HEURISTICS IN THE PATENTING SYSTEM: HOW TECHNOLOGY BREADTH AND APPLICANT PRIOR INVENTIVE ACHIEVEMENT RELATE TO INTELLECTUAL PROPERTY RIGHTS

Abstract: Impartiality in the patent examination process is critical to preserving the incentives to invent. The Unites States Patent Office is charged with attending to the interests of the public by maintaining accessibility. Perceived or real bias in the patenting system can delay the diffusion of innovation and damage the overall innovation system. Using archival data on patent applications, we predict and find that technology breadth and prior inventive achievement of the patent applicant are systematically related to the breadth of the patent award, suggesting that these factors influence the outcome of the patenting process and the appropriation potential of intellectual property. Our findings are particularly relevant for policy makers and inventors of boundary spanning technologies.

Key words: Intellectual property rights, patenting process, behavioral perspective

Fairness and equality in patent examination are critical to protecting enterprising individuals and firms' creative efforts and thereby preserving incentives to invent and innovate (Mazzoleni and Nelson, 1998). The patenting system relies on a fee-for-service institution – the United States Patent Office (USPTO) - to represent the public's interests by maintaining and fair and just prosecution process. Maintaining fairness through appropriate policies is essential to maintaining confidence in the institution as an adjudicator of intellectual property rights. Weakening confidence in the institution could delay the diffusion of valuable knowledge (Arundel, 2001) and lead inventors to protect intellectual property in ways less beneficial to society such as trade secrets. Moreover, if the process is biased based on applicant characteristics, established technological regimes may be inappropriately reinforced at the expense of superior novel alternatives. In this paper, we consider predictors of variance in examiner added citations to patent applications which could indicate partiality in the prosecution process.

Patents play a central role in facilitating transactions involving IP. Entities that satisfy the patentability requirements benefit from disclosing details about their inventions by being granted exclusivity rights. The right to exclude others from commercializing an invention allows for appropriating the value of the inventors' creative achievement (Teece, 1986). Ideally, the agents of the USPTO evaluate patent applications solely on the merit of the application. In this paper, we consider examiner added citations as an essential phenomenon in the adjudication of IPR at the USPTO. The addition of citations in the prosecution process can narrow the scope of IPR granted to the applicant.

Researchers have begun to examine behavioral aspects that relate to differential patenting outcomes. These behavioral differences include the role of institutional gatekeeping (Ferguson and Carnabuci, 2017), examiner workload (Kim and Oh, 2017), and the role of examiner cohorts

(Frakes and Wasserman, 2016). This research has contributed to our understanding of the patenting process related to the institutional pressures and human resource policies at the USPTO. Still, they have generally focused on the patent examiner in isolation. However, patent examiners operate within the context of applicants with varying levels of experience and patents of varying technological complexity. Previous research suggests that applicant firms with extensive patenting histories typically receive fewer examiner added citations (Alcácer et al., 2009). This research explains the difference between applicant disclosure practices. By doing so, it implicitly attributes all systematic variance in examiner added citations to applicant agency. Our research challenges this assumption. We propose several theoretical mechanisms and conditions when systematic variance in examiner added citations could undermine new ventures' IPR efforts.

We build on an emerging stream of research that suggests the patent prosecution process as a phenomenon has systematic variance related to non-technological factors (Cockburn et al., 2003; Criscuolo and Verspagen, 2008; Ferguson and Carnabuci, 2017; Frakes and Wasserman, 2016; Kim and Oh, 2017). We investigate the possibility of systematic variance in patent examiner scrutiny by analyzing the extent to which the invention's technological breadth and the applicant's inventive track record independently and interactively relate to the number of examiner-added citations. We test these relationships in the computer and electronic manufacturing industry over a four-year period. By default, USPTO policy does not require examiners to add citations; rather, they can search for related prior art to position and potentially narrow the applicant's intellectual property. By technological breadth, we mean the number of technology classes to which the patent application is assigned. We find that the technological breadth and applicant inventive track record play a role in the patent examiner's decision-making process even after controlling for applicant legal expertise and examiner workload. We argue that this potential bias could dampen applicant enthusiasm for participating in the patenting process, perhaps leading new ventures to seek less societally desirable avenues for maintaining appropriation rights to their intellectual property.

Our research contributes to institutional gatekeeping literature by considering how cognitive limitations may influence intellectual property rights allocation (Choudhury and Haas, 2018; Clayman and Reisner, 1998; Ferguson and Carnabuci, 2017). The USPTO patent office serves as an institutional gatekeeper by imposing standards that can alter the flow of goods through society. Specifically, by rejecting applications or changing a patent application's scope, the associated intellectual property rights and subsequent rents are differentially allocated. First, we shed light on why and under what conditions the applicants' past inventive achievement might serve as a salient signal of patent application quality to USPTO examiners. Second, we explore a variety of potential mechanisms linking individual discretion and institutional gatekeeping.

In the following, we present a review of the USPTO's institutional controls to minimize systematic variance during the patent prosecution process. These include aligning applications with appropriate examiners, allocating reasonable time for prior art searches and issues related to examiner heterogeneity. We then develop a rationale for how an applicant's technological track record and technology breadth could play a role in allocating IP rights as measured by examiner-added citations.

The USPTO and Patent Application Prosecution

Managing both the accessibility and rigor of the patent prosecution process is fundamental to the integrity of intellectual property protection. Without accessibility, inventors are more likely to capture the value of their discoveries through secrecy rather than patents with negative consequences for societal technological progress. A rigorous process of delineating IP boundaries enhances investor confidence in technological ventures and economic growth.

To ensure both equal access and rigor, the USPTO adjudicates the scope of granted IP rights in a negotiation between the inventing entities and their legal representatives on the one side and the USPTO examiners on the other (Nordhaus, 1969).[1] The inventing party has incentives to apportion as large a scope as possible to maximize the value obtained from intellectual property (Lerner, 1994). Inventors often pursue IP boundary maximization by limiting the scope-reducing[2] citations of prior art included on the patent application. By searching for and amending patent applications to include additional citations to the relevant prior art, examiners counteract this tendency and ensure that patent awards delineate the appropriate boundaries (Cockburn et al., 2003).

The negotiation of patent boundaries occurs within the constraints of an organizational context. The USPTO is tasked with appropriately applying patent law under the financial constraints of a fee for service organization (Merges, 1999). As human beings, patent examiners at the USPTO are subject to cognitive limitations (Kahneman, 2011; Kahneman et al., 1982; Tversky and Kahneman, 1974). Thus, they may rely on decision heuristics to save time and cognitive effort in making decisions. Therefore, one factor that could affect an IP's scope is the degree to which examiners replace exhaustive search processes with heuristics when reviewing

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[1] For this study we conducted interviews with several (5) patenting process experts including a patent examiner, patent lawyers and patent consultants. These interviews focused on the patent prosecution process with interest in how behavioral factors may play a role in the prosecution process. The interviews served to better understand how the USPTO organizes to reduce the risk of granting patents which can be invalidated while managing a fee for service organization.

