required, with less thorough prior art searches by the examiner. The

following subsection will explore deeper into how these workload-induced changes impact the search effort.

Column (1) of Table 7 presents the estimation results on the impact of examiner workload on search efforts. We employ the number of patents in the backward citation list that was neither previously cited nor examined by the examiner—as a measure for an examiner's search efforts. The results indicate a decline in the search effort as the workload intensifies, particularly when the workload surpasses 150. For example, examiners managing over 300 patent applications exhibit a marked reduction in new searches, with 0.123 fewer new citations compared to the baseline group (1-50). This trend suggests that as workload increases, examiners are less inclined to conduct comprehensive searches for previous inventions, likely due to time constraints. However, at moderate workload levels, the decrease in search effort is not significant, as indicated by the insignificant coefficients for workload categories 51-100 and 101-150. This observation aligns with our findings on Type I errors (approving unqualified patents), which tend to escalate under conditions of higher workload.

7.3 Enhanced Knowledge Accumulation

While the increased workload can prompt examiners to expedite their decision-making process and reduce their search efforts, it also offers some advantages, such as fostering knowledge accumulation. Examiners can gain expertise through their exposure to technologies presented in patent applications. This on-the-job learning means that much of an examiner's technical knowledge accrues from the number of patent applications they have reviewed. Consequently, the more applications they handle, the more familiar they become with prior arts, reducing the need to conduct extensive searches for previously encountered references.

To gauge the extent of examiners' knowledge accumulation through workload, we employ two variables: the number of patents in the backward citation list that were either previously cited or previously examined by the focal examiner, and a dummy variable indicating whether any patents in the backward citation list were either previously cited or previously examined

Table 7: The Impact of Examiner Workload on Search Cost and Knowledge Accumulation

	(1)	(2)	(3)
	Search Effort	Knowledge Accumulation	
	New citations	Prior citations	Prior citations > 0
Workload=[51,100]	0.009	0.008**	0.008***
	(0.020)	(0.004)	(0.002)
Workload=[101,150]	-0.007	0.020***	0.015***
	(0.027)	(0.005)	(0.002)
Workload=[151,200]	-0.072**	0.027***	0.020***
	(0.033)	(0.006)	(0.003)
Workload=[201,300]	-0.146***	0.039***	0.028***
	(0.041)	(0.007)	(0.003)
Workload=300+	-0.123**	0.057***	0.036***
	(0.061)	(0.015)	(0.005)
FE	Examiner, IPC-code×Examine-year		
Observations	343,877	343,877	343,877
Adjusted R^2	0.401	0.057	0.060

Notes: This table presents the impact of examiner workload on search cost and knowledge accumulation by examiners for approved patents. Dependent variables across the Columns are the number of subsequent citations that were neither previously cited nor examined by the examiner before in Column (1), the number of subsequent citations that were either previously cited or previously examined by the examiner in Column (2), and a dummy variable indicating whether any subsequent citations were either previously cited or previously examined by the examiner in Column (3). Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. All specifications control for examiner experience categorized into two-year intervals and the set of initial quality variables. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

by the focal examiner. The results presented in Columns (2) and (3) of Table 7 show that as workload increases, there is a notable rise in the number of citations that were either previously cited or examined by the focal examiner. This trend is more pronounced in higher workload categories, suggesting that examiners increasingly rely on previously encountered applications. This pattern may indicate a knowledge accumulation effect, where familiarity with prior patents aids in the more efficient processing of new examinations. The increase in the dummy variable in Column (3), which denotes the use of prior citations, further supports the idea that higher workloads help examiners benefit from knowing more about

existing knowledge. The results of increased knowledge accumulation support our findings that Type II errors (rejecting qualified patents) decline as workload rises.

7.4 Heterogeneous Analysis

7.4.1 Patent Quality Heterogeneity

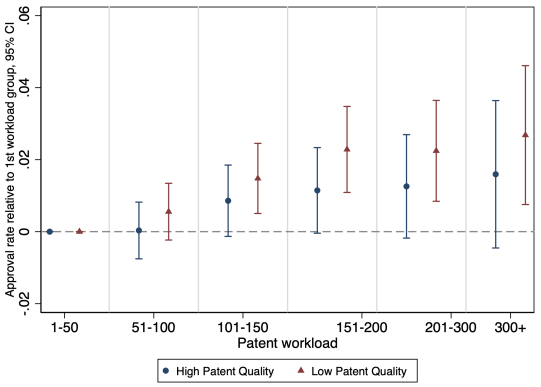
In this subsection, we examine the heterogeneity of patent applications to understand whether examiners respond differently to workload when handling patents of initially different quality. We categorize applications into two groups based on whether the number of claims is above the mean. Specifically, an application is considered of high quality if it has more claims than average. We re-analyze three key outcomes—approval rate, patent renewal over three years, and re-examination request, and present the results in Figure 3.

Panel A of the figure presents the effects of workload on the likelihood of approval for both low-quality and high-quality patents. In both categories, increased workload correlates with a higher probability of approval. However, the rise in approval rates is less pronounced for high-quality patents compared to lower-quality ones. Low-quality patents appear more susceptible to the pressures of increased workload, likely due to their simpler nature, which facilitates quicker processing under high workload conditions. In Panel B, we explore the impact of workload on the quality of approved patents, as indicated by renewal status over three years. We observe a decreasing trend in the likelihood of continuous renewal for low-quality patents, a pattern not seen for high-quality patents. This suggests that higher workloads predominantly affect lower-quality patents, leading to the approval of unqualified patents. Panel C focuses on re-examination requests for initially rejected patent applications, showing a significant reduction only in high-quality ones. These findings align with our baseline results. On one hand, the quality of patent approval decisions improves with increased workload, as high-quality patent applications benefit from it, leading to a decrease in Type II errors. On the other hand, the quality of decisions deteriorates because low-quality patent applications are less effectively filtered out, resulting in an increase in Type I errors. The

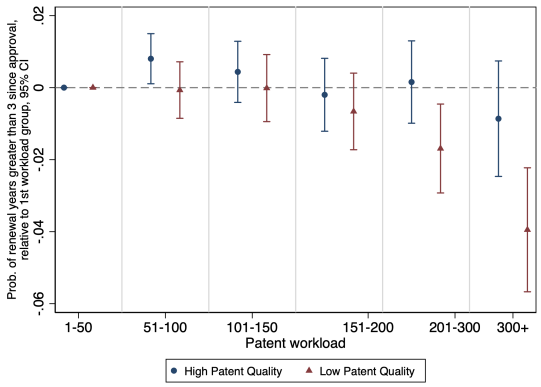
overall impact of workload on the quality of patent approval decisions depends on whether the improvement in high-quality approvals outweighs the increase in errors. This balance is often not maintained when the workload becomes excessively high.

Figure 3: The Impact of Workload on Examiner Decisions: By Initial Patent Quality

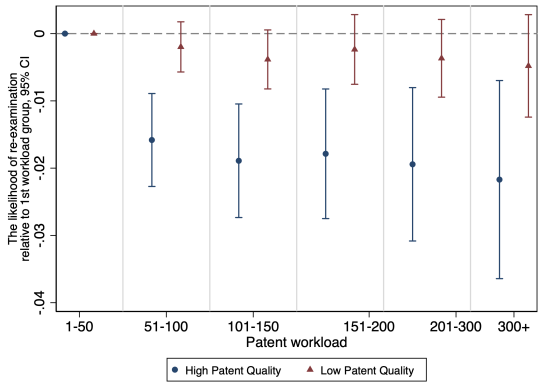
(a) Approval Rate



(b) Patent Renewal Over 3 Years



(c) Re-examination Request



Notes: This figure illustrates the effect of examiner workload on the patent outcomes, by initial patent quality. Dependent variables across the panels include a binary indicator for patent approval (Panel A), renewal status over three years (Panel B), and the likelihood of reexamination request (Panel C). Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. High patent quality is defined by the number of claims exceeding the average. Applications of initial high-quality account for 42.58% in our sample. All specifications control for examiner experience, the set of initial quality variables, and include examiner and IPC-code×Examine-year fixed effects. Standard errors are clustered at the examiner level.

7.4.2 Patent Applicant Heterogeneity

In this analysis, we examine the heterogeneity among patent applicants—firms, individuals, and universities—and how these differences influence examiner decisions under varying

workloads. Applications from different types of applicants may affect examiners' responses due to different levels of resources, expertise, and the perceived quality of patent applications. Firms and universities often have more resources, such as dedicated intellectual property departments or legal assistance, leading to more thoroughly prepared applications. In contrast, individual applicants may submit simpler, less resource-intensive applications, potentially resulting in quicker, less detailed examinations, especially under high workload conditions.

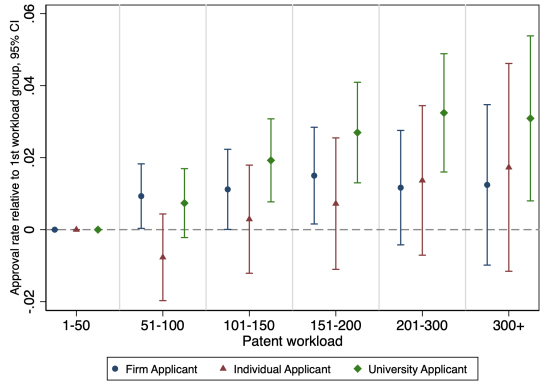
Figure 4 presents the effects of examiner workload by applicant type. Panel A shows that approval rates rise with increasing workload across all applicant types, with the increase being more pronounced for university applicants. Panel B shows that patent renewal rates over three years decrease as workload increases, with the decline being steeper for university and individual applicants, suggesting that the quality of patents approved under higher workloads may be lower. In contrast, the quality of patents from firm applicants remains relatively unchanged as workload increases, potentially indicating that Type I errors do not rise significantly for this group. Panel C highlights the reduction in re-examination requests as the workload increases. There is a significant and consistent decline in re-examination requests among firm applicants across all workload brackets, whereas the decline in re-examination requests diminishes for university and individual applicants in high-workload environments. These findings suggest that examiners respond differently to workload depending on the type of applicant, with policy implications indicating that the patent office should pay closer attention to university applications, which appear to be treated most leniently by examiners.