[2] In contrast to applicants and their legal representatives who may provide an extensive list of prior art references in their application which are innocuous with respect to the proposed claims, patent examiners are incentivized to concentrate on prior art that has a limiting effect with respect to requested patent scope (Lemley, 2000).

IP applications. While individual reliance on decision heuristics is not bound to a specific context, we argue that certain organizational constraints and task characteristics are likely to influence the extent to which patent examiners rely on decision heuristics during the IP delineation process. Consequently, examiners are more likely to settle for a feasible solution instead of engaging in an exhaustive evaluative search process (Cyert and March, 1963) as they seek to deliver sufficient prosecution of the patent application (Lemley, 2000). Among the biggest challenges for the USPTO in managing these constraints is ensuring that applicants have an equal opportunity to secure the intellectual property while reducing the chances that a granted patent will later be ruled invalid.

The term equal opportunity refers to whether there is systematic variance in the prosecution of patents based on examiner agency. A variety of factors may affect the review of applications and thus impact the degree of systematic variance. In our use of systematic variance, we argue that applicants vary in specific characteristics that examiners may see. If this happens, they may reduce or increase the intensity of the examination. We do not suggest that this is a conscious choice; instead, to prioritize their labor, examiners may adjust their focus of intensity among applications to spend more effort on some than on others.

The USPTO uses several policies to ensure that applicants have an equal chance to secure intellectual property; however, upon closer examination, some of these policies may have unintended, negative consequences for a patent applicant and their application. An essential challenge to the institutional mandate of equal access is heterogeneity in patent examiner scrutiny (Cockburn et al., 2003; Sampat and Williams, 2015). Empirical evidence suggests that patent examiners differ in their scrutiny and willingness to grant a patent application (Cockburn et al., 2003). The USPTO manages rigor and fairness by assigning applications according to relevant knowledge expertise and an examiner not of the applicants choosing (Righi and Simcoe, 2017). If, for example, the USPTO has two examiners with similar knowledge stocks and one has a greater level of scrutiny than another, there is a chance for either examiner to prosecute the application. This potential random assignment minimizes the risk of embedded interactions between applicants and examiners.

In addition to the directed assignment of patent applications, the USPTO utilizes a count system to ensure examiners allocate a consistent amount of time necessary to prosecute patent applications. The count system is a production management approach to allocate time to execute office actions and conduct prior art searches (Eckert and Langinier, 2014). In all, the count system ensures sufficient time to complete patent prosecution's essential tasks. However, productivity demands increase as examiners are promoted and assumed to become more efficient with experience. Together, these factors suggest that increasing workload demands are related to less effective prior art searches (Kim and Oh, 2017).

Aligning the patent technology with the examiners' knowledge is a policy intended to enhance prosecution effectiveness and efficiency. Having the technological background to assess a patent application effectively is critical to granting a valid patent. Indeed, examiners with highly specialized technical expertise are less likely to award the patent and more likely to scrutinize the claims (Righi and Simcoe, 2017). Therefore, differences in accessibility can result from whether the examiner has the specialized knowledge necessary to prosecute the patent effectively. However, highly technical expertise is more likely to occur within a specific technology class than across multiple technological classes. Thus, while the policy may ensure effective prosecution of focused technologies, there remains a challenge of prosecuting patents spanning multiple technological domains where such expertise may be less readily available

(Ferguson and Carnabuci, 2017).

Technologies that span multiple domains can also increase variability in the search process because of ambiguity. Domain spanning technologies are more likely to misalign with examiner specializations. Further, applicants of domain spanning technologies are likely to conduct their searches in different ways, thus increasing ambiguity, more unanticipated prior art, and added citations (Tan and Roberts, 2010).

Knowledge gaps during the evaluation of applications are likely to arise as a function of application's technological breadth and examiner tenure. On average, examiners with greater experience are more likely to have worked in multiple art units. Therefore, they may be better qualified to prosecute applications related to more integrative, boundary-spanning technological advancements (Langinier and Lluis, 2015). The examiner's length of tenure at the USPTO also appears to be associated with the amount of scrutiny exercised by the examiner (Cockburn et al., 2003). The USPTO allocates less time for office actions to experienced and promoted examiners. These increasing time constraints are associated with less scrutiny of patent applications (Kim and Oh, 2017).

Examiners also exercise discretion and may vary in their overall generosity. Previous work suggests that some examiners may be more generous in their allowance of claims (Cockburn et al., 2003). Greater generosity can increase the chances the patent is invalidated or cited in the future. More specifically, previous research suggests that invalidated patents are more likely to come from primary examiners (those with more experience) and further that it is the middle range examiner (those with 3-5 years of experience and who grant between 45-60 patents a year) with a higher rate of invalidation. Conversely, examiners with higher grant rates (80 patents per year and more than eight years of experience) do better than expected (Tu, 2013).

Finally, examiners have incentives that can complicate the prosecution process. Examiners have more incentives to allow patents than reject them (Lemley, 2000). The incentive to award is due to additional work to explain denial rather than the lack of writing required to grant a given patent. While there are controls within the system to hold examiners accountable to quality prosecution, the general incentive structure toward allowance remains (Wasserman, 2011).

Together, previous research suggests that there are multiple mechanisms by which examiners may vary in their prosecution of patent applications and prior art searches, including their knowledge, skill, and incentives. We add to this list by exploring how applicant reputation may provide additional input into examiner reviews of patent applications.

The Patent Prosecution Process

All non-provisional applications are assigned to a Technology Center and are classified and assigned by the supervisory patent examiner. One of the first actions is an office action regarding the completeness of the application. If the application is incomplete, there is a time period to complete the filing where the examiner will ask the applicant for more information to complete the application. If it is not corrected, the application is disposed of or returned.

The examiner then reviews the application to develop an understanding of the invention and claims. Upon understanding the invention, the examiner then searches for prior art disclosed in previous patents and other documents such as nonpatent literature. The Scientific and Technical Information Center maintains Electronic Information Centers and is responsible for providing efficient and accurate prior art searches and document delivery (901.06(a) US Patent & Trademark Office, 2001).