7.4.3 Patent Examiner Heterogeneity

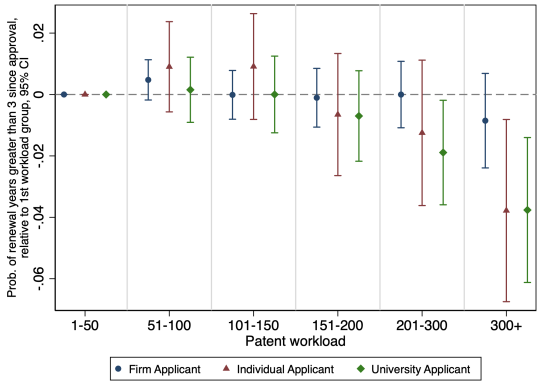
We explore the heterogeneity of patent examiners by examining how work experience is related to patent processing outcomes, in the absence of specific demographic data such as age, education, or gender. We compare the differential effects of workload on decision-making between junior and senior examiners. Examiners are categorized into two groups

Figure 4: The Impact of Workload on Examiner Decisions: By Patent Applicants

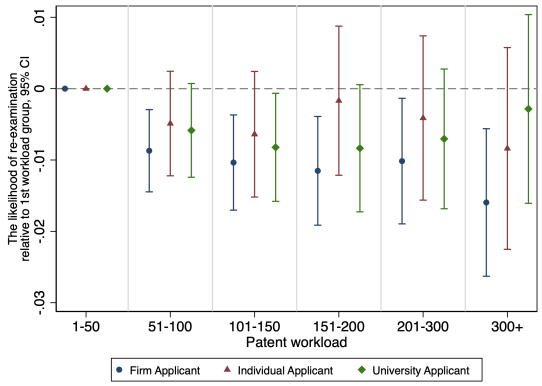
(a) Approval Rate



(b) Patent Renewal Over 3 Years



(c) Re-examination Request



Notes: This figure illustrates the effect of examiner workload on the patent outcomes, by the status of patent applicants. Dependent variables across the panels include a binary indicator for patent approval (Panel A), renewal status over three years (Panel B), and the likelihood of reexamination request (Panel C). Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. Firm applicants make up 39.38% of our sample, individual applicants 20.82%, and university applicants 30.12%. All specifications control for examiner experience, the set of initial quality variables, and include examiner and IPC-code×Examine-year fixed effects. Standard errors are clustered at the examiner level.

based on whether they have more or less than five years of experience, which represents both the median and mean of experience. Figure 5 presents the results of our analysis. We find that workload has significant effects primarily on senior examiners, while junior examiners are less affected by workload increases. Under high workload conditions, senior examiners tend to have a higher approval rate, but the quality of approved patents declines more significantly, indicating a greater increase in Type I errors (approving unqualified patents) among seniors. This difference may be attributed to age-related factors; as individuals

grow older, they often face more time constraints. For instance, senior examiners may have additional family responsibilities and be less flexible in responding to increased workloads, such as working overtime to complete tasks. This interpretation aligns with the findings of Frakes and Wasserman (2017), which indicate that examiner experience is associated with reduced time spent on examination. An exception is observed for junior examiners: while their approval rate remains unchanged under very high workloads, the quality of approved patents declines. This may result from approving more unqualified patents while rejecting some qualified ones, reflecting an increase in both Type I and Type II errors. Consistent with this, re-examination requests do not decline significantly for junior examiners, suggesting that Type II errors (rejecting qualified patents) remain largely unaffected for them but decrease more for senior examiners. This pattern may indicate that knowledge accumulation plays a more substantial role for senior examiners, as they build expertise over time.

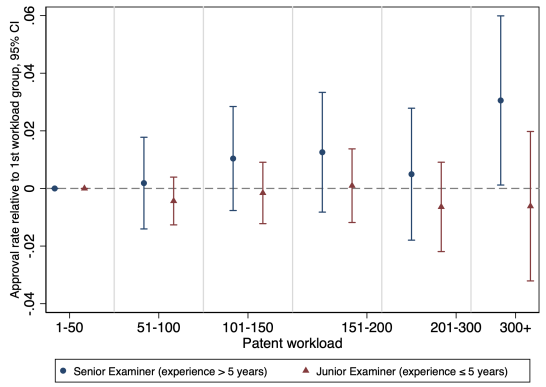
8 Conclusion

The relationship between workload and work performance has significant implications for both academia and policymakers, yet research in this area often faces challenges related to data availability and endogeneity. This article provides empirical evidence on the impact of workload on patent examiners' decision-making, using detailed patent application data from China between 2000 and 2011. We address the endogeneity of examiner workload by leveraging the unique situation of a rapid surge in patent applications while the number of examiners remained relatively sluggish, coupled with the random assignment of applications to examiners within art units.

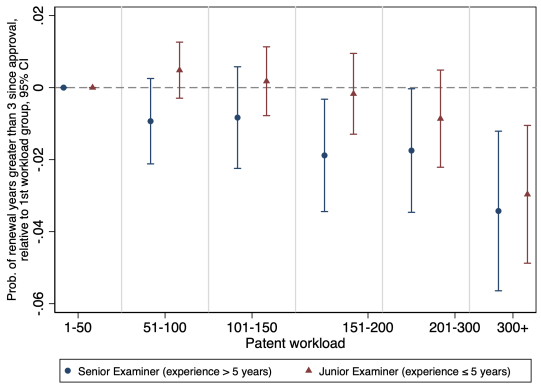
We identify an increase in the likelihood of patent approval as the workload intensifies. We further explore the relationship between workload and patent quality of approved applications and the likelihood of re-examination requests from initially rejected applications, distinguishing between Type I (approving unqualified patents) and Type II errors (reject-

Figure 5: The Impact of Workload on Examiner Decisions: By Initial Patent Quality

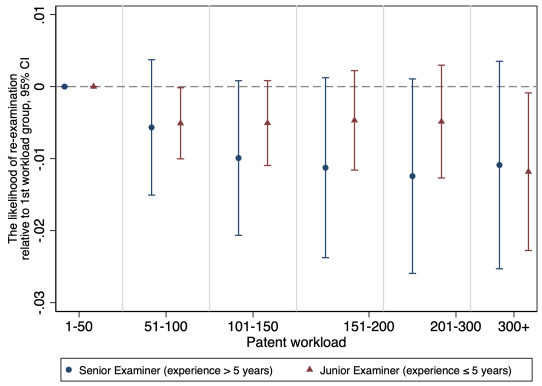
(a) Approval Rate



(b) Patent Renewal Over 3 Years



(c) Re-examination Request



Notes: This figure illustrates the effect of examiner workload on the patent outcomes, by the different experience levels of patent examiners. Senior examiners are those with over 5 years of experience, while junior examiners have less than 5 years of experience but are not newcomers. Dependent variables across the panels include a binary indicator for patent approval (Panel A), renewal status over three years (Panel B), and the likelihood of reexamination request (Panel C). Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. All specifications control for the set of initial quality measures and include examiner and IPC-code×Examine-year fixed effects. Standard errors are clustered at the examiner level.

ing qualified patents). Both types of errors can increase approval rates but have different impacts on patent quality. The results indicate that moderate workloads effectively balance the rise in Type I errors with a decrease in Type II errors, maintaining the overall quality of patent assessments. However, excessively high workloads dramatically increase Type I errors without corresponding mitigation in Type II errors. This suggests that extremely high workloads substantially degrade the decision-making quality. This emphasizes the critical need for meticulously designed policies to manage examiner workloads adeptly. Moreover,

our findings reveal a reduction in examination time and search effort as workloads escalate, alongside noting some advantages of increased workload, such as enhanced knowledge accumulation. The analysis also highlights the variability in how different types of applications, applicants, and examiners respond to increased workloads.

Our research contributes to a better understanding of how workloads affect decision-making in a critical sector of the economy that significantly influences innovation. For policymakers, these insights highlight the importance of carefully designing work systems and managing workloads in patent offices to maintain a balance between quantity and quality. This is especially relevant in environments where workload increases are not matched by corresponding resource growth. Our findings open avenues for further research on workload management and decision quality in other bureaucratic and administrative contexts where decision accuracy is essential. Additionally, the study advocates for the development of comprehensive policies that prioritize not only the volume of outputs but also the integrity of outcomes in high-workload settings. Implementing such policies could lead to substantial improvements in how public and private institutions manage workload pressures while preserving the quality of decision-making.