In developing an approach for searching prior art, examiners are encouraged to take three steps. First, identify the field of search, select the appropriate tool and then develop a search strategy for each tool selected. The field of search can include domestic patents, foreign patents, and nonpatent literature. Examiners then prioritize search efforts based on those fields that are most likely to possess prior art. Choosing a search tool is based on the examiner's knowledge of the domain and their understanding of each search tool's strengths and weaknesses. In high technology areas that progress quickly, search tool choice is crucial because patent documents may lag the technological frontier. In this situation, examiners ensure their searches include nonpatent literature (904.02 US Patent & Trademark Office, 2001). Examiners can seek out trained search personnel if they need assistance choosing a search tool (901.06(a) US Patent & Trademark Office, 2001).

The search tools provided include both text and classified search capabilities. When the art uses well-established terminology, text search can offer a robust approach to search for prior art. Typically both text search and other criteria (e.g., classification, chemical structure, or molecular sequence) are expected within many areas. In their adjudication of the prior art, examiners are encouraged to take the invention as read rather than looking behind the application to the "real invention" because such developments introduce more errors than benefits (904 US Patent & Trademark Office, 2001).

The examiner considers prior art cited in the application and records the office action (904 US Patent & Trademark Office, 2001). Another critical step in prior art searches is to search the inventor's name to find applications and patents to check for double patenting. The initial non-included reference search is to cover the invention as claimed, including the concepts driving the claims. When doing so, examiners are encouraged in this process not to include immaterial variants of the invention. The first office action relies on references found in this initial search (904 US Patent & Trademark Office, 2001). Subsequent art searches are unnecessary unless the applicant amends claims, shifting the described invention away from cited prior art toward other work.

Upon completing the prior art search, the examiner completes an Image File Wrapper form in the Office Action Correspondence Subsystem. They include information about the classification locations, abstract collections, and other prior art search sources (719.05 US Patent & Trademark Office, 2001).

At this time, the examiner decides whether to allow the application to give a non-final rejection or a final rejection. A non-final rejection is a decision that allows applicants to refine the application and claims further. Generally, final rejections end the process, but applicants can request continued examination (706.7 US Patent & Trademark Office, 2001). Most applications get a non-final rejection decision the first round (82.8%), and 70% of original applications will eventually be allowed (Kovács, 2017).

Applicant Prior Technological Achievement

Organizational reputation reflects an organization's cumulative effort over time to be viewed as legitimate through accomplishments (Rao, 1994)[3]. Veteran firms are more likely to develop numerous social connections, enhancing their reputation within a social network (Hannan and Carroll, 1992; Podolny and Page, 1998). For inventing organizations, a strong history of technology development is likely to enhance its reputation among key stakeholders.

[3]Technological reputation should not be confused with organizational status. Status should not be confused with organizational reputation. Reputation is associated with an expectation of future behavior based on past behavior (e.g. Jensen and Roy, 2008) whereas status derives from an organization's position in the hierarchical social order (e.g. Podolny, 1993), whereas In order to compensate for uncertainty, external observers often consider either construct as a signal of quality (Devers et al., 2008); in this study we examine reputation mechanisms rooted in social ranking differences as measured by a firm's position in the technological certification network relative to its peers.

When facing uncertainty about the quality of an organization's outputs, positions of prominence in social or industrial network structures can signal organizational reliability (e.g., Aldrich and Auster, 1986; Stuart et al., 1999).

Securing IP rights in the form of patents represents accomplishments because it affirms a firm's ability to convince powerful external constituents of their novel ideas and often requires a significant amount of resources, time, and expertise. An applicant's patenting history provides a particularly salient basis for patenting reputation (Hannan and Carroll, 1992; Podolny and Page, 1998). Thus, the strength of a firm's technological reputation increases when others recognize and build on the firm's prior patents in their inventions.

It is plausible that an applicant's track record of validated technological achievement increases a patent examiner's confidence in the claims put forward by that applicant. This notion is consistent with extant research showing that firms with history and connections are more likely to be favorably considered by outsiders such as investors, customers, and regulators when compared to newer and less connected firms (Meyer and Scott, 1992). More specifically, patent examiners are likely to associate reputable inventing entities with a heightened awareness of relevant prior art and, owing to their substantial reputational risk, unlikely to ignore or conceal such prior art in their patent applications. Furthermore, applicants with greater technological achievement may have greater resources to defend a granted patent against the challenge of invalidation. Examiners may take this into account when they make choices about searching for prior art. Thus, when scrutinizing an application from an applicant with extensive prior inventive achievement, examiners may economize their efforts in searching for and adding citations of prior art to a patent application relative to an application submitted by an entity without such history.

Hypothesis 1. *Applicant prior technological achievement is negatively related to the reduction in patent scope through the addition of prior art to the patent application by USPTO examiners*.

Applicant Prior Technological Achievement And Technological Breadth

Patent applications can vary in their technological breadth. Patents that combine multiple diverse domains face greater scrutiny at the USPTO when compared to similar patents which cover single domains (Ferguson and Carnabuci, 2017). However, patent examiners facing applications with broader technologies are less likely to possess the knowledge necessary for scrutinizing the full scope of the application (Boudreau et al., 2016). They may also face greater ambiguity regarding the nature of the invention (Tan and Roberts, 2010), and therefore may inadvertently misconstrue the nature of the application. When faced with knowledge gaps, patent examiners are more likely to consider other quality signals. One salient signal accessible to patent examiners is the applicant's prior technological achievements in the form of patents. In this situation, examiners may complement their assessment process with easily accessible information provided in the initial patent application as a screen for judging the appropriate level of scrutiny for prior art search. The applicant's identity and patent history represent obvious and inexpensive quality signals for the patent examiner. They indicate the adequacy and completeness of the prior art acknowledged by the prospective patentee.

The risk of invalidation may be lower for accomplished applicants, and therefore examiners may feel more comfortable economizing efforts for high reputation applicants. Based on the interviews with patenting experts, patent examiners' key performance outcome is that the patents they prosecute will withstand possible future scrutiny. In this context, it is worth noting that patent examiners may perceive patent applicants without a track record of inventive achievement as resource-limited and unable to defend against invalidation threats effectively. Consequently, examiners have incentives to more stringently prosecute these patent applications to reduce the risk of subsequent invalidation. Together, when facing the cognitive strain of gaps in their relevant knowledge bases, patent examiners are more likely to rely on decision heuristics that reduce cognitive strain and effort (Kahneman, 2011). In patent applications, examiners may unconsciously consider applicants' prior inventive achievements as cognitive shortcuts to economize on prior art searches. The risk of invalidation may also be lower for applicants with a greater technological track record. Examiners may be more likely to consider this reduced risk when prosecuting patent applications with the greater technological breadth to economize on searching for prior art. Thus, we hypothesize that the patent's technological breadth moderates the relationship between past applicant patenting and current examiner-added citations.