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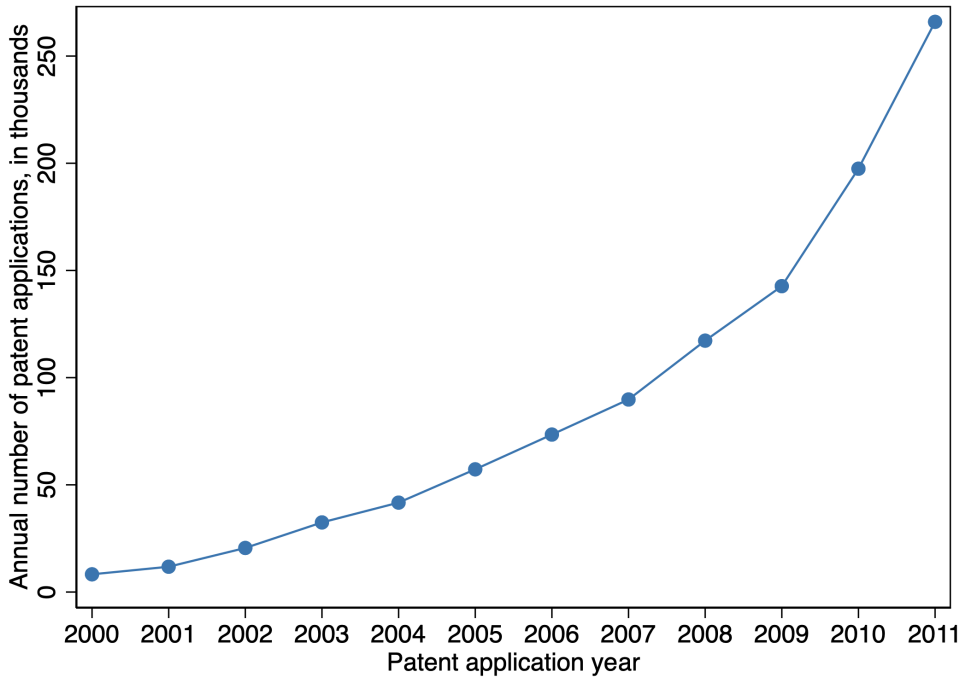
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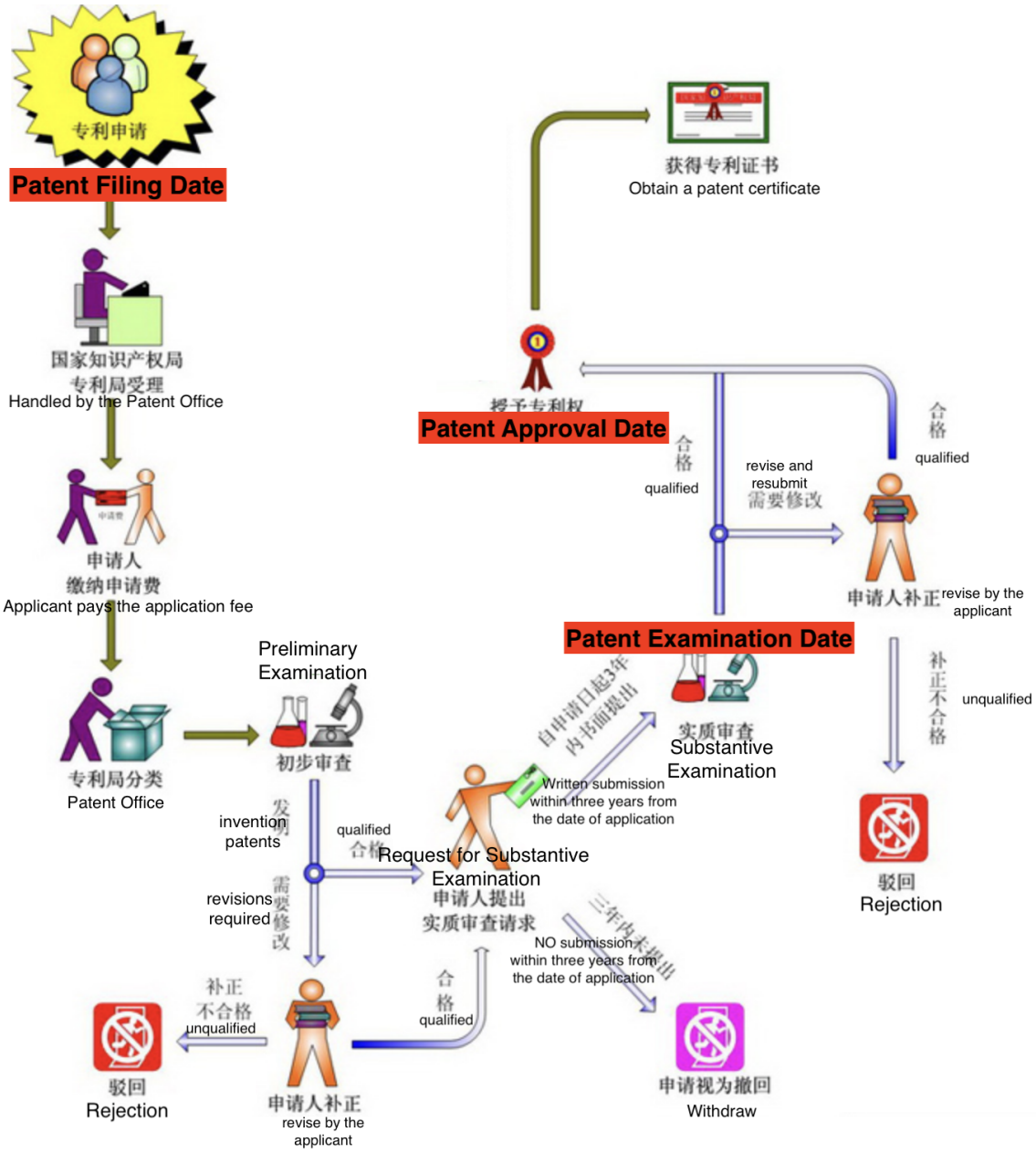
Appendix on The Impact of Workload on Decision-Making: Evidence from Patent Examination

Figure A1: The Number of Patent Applications Between 2000 and 2011



Notes: This graph displays annual patent applications selected based on specific criteria: the applications must have been filed for examination within five years from the application date, and published within 36 months. Data sources: State Intellectual Property Office (SIPO) of China.

Figure A2: The Patent Examination Process



Notes: This graph illustrates the complete patent examination process, from the filing date to the final decision, as outlined by the State Intellectual Property Office (SIPO) of China.