> **Hypothesis 2.** *The negative relationship between applicant prior technological achievement and the reduction in patent scope through the addition of prior art to the patent application by USPTO examiners become more pronounced as the technological breadth increases.*

Data and design

Our study's empirical setting was the computer and electronic manufacturing industry as defined by the North American Industry Classification System (NAICS) Code 334 and the associated patenting activity covering the period from 2001 to 2005. This context is well suited for examining potential systematic examiner variance for several reasons: 1) it is a key industry driving growth in the overall U.S. economy; 2) firms in this industry have shortened their product development cycles to compete, primarily by releasing a steady stream of innovative products into the market; 3) growth in this industry derives in part from entrepreneurial opportunities created by rapid technological change; and 4) it is the locus of digital convergence which involves the integration of telecommunication, computing, and electronics technologies, leading to overlapping IP rights. Together, these characteristics potentially amplify non-technical factors in granting IP due to the steep knowledge asymmetry between inventor and examiner.

We began our data construction by identifying all four-digit level Standard Industry Classification (SIC) codes that correspond to the computer and electronic product manufacturing sector. We then matched the four-digit SIC codes with the International Patent Classification (IPC) system's corresponding classes, using the concordance table developed by Silverman (2002). We collected data on applicant firms from the NBER patent project database. We then merged these data with patent data from patentview.org. Our sample begins in 2001 because this time coincides with a rapid increase in patenting activity and digital information availability identifying examiner-added citations in USPTO records. The distinction between prior art citations added by the examiner and those disclosed by the applicant was critical in distinguishing the impact of patent examiners on the scope of innovation.

We next extracted and integrated into our sample data from multiple archival sources (Li et al., 2014).[4] From 2001 to 2005, applicants submitted 844,165 successful patent applications in the computer and electronic manufacturing industry to USPTO. We restricted our sample to single patent applicants to avoid the confounding effects of inventions attributed to multiple entities. Because our theoretical arguments apply to organizations who use the patenting system to secure valuable intellectual property rights for their innovations, we excluded those organizations which held a single patent that did not represent prior art for subsequent inventions. Within this study, we only explore examiner added citations to the patent literature, not to any non-patent literature.

[4]https://sites.google.com/site/patentdataproject/Home

To control for patent application quality, we included a variable for the legal experience. We collected this variable from the bibliographic data page from the Google patent database, including law firms and specific lawyers representing the application (Chari et al., Forthcoming). The information for lawyers and law firms was collected when the patent application is submitted initially and issued are the data available from Google's patent datapages. The spellings of law firms and lawyers are not standardized within the USPTO and Google records. We disambiguated these names using a gestalt pattern-matching algorithm to cluster together close spellings and assigned each cluster a unique identifier. We then manually checked false and missing matches.

To enhance the internal validity of our analysis, we relied on fixed-effect empirical models to control for unobserved time-invariant heterogeneity associated with examiners. We dropped examiners who had only one possible prosecuted patent application during the 2001–2005 timeframe due to our use of a within-subject design. After this process, 356,071 patents prosecuted by 2,387 examiners and granted to 29,280 distinct organizations over five years remained in the sample. We compared our final sample of 356,071 patents to the population of 1,024,499 patents granted during this period across all international technology subcategories (Hall et al., 2001). Out of the 659 subcategories, the difference in proportional representation between our sample and the population was less than four percent.

Key variables

Examiner added citations. Examiners are responsible for identifying prior art, which may limit the novelty of a given technological advance. Because examiners work under a production quota system (Wang, 2010), they have no incentive to add irrelevant prior art citations. The Manual of Patent Examining Procedure, section 707.5, states that "the examiner should cite *appropriate* *prior art* nearest to the subject matter defined in the claims. When examiners add prior art, “its *pertinence should be explained* [emphasis added].” The policy suggests examiners have no incentive to engage in a time-consuming search for marginally related or insignificant prior art, as it could compromise the chance to be rewarded for exceeding their quota (of processed patent applications). Instead, examiners have a solid incentive to add only citations of consequence to the intellectual property rights granted.

Patent applicants face a challenge regarding how examiners may understand and interpret their invention. The non-obviousness of the proposed technology is a crucial criterion for patentability, which is at the discretion of examiners (Eisenberg, 2004; Tan and Roberts, 2010). Examiners search for prior art and citations to address the non-obviousness requirement. Examiners then search and cite prior art close enough that a ‘person having ordinary skill in the art’ would see the technological claim as an obvious inventive step. The more citations an examiner adds, the more the intellectual property claim afforded to the patent holder will be constrained, effectively narrowing the scope of the patent (Akers, 1999; Criscuolo and Verspagen, 2008; Steensma et al., 2015). More specifically, when plaintiffs challenge a patent in the courts, the citations added to the patent may serve as an indicator to curb the protection of a given claim. Examiner added citations could also be detrimental to the applicant firm because it can provide an information signal to inform competing firms to imitate the technology in a legally defensible way (Tan and Roberts, 2010). Thus, we measured the number of citations examiners added to an awarded patent.

To validate that our dependent variable relates to an economically meaningful reduction in the scope of intellectual property rights, we examined the correlation between the number of examiner-added citations and the number of rejected claims on a subset of our database (20,291 patents). The pairwise correlations indicate that higher examiner added citations are associated with an increased rate of denied claims. Specifically, an examiner added citation is associated with a 16.28% increase in the chance of rejecting the claim ($p<0.000$), and an examiner added citation is associated with an 8.12% decrease in the chance of the claim being allowed ($p<0.000$) (Tan, 2017).[5]

Technological breadth. Technological breadth refers to the degree to which the technology represents the intersection of multiple technical areas. Technologies high in breadth are more likely to be based on broader knowledge bases and require integrating numerous areas. These technologies are thought to be more complex and may require additional examiner expertise to prosecute patent applications effectively. We measure technological breadth as the count of distinct technology classes assigned to the patent based on the International Patent Classification (IPC)[6] (Lerner, 1994; Nerkar and Shane, 2003; Shane, 2001). The IPC is a hierarchical system of symbols for assigning patents to different areas of technology. The IPC comprises eight sections and 70,000 subdivisions and plays a vital role in retrieving the relevant prior art. The IPC classification's hierarchical levels include section, class, subclass, group, and complete classification symbol. The intent of this measure is to assess the cognitive demands on examiners to search for relevant prior art. Patents that cover several different technology classes are likely to require additional effort to search for relevant prior art than patents in a single class. Patents that cover multiple technology classes are more likely to be integrated technologies where patent scope boundaries are likely to be blurred. At very small differences in technology class, such as

[5] % of claims rejected refers to claims rejected during the examination process, some of which may have been later allowed. These data were collected by Tan, 2017. The claim level data can be found in the image file wrapper for each application which documents the text of rejection and allowance mailed during the application process. The data are available through the Patent Application Information Retrieval System (PAIR).
[6] See https://www.wipo.int/classifications/ipc/en/preface.html for additional information about the International Patent Classification system.

the complete classification symbol, such differences may be insignificant. However, measures at the section level may be too great. This study measured technological breadth at the subclass level, which is the four-digit IPC level, and is consistent with previous work (Shane, 2001). We logged this variable in the analysis to manage the disparity in values.

Applicant prior inventive achievement. We employed a network-based measure of public agents' perception of applicant quality (Podolny, 1993; Stuart, 1998). Because examiners have a mandate to assess patent applications based on their technological merit, the relevant citation network's position should offer a salient signal of an applicant's technical capabilities and technological reputation.[7] The use of a network measure of centrality as a proxy for perceived capabilities is similar to Google's approach to developing their search engine algorithm. Before Google's algorithm, search engines prioritized websites based on keywords, the number of outward-directed links, and how often the page is updated. Each of these measures, however, could be easily manipulated by the webpage developer. Google engineers chose to use a measure similar to how academia measures impact, in this case, the number of websites that link to a given site. If a website is referenced often by other websites, it is likely to be deemed credible and quality. The number of applicants that cite another applicant is an effective measure of prior inventive achievement because it likely measures the degree to which a firm's technological capabilities are recognized and leveraged in future technology. Conversely, the number of applicants that cite a firm's previous work indicates the degree to which multiple applicants

[7] To evaluate how our measure of Applicant Prior Inventive Achievement aligns with prominent publicly available indicators of a firm's technological capabilities, we gathered a rank measure of the most innovative companies in 2005 as measured by Boston Consulting group at https://www.bcgperspectives.com/content/interactive/innovation_growth_most_innovative_companies_interactive_guide/. We then merged these measures with the company and their subsidiaries in the patent data. We conducted a t-test of the mean measure of technological centrality for those rated and those not rated on the top 50 companies in 2005. Applicants with a top rating had a mean centrality measure of .015 where as those unrated in the top ranking had a measure of .001 and the difference in these means was statistically significant ($t=-12.93$ $df = 16440$ $p < 0.000$).

recognize a firm's technological track record within the industry. We use a similar method when constructing our measure of prior inventive achievement. We created a citation network of prior patents using the applicant as the node and both examiner and applicant citations to the applicant's patents as the edges.

To measure applicant prior inventive achievement, we computed the inventing organization's centrality within the computer and electronic manufacturing patent citation network. First, we identified all organizations that filed a successful patent application between 2001 and 2005. We constructed patent citation networks for each year of our sample period based on patents granted to firms five years before the focal year. In the network, each applicant firm is the node, and the citations are the edges within the 6-year window (focal year plus the five years prior). To account for changes in the number of inventing organizations in the patent citation network, we computed the scaled in-degree centrality for each patenting entity in the focal year. Adding the in-degree centrality is different from counting the number of citations a given applicant receives. A simple count of citations doesn't capture how many firms are represented by these citations, one firm or many firms? We calculate our in-degree centrality by counting the number of other applicants that cite the focal applicant. This measure provides a broader perspective of how other applicants in the industry perceive the quality of the applicant's patents. Furthermore, by measuring in-degree centrality, we are not considering whether the applicant cites many other applicants but instead whether other applicants cite them.

Control Variables

Legal service experience. Applicants and legal representatives vary in their ability to manage the patenting process; those applications filed with experienced external legal counsel are likely of higher quality. To control for this effect, we included a proxy for application quality. Patenting entities typically enlist a patent attorney's services to conduct a prior art search that assesses the invention's patentability and the scope of potential intellectual property rights from the invention. To address experience effects on patent application quality, we controlled the presence or absence of specialized legal services during the patent application process and the depth of any legal representative's domain-specific experience. We measured legal representation experience by assigning either zero to patents when no law firm is named in the prosecution documents or by using the number of granted patents before the patent represented by the law firm. We drew information from the Google patent database's "law firm" field of the Agents section. Our measure did not observe the overall experience that applicants might possess in internal legal capabilities. The absence of this control variable suggests that the statistical test is a conservative one. We log-transformed the measure to enhance the normality

Applicant citations. Instead of using legal counsel to handle a patent application, highly skilled applicants sometimes choose to prosecute patent applications in-house. In our sample, IBM is a high reputation applicant who has prosecuted over a thousand patents without hiring legal counsel, as well as several patents using outside counsel (Steensma et al., 2015). Such applications might be considered low quality based on a lack of outside legal counsel and high quality, given this high reputation applicant's prior experience. However, not all patents produced by an entity are likely of the same quality. Thus, in the absence of an independent signal of quality, such as outside counsel, we had to look to the patent's characteristics to distinguish higher and lower quality. We did this by considering applicant effort expressed as the count of *applicant citations.*

Applicants vary in their effort to disclose prior art; this may lead to more examiner-added citations as existing citations can serve as a search signal for patent examiners looking for relevant prior art. Applicants are more likely to include citations when the quality of the application is higher. We applied a logarithmic transformation of the measure.

Examiner patent grant rate. To control for an estimate of workload for each examiner, we included the number of claims for each granted application based on the application year number of granted patent applications each examiner was assigned and prosecuted within the focal year (Cockburn et al., 2003; Régibeau and Rockett, 2010).

Self-citations. A possible alternative explanation is that examiners may include more citations if the applicant has disclosed self-citations. In this case, the examiner may feel compelled to include citations other than the applicants' prior work. To address this alternative explanation, we have self-citations as a control: the count of applicant added citations that are patents previously granted to the applicant.[8]

Examiner and year fixed effects. A patent examiner's ability to develop a thorough record of relevant prior art for a given patent depends in part on their level of experience and partly on other unobservable attributes. Examiners with more experience granting patents in a technology class are likely to have greater knowledge of potentially relevant prior art. We specify examiner and year fixed effects to control the time-invariant examiner and period-specific factors that may affect the relationship between the number of examiner-added citations and our explanatory variables. Because patent examiners tend to specialize in a technology area, these fixed effects also account for the differences in the proposed relationships across technology classes.

Model Estimation

Our dependent variable of interest is reducing patent scope, measured as examiner-added citations, a count variable that can take on only non-negative values. Using a linear regression

[8] Thank you to an anonymous reviewer for the suggestion to add this as a control

model would result in inefficient, inconsistent, and biased coefficient estimates (Wooldridge, 2009). Furthermore, the distribution of examiner-added citations is positively skewed. With such dependent variable measures, negative binomial regression would be an appropriate analysis technique.