Table A1: Robustness Check: Examiner Dynamics I

	(1)	(2)	(3)	(4)
Panel A The likelihood of patent approval				
workload=[51,100]	0.003	0.001	0.003	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)
workload=[101,150]	0.016***	0.011**	0.014***	0.007
	(0.004)	(0.005)	(0.004)	(0.005)
workload=[151,200]	0.025***	0.019***	0.022***	0.013**
	(0.005)	(0.006)	(0.005)	(0.005)
workload=[201,300]	0.029***	0.021***	0.025***	0.014**
	(0.006)	(0.006)	(0.006)	(0.006)
workload=300+	0.034***	0.027***	0.029***	0.019**
	(0.009)	(0.009)	(0.009)	(0.009)
N	727,639	727,639	727,639	727,639
adj. R2	0.126	0.126	0.164	0.164
Panel B Approved patent quality				
workload=[51,100]	0.006*	0.006*	0.004	0.002
	(0.003)	(0.003)	(0.003)	(0.003)
workload=[101,150]	0.009**	0.009**	0.005	0.002
	(0.004)	(0.004)	(0.004)	(0.004)
workload=[151,200]	0.006	0.006	-0.001	-0.005
	(0.004)	(0.004)	(0.004)	(0.004)
workload=[201,300]	0.005	0.005	-0.006	-0.010**
	(0.005)	(0.005)	(0.005)	(0.005)
workload=300+	-0.012*	-0.012*	-0.024***	-0.028***
	(0.007)	(0.007)	(0.007)	(0.007)
N	476,201	476,201	476,201	476,201
adj. R2	0.030	0.030	0.092	0.092
Panel C The likelihood of re-examination				
workload=[51,100]	-0.004**	-0.005**	-0.005**	-0.005**
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[101,150]	-0.006***	-0.007***	-0.006***	-0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[151,200]	-0.005*	-0.005*	-0.005*	-0.005**
	(0.003)	(0.003)	(0.003)	(0.003)
workload=[201,300]	-0.006**	-0.007**	-0.007**	-0.007**
	(0.003)	(0.003)	(0.003)	(0.003)
workload=300+	-0.009**	-0.010**	-0.009**	-0.009**
	(0.004)	(0.004)	(0.004)	(0.004)
N	254,690	254,690	254,690	254,690
adj. R2	0.028	0.028	0.040	0.040

Notes: This table shows the effect of examiner workload on the patent approval rate (Panel A), the quality of approved patents (Panel B), the likelihood of patent re-examination for initially rejected applications (Panel C). Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is a binary indicator where 1 denotes a patent approval (Panel A), a binary indicator where 1 denotes that the patent is renewed continuously for over three years, and 0 otherwise (Panel B), a binary indicating whether an initially rejected patent was re-examined (1) or not (0) (Panel C). We exclude examiners with only one year of experience, accounting for around 7% (56,147/ 784,004) of the total. All regressions control for Examiner FEs and IPC-code×Examine-year FEs. Column (2) controls for examiner experience, Column (3) controls for initial quality, and Column (4) controls for both examiner experience and initial quality. Examiner experience and initial quality are defined in the same way as in the baseline results. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

Table A2: Robustness Check: Examiner Dynamics II

	(1)	(2)	(3)	(4)
Panel A The likelihood of patent approval				
workload=[51,100]	0.006	-0.000	0.007*	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)
workload=[101,150]	0.019***	0.010*	0.019***	0.007
	(0.005)	(0.005)	(0.005)	(0.005)
workload=[151,200]	0.030***	0.019***	0.030***	0.015**
	(0.006)	(0.006)	(0.006)	(0.006)
workload=[201,300]	0.037***	0.024***	0.036***	0.019***
	(0.007)	(0.007)	(0.007)	(0.007)
workload=300+	0.039***	0.027***	0.038***	0.021**
	(0.009)	(0.010)	(0.009)	(0.009)
N	583,693	583,693	583,693	583,693
adj. R2	0.101	0.102	0.141	0.141
Panel B Approved patent quality				
workload=[51,100]	0.004	0.004	0.005*	0.003
	(0.003)	(0.003)	(0.003)	(0.003)
workload=[101,150]	0.004	0.004	0.004	0.001
	(0.004)	(0.004)	(0.004)	(0.004)
workload=[151,200]	0.001	0.000	-0.001	-0.005
	(0.004)	(0.005)	(0.004)	(0.004)
workload=[201,300]	-0.001	-0.001	-0.005	-0.010**
	(0.005)	(0.005)	(0.005)	(0.005)
workload=300+	-0.016**	-0.016**	-0.022***	-0.027***
	(0.007)	(0.007)	(0.007)	(0.007)
N	390,270	390,270	390,270	390,270
adj. R2	0.030	0.030	0.092	0.092
Panel C The likelihood of re-examination				
workload=[51,100]	-0.007***	-0.007***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[101,150]	-0.010***	-0.010***	-0.010***	-0.009***
	(0.003)	(0.003)	(0.002)	(0.003)
workload=[151,200]	-0.007**	-0.007**	-0.007**	-0.006**
	(0.003)	(0.003)	(0.003)	(0.003)
workload=[201,300]	-0.010***	-0.009***	-0.010***	-0.009***
	(0.003)	(0.003)	(0.003)	(0.003)
workload=300+	-0.014***	-0.013***	-0.014***	-0.013***
	(0.004)	(0.004)	(0.004)	(0.004)
N	196,234	196,234	196,234	196,234
adj. R2	0.033	0.033	0.044	0.044

Notes: This table shows the effect of examiner workload on the patent approval rate (Panel A), the quality of approved patents (Panel B), the likelihood of patent re-examination for initially rejected applications (Panel C). Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is a binary indicator where 1 denotes a patent approval (Panel A), a binary indicator where 1 denotes that the patent is renewed continuously for over three years, and 0 otherwise (Panel B), a binary indicating whether an initially rejected patent was re-examined (1) or not (0) (Panel C). We first identify examiners who have worked continuously for five years in our sample and retain all their records, including those from their first four years of work, accounting for 74% (583,720 out of 784,004) of the total. All regressions control for Examiner FEs and IPC-code×Examine-year FEs. Column (2) controls for examiner experience, Column (3) controls for initial quality, and Column (4) controls for both examiner experience and initial quality. Examiner experience and initial quality are defined in the same way as in the baseline results. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

Table A3: Robustness Check: Filing Seasonality

	(1)	(2)	(3)	(4)
Panel A The likelihood of patent approval				
workload=[51,100]	0.011***	0.006*	0.011***	0.004
	(0.003)	(0.003)	(0.003)	(0.003)
workload=[101,150]	0.025***	0.017***	0.024***	0.013***
	(0.004)	(0.004)	(0.004)	(0.004)
workload=[151,200]	0.036***	0.026***	0.033***	0.019***
	(0.005)	(0.005)	(0.005)	(0.005)
workload=[201,300]	0.040***	0.029***	0.036***	0.020***
	(0.006)	(0.006)	(0.006)	(0.006)
workload=300+	0.043***	0.032***	0.038***	0.023***
	(0.008)	(0.009)	(0.008)	(0.008)
N	783,406	783,406	783,406	783,406
adj. R2	0.142	0.142	0.179	0.179
Panel B Approved patent quality				
workload=[51,100]	0.004	0.003	0.005**	0.004
	(0.003)	(0.003)	(0.003)	(0.003)
workload=[101,150]	0.004	0.003	0.006*	0.004
	(0.003)	(0.004)	(0.003)	(0.003)
workload=[151,200]	-0.001	-0.002	0.001	-0.002
	(0.004)	(0.004)	(0.004)	(0.004)
workload=[201,300]	-0.003	-0.005	-0.002	-0.005
	(0.005)	(0.005)	(0.004)	(0.005)
workload=300+	-0.022***	-0.024***	-0.020***	-0.023***
	(0.007)	(0.007)	(0.006)	(0.006)
N	505,433	505,433	505,433	505,433
adj. R2	0.035	0.035	0.094	0.094
Panel C The likelihood of re-examination				
workload=[51,100]	-0.007***	-0.007***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[101,150]	-0.010***	-0.010***	-0.010***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[151,200]	-0.008***	-0.008***	-0.008***	-0.007***
	(0.002)	(0.003)	(0.002)	(0.003)
workload=[201,300]	-0.010***	-0.010***	-0.010***	-0.009***
	(0.003)	(0.003)	(0.003)	(0.003)
workload=300+	-0.012***	-0.012***	-0.012***	-0.011***
	(0.004)	(0.004)	(0.004)	(0.004)
N	281,418	281,418	281,418	281,418
adj. R2	0.031	0.031	0.042	0.042

Notes: This table shows the effect of examiner workload on the patent approval rate (Panel A), the quality of approved patents (Panel B), the likelihood of patent re-examination for initially rejected applications (Panel C). Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is a binary indicator where 1 denotes a patent approval (Panel A), a binary indicator where 1 denotes that the patent is renewed continuously for over three years, and 0 otherwise (Panel B), a binary indicating whether an initially rejected patent was re-examined (1) or not (0) (Panel C). All regressions control for Examiner FEs, IPC-code×Examine-year FEs, and the filing month FEs. Column (2) controls for examiner experience, Column (3) controls for initial quality, and Column (4) controls for both examiner experience and initial quality. Examiner experience and initial quality are defined in the same way as in the baseline results. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

Table A4: The Impact of Examiner Workload on Quality of Approved Patents

	(1)	(2)	(3)	(4)
	Dep. Var. = Approved patent quality			
workload=[51,100]	-0.000	-0.000	0.001	0.000
	(0.003)	(0.003)	(0.003)	(0.003)
workload=[101,150]	-0.002	-0.002	-0.000	-0.002
	(0.004)	(0.004)	(0.004)	(0.004)
workload=[151,200]	-0.005	-0.005	-0.003	-0.006
	(0.005)	(0.005)	(0.004)	(0.005)
workload=[201,300]	-0.004	-0.004	-0.004	-0.007
	(0.005)	(0.006)	(0.005)	(0.005)
workload=300+	-0.017**	-0.017**	-0.016**	-0.018***
	(0.007)	(0.008)	(0.007)	(0.007)
FE	Examiner, IPC-code×Examine-year			
Initial quality	N	N	Y	Y
Examiner Experience	N	Y	N	Y
N	505,433	505,433	505,433	505,433
adj. R2	0.049	0.049	0.150	0.150