Absent the need for an unconditional fixed effect; negative binomial regression would be an appropriate modeling approach. However, previous research indicates the fixed effects negative binomial estimator produces inconsistent/biased estimates (Allison and Waterman, 2002; Wooldridge, 1999). For example, fixed effects negative binomial model estimations have no known robustness properties and enforce a particular form of over-dispersion; specifically, the over-dispersion must also be present for each cross-sectional unit. Thus, an unconditional fixed effect for negative binomial regression is likely to suffer from an incidental parameters problem and thus be inconsistent. The incidental parameters problem is more significant for fixed effects with limited repeated measures. Within our dataset, 235 examiners have fewer than ten patents prosecuted within a given year. This low number of repeated measures reduces the utility of the negative binomial approach. The use of negative binomial regression offers advantages for estimating the probability of a given integer. However, Poisson regression techniques generate more robust, efficient, and reliable estimates of the conditional relationship of x and y (Wooldridge, 1997).

In contrast, the Poisson quasi-maximum likelihood estimation does not require consistent distributions across cross-sectional units. We employed the Poisson quasi-maximum likelihood estimator with robust standard errors clustered by the examiner, consistent with techniques used to model relationships for over-or under-dispersed count-dependent variables with fixed effects (Funk, 2014; Wooldridge, 1999). Because we estimate a fixed-effects model, coefficient estimates are derived using within-unit variability rather than cross-sectional variance.

Results

The descriptive statistics and correlations are presented in Table 1. One potential drawback of relying on within-unit variance is that point estimates, and standard errors may be biased when independent variables exhibit a low within-unit variance. We have reported the fixed-effects coefficient estimates and robust standard errors because each of our variables exhibited substantive within-unit variance.[9]

Insert Table 1 about here

The average number of *examiner-added citations* is 4.98, and the average number of *applicant citations* is 9.53, meaning that examiners contributed approximately 34 percent of total citations. The correlation between *applicant citations* and *examiner-added citations* is negative, suggesting a substitution effect that as applicants include more citations, examiners add fewer.

Poisson Quasi-Maximum Likelihood coefficient estimates and standard errors testing our hypotheses are presented in Table 2. Model 1 considers only control variables. Model 1 illustrates a negative relationship between *examiner patent grant rate* and *examiner-added citations,* which is not statistically significant. This result illustrates some support for the assertion that cognitive demands are related to examiner-added citations. *Applicant citations* are also negatively related to *examiner-added citations* and are statistically significant. This result also suggests that there is perhaps a substitution effect that as applicants include more citations, examiners are less likely to search for prior art. It may also indicate some demand on examiners

[9]An exception would occur if examiner workload were higher for between-unit variance than within-unit. As a robustness check, we ran a random effects model with bootstrap standard errors to account for possible over-dispersion and serial correlation. The results were consistent with those presented.

that they are likely to conserve on efforts for search with additional applicant citations. In contrast, the coefficient for *applicant self-citations* is positive and statistically significant. This finding suggests that examiners may seek to broaden the sources for prior art with additional searching when applicants leverage their own prior art. Model 1 also estimates the positive relationship of *technology breadth* and *examiner-added citations* ($\beta = 0.028$; $p < .001$). Model 2 tests the main effect of *applicant prior inventive achievement* as predicted in H1. As expected, *applicant prior inventive achievement* is negatively related and statistically significant to *examiner-added citations* ($\beta = -0.011$; $p < .001$).

Insert Table 2 about here

Insert Figure 1 about here

We predicted that the positive effect of *technological breadth* on *examiner-added citations* would be less pronounced for applicants with higher prior inventive achievement. The interaction of *technological breadth* and *examiner-added citations* in Model 3 is both negative and significant ($\beta = -0.004$; $p = .014$). This result indicates that when examiners review an applicant's application with a substantial inventive track record while dealing with higher technological breadth, they add fewer citations to the patent application.

Although the coefficient is statistically significant, some uncertainty remains in terms of this interaction's practical significance. To better interpret these results, we plotted the interaction in Figure 1 (at +/- 3 standard deviations in *technological breadth* at 0 to .45 in *applicant track record*). Based on this plot, the difference is greatest at low levels of *applicant track record* at low and high levels of *technological breadth*, suggesting that the interaction's material effect is a subtle one. Figure 1 also includes the 90% confidence intervals for the interaction, indicating that the greatest statistical difference occurs at low levels of *applicant track record* when comparing high and low levels of *technological breadth*. Both the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) diagnostics suggest that the addition of the interaction coefficient accounts for previously unaddressed variance in our dependent variable compared with increased complexity. To avoid over-interpreting our results, we acknowledge that while there is statistical support for our predictions, the overall effect per patent is small.

To explore the results, we estimated the main effect of *applicant track record* across 0 to .45, the minimum to 3 standard deviations above the mean—this difference related to a .17 or a 3% difference in *examiner-added citations.* We also estimated *examiner-added citations* at 0 *applicant track record. Here,* the difference between high and low *technological breadth* results in a .3 difference in *examiner-added citations,* which is a 6% difference in *examiner-added citations.* While this interaction's effect is modest, we suggest that the difference is still of material significance. The overlapping confidence intervals for applicants with greater track records indicate that these are not likely to face a penalty of more *examiner-added citations.* To further substantiate the results, we also conducted several robustness tests. A potential alternative explanation is that applicants with substantial inventive records will have more resources, do stronger technological work and have stronger applications that may not require additional citations. To test this potential alternative explanation, we included the five years forward citations for the patent as a possible control variable for application quality. Again, the results were consistent with those reported here. We also ran the analysis using negative binomial regression analysis and analysis, including applicant fixed effects, and the results were broadly consistent with those reported here. These results are reported in Table 2, 3, and 4.

Insert Table 3 about here

Insert Table 4 about here

Insert Table 5 about here

Discussion

This study explores how and when examiners vary in the delineation of IP rights at the USPTO. We find evidence supporting the assertion that examiners are more likely to exercise discretion when patent applications cross technological domains. In this circumstance, we find that examiners may rely on non-technical information as a signal to enhance or reduce the scrutiny exercised during patent application prosecution. By non-technical information, we refer to information that, according to policy, should not be considered in prosecution, such as the applicant's prior inventive achievement, the patent's geographic location, or the reputation of associated legal representation. Consideration of non-technical information introduces systematic variation into how much value different applicants might capture from their creative activities. Such systematic variation can threaten the USPTO's mission to provide equal access when adjudicating patent applications.