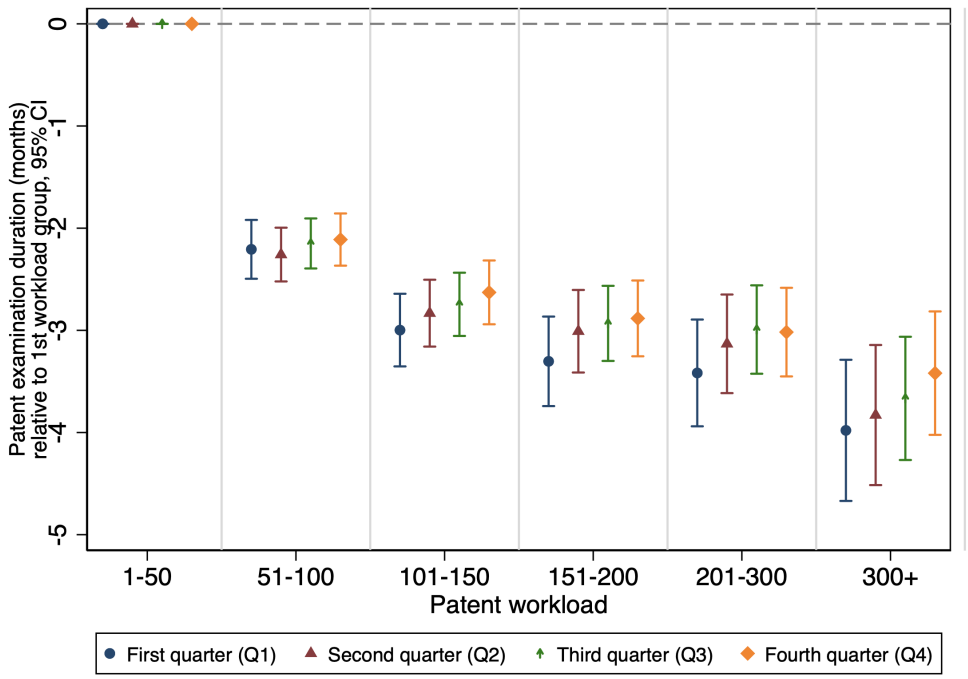
Notes: This table presents the effect of examiner workload on the quality of approved patents. Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is a binary indicator where 1 denotes that the patent is renewed continuously for over five years, and 0 otherwise. Examiner experience is categorized into two-year intervals. The initial quality includes a set of variables: the logarithm of the number of claims, whether the applicant has previously applied for a patent, the type of applicant (individual, joint by individuals, or corporate), the geographical origin of the patent (province), and the duration (in years) between the filing and the disposition of the application. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

Table A5: The Impact of Examiner Workload on Patent Quality For Initially Rejected Applications

	(1)	(2)	(3)	(4)
	Dep. Var. = The likelihood of re-examination and approval			
workload=[51,100]	-0.008***	-0.008***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
workload=[101,150]	-0.011***	-0.011***	-0.011***	-0.011***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[151,200]	-0.011***	-0.011***	-0.011***	-0.011***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=[201,300]	-0.012***	-0.011***	-0.012***	-0.011***
	(0.002)	(0.002)	(0.002)	(0.002)
workload=300+	-0.012***	-0.012***	-0.012***	-0.012***
	(0.003)	(0.003)	(0.003)	(0.003)
FE	Examiner, IPC-code×Examine-year			
Initial quality	N	N	Y	Y
Examiner Experience	N	Y	N	Y
N	281,418	281,418	281,418	281,418
adj. R2	0.049	0.049	0.055	0.055

Notes: This table presents the effect of examiner workload on the likelihood of patent re-examination and eventual approval for initially rejected applications. Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is a binary indicator where 1 denotes that the patent is re-examined and ultimately granted, and 0 otherwise. Examiner experience is categorized into two-year intervals. The initial quality includes a set of variables: the logarithm of the number of claims, whether the applicant has previously applied for a patent, the type of applicant (individual, joint by individuals, or corporate), the geographical origin of the patent (province), and the duration (in years) between the filing and the disposition of the application. Standard errors are clustered at the examiner level. ***, **, * denote statistical significance at the 1%, 5%, 10% levels, respectively.

Figure A3: The Impact of Examiner Workload on Patent Examination Duration: By Quarter



Notes: This figure illustrates the effect of examiner workload on the patent examination duration for granted patents, segmented by examination quarter. Workload is categorized into six groups, with the lowest range (1-50) serving as the baseline. The dependent variable is the duration between the disposition of the application and the approval date in months. Examiner experience is categorized into two-year intervals. The initial quality includes a set of variables: the logarithm of the number of claims, whether the applicant has previously applied for a patent, the type of applicant (individual, joint by individuals, or corporate), the geographical origin of the patent (province), and the duration (in years) between the filing and the disposition of the application. All specifications include examiner and IPC-code×Examine-year fixed effects. Standard errors are clustered at the examiner level.