The USPTO tasks examiners with the responsibility of citing relevant prior art to limit the scope of an applicant's claims. Specifically, we proposed that examiners are likely to vary in their searching for and citing prior art under boundary-crossing conditions, which could lead examiners to consider non-technical information during the patent prosecution process.

Consistent with this proposition, we find that USPTO prompted reductions in patent scope decrease as the applicants' prior inventive achievement increases. Moreover, this effect becomes more pronounced when examiners experience the cognitive burden of evaluating inventions that span multiple technological domains.

Our findings suggest that examiners may exercise greater scrutiny of the patent applications due to the applicant's technological track record. The presence of any systematic process differences is of concern for the USPTO, even if the effect size appears to be modest. This difference in examiner added citations attributable to applicant prior inventive achievements is comparable to that found in examining patent-granting decisions (Kovács, 2017).

Throughout this paper, we have argued that adding citations reduces the patent scope and is generally not advantageous to the applicant. However, as an agent of the USPTO, examiners are charged with scrutinizing applications to ensure they can withstand future scrutiny. Therefore, applicants may benefit from a reduced scope that is more likely to maintain validity in the face of a legal challenge. We also argue that the risk of invalidation remains more remote when compared to the possible upside of broader intermediate scope.

We contribute to the ongoing conversation related to factors influencing the IP delineation (e.g., Steensma et al., 2015). Extant research in this domain has already documented that examiners are subject to variation in prosecution due to internal factors such as workloads and HR policies (Frakes and Wasserman, 2016; Kim and Oh, 2017). Others have found systematic variance in external conditions such as weather patterns (Kovács, 2017). Our research extends this body of work by exploring the interplay between technological breadth and applicant characteristics as a potential source of variance in patent examiner decision-making.

Empirically, we offer a more nuanced measure of variance in individual decision-making during the IP delineation process. By concentrating on examiner-added citations, we illustrate how institutional gatekeeping can emerge as a bottom-up process involving systematic variance in individual decision processes. While the USPTO already expends great effort in designing policies and procedures to minimize variance in the IP delineation process, our results point towards a particular set of conditions that may be worthy of deploying additional resources to ensure equal access to the patenting system.

We sought to address the challenge of establishing a link between a measure of applicant prior inventive achievement and observed outcomes. One alternative explanation for our findings would suggest that patent applications produced by more competent applicants are of higher quality. To avoid confounding quality and signaling effects, we included two patent-quality related controls in our model specification. The statistical significance and small effect size of the interaction between technological breadth and applicant prior inventive achievement are consistent with previous findings that show that significant signaling effects are contingent upon elevated levels of evaluation uncertainty (Simcoe and Waguespack, 2010).

Several practical implications flow from a systematic relationship between patenting outcomes and applicant inventive track record. The first set of implications relates to the inventing entities. For applicants with extensive patenting history, a reduction of examiner-added citations to their patents enhances their ability to extract value from their patents. It gives greater credibility to their legal strategies to ward off competitors (Paik and Zhu, 2016). Patent applications submitted by applicants with a limited patenting track record may face greater scrutiny, increasing the chance of claim rejection (Tan, 2017). These effects result in a weaker technological resource base and subsequent resource acquisition opportunities (e.g., venture capital funding) (Cockburn and MacGarvie, 2009; Delmar and Shane, 2004).

Perceptions of systematic variance in the patenting process can impose high social welfare costs when inventors and inventing organizations choose to exit the market for ideas in favor of protecting valuable new knowledge through secrecy (Hall et al., 2013; Holgersson, 2013). In combination with the risk of reinforcing the technological regimes of high track record applicants through the gatekeeping process, this could undermine the innovation progress at a societal level (Economist, 2013; Hall et al., 2014; James et al., 2013). Hence, we hope that this research can help inform future resource allocation and process control decisions within the USPTO to reduce systematic variance in evaluating and granting intellectual property.

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Table 1: Descriptive Statistics and Inter-correlations

	Variable	Mean	Standard Deviation Overall	Between	Within	Min	Max	1	2	3	4	5	6	7	8
1	Examiner added citations	4.98	4.65	2.92	3.98	0	102								
2	Applicant prior inventive achievement	0.06	0.14	0.06	0.14	0	1.02	-0.01							
3	Technology breadth	6.26	9.23	4.09	8.54	1	388	-0.02	0.00						
4	Legal service experience	895.06	2182.07	660.93	2125.81	0	15120	-0.02	0.05	0.00					
5	Applicant citations	9.53	27.00	10.66	25.74	0	801	-0.04	-0.07	0.13	-0.05				
6	Examiner claims workload	151.72	151.92	70.71	61.56	1	1375	0.04	0.03	-0.01	0.04	-0.03			
7	Applicant self-citations	0.81	2.87	2.00	2.79	0	203	0.01	0.05	0.06	0.10	0.27	0.03		
8	Examiner applicant repeated ties	2.09	4.54	1.11	4.49	0	475	-0.02	0.19	0.00	0.01	0.00	0.00	0.05	
9	Examiner law firm repeated ties	2.99	13.62	3.74	12.95	0	675	-0.01	0.01	-0.01	0.01	0.00	-0.02	0.00	0.00

N= 356,071 all correlations are significant p<.01

* Examiner fixed effects necessitates the usage of within examiner variance to compute effect sizes.

Table 2: Standardized Poisson Coefficients and Standard Errors

	Examiner added citations		
	Model 1	Model 2	Model 3
Technology breadth # Applicant prior inventive achievement			-0.004*
			(0.002)
Applicant prior inventive achievement		-0.011***	-0.011***
		(0.002)	(0.002)
Technology breadth	0.028***	0.028***	0.028***
	(0.003)	(0.003)	(0.003)
Applicant citations	-0.104***	-0.105***	-0.105***
	(0.003)	(0.003)	(0.003)
Examiner claims workload	-0.014	-0.014	-0.014
	(0.013)	(0.013)	(0.013)
Applicant self-citations	0.031***	0.031***	0.031***
	(0.004)	(0.004)	(0.004)
Examiner applicant repeated ties	-0.009***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)
Examiner law firm repeated ties	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
Legal service experience	-0.028***	-0.028***	-0.028***
	(0.002)	(0.002)	(0.002)
Year fixed effects	Included	Included	Included
Examiner fixed effects	Included	Included	Included
chi2	1985.394	2051.857	2063.736
AIC	1945370	1945204	1945195
BIC	1945252	1945074	1945055
N Patents	356071	356071	356071
N Examiners	2387	2387	2387

Significance levels: * p<.05, ** p<.01, *** p<.001

Table 3: Standardized Poisson Coefficients and Standard Errors Robustness Test with Applicant Fixed Effects

	Examiner added citations		
	Model 1	Model 2	Model 3
Technology breadth # Applicant prior inventive achievement			-0.003*
			(0.001)
Applicant prior inventive achievement		-0.026*	-0.025*
		(0.012)	(0.012)
Technology breadth	0.025***	0.025***	0.026***
	(0.002)	(0.002)	(0.002)
Applicant citations	-0.140***	-0.140***	-0.140***
	(0.004)	(0.004)	(0.004)
Examiner claims workload	0.009***	0.009***	0.009***
	(0.003)	(0.003)	(0.003)
Applicant self-citations	0.041***	0.041***	0.041***
	(0.009)	(0.009)	(0.009)
Examiner applicant repeated ties	-0.002+	-0.002+	-0.002+
	(0.001)	(0.001)	(0.001)
Examiner law firm repeated ties	-0.005**	-0.005**	-0.005**
	(0.002)	(0.002)	(0.002)
Legal service experience	-0.032***	-0.032***	-0.032***
	(0.003)	(0.003)	(0.003)
Year fixed effects	Included	Included	Included
Applicant fixed effects	Included	Included	Included
chi2	1785.050	2089.161	2112.246
AIC	1974733	1974706	1974702
BIC	1974615	1974576	1974562
N Patents	347681	347681	347681
N Examiners	20540	20540	20540

Significance levels: * p<.05, ** p<.01, *** p<.001

Table 4: Standardized Poisson Coefficients and Standard Errors Robustness Test with Forward Citations

	Examiner added citations		
	Model 1	Model 2	Model 3
Technology breadth # Applicant prior inventive achievement			-0.003*
			(0.002)
Applicant prior inventive achievement		-0.010***	-0.011***
		(0.002)	(0.002)
Technology breadth	0.026***	0.027***	0.027***
	(0.003)	(0.003)	(0.003)
Applicant citations	-0.106***	-0.107***	-0.107***
	(0.003)	(0.003)	(0.003)
Examiner claims workload	-0.014	-0.014	-0.014
	(0.013)	(0.013)	(0.013)
Applicant self-citations	0.030***	0.030***	0.030***
	(0.004)	(0.004)	(0.004)
Examiner applicant repeated ties	-0.009***	-0.007***	-0.007***
	(0.002)	(0.002)	(0.002)
Examiner law firm repeated ties	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
Forward citations	-0.028***	-0.028***	-0.028***
	(0.002)	(0.002)	(0.002)
Legal service experience	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Year fixed effects	Included	Included	Included
Examiner fixed effects	Included	Included	Included
chi2	2029.285	2089.140	2099.378
AIC	1944920	1944768	1944763
BIC	1944791	1944628	1944612
N Patents	356071	356071	356071
N Examiners	2367	2367	2367

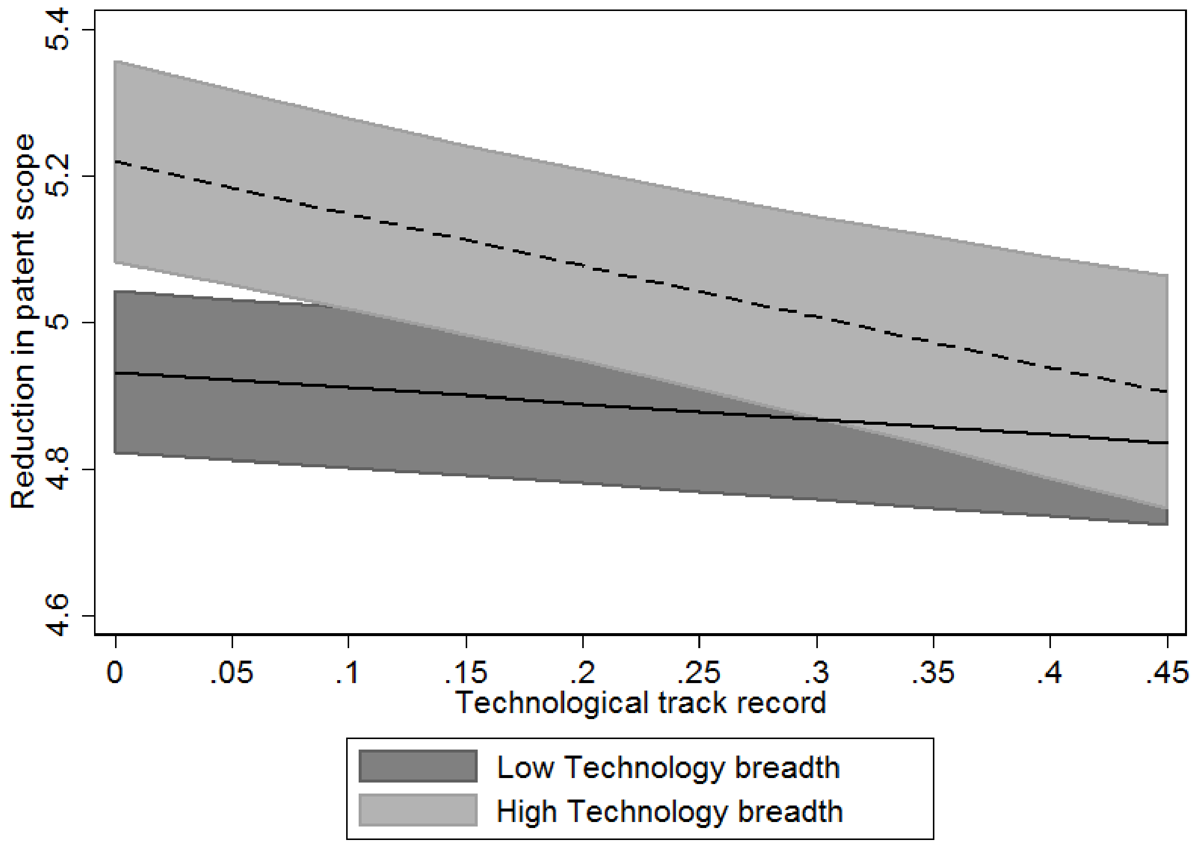
Significance levels: * p<.05, ** p<.01, *** p<.001

Table 5: Standardized Poisson Coefficients and Standard Errors Robustness Test with Negative Binomial Regression

	Examiner added citations		
	Model 1	Model 2	Model 3
Technology breadth # Applicant prior inventive achievement			-0.002+
			(0.001)
Applicant prior inventive achievement		-0.009***	-0.009***
		(0.001)	(0.001)
Technology breadth	0.017***	0.017***	0.017***
	(0.001)	(0.001)	(0.001)
Applicant citations	-0.137***	-0.138***	-0.138***
	(0.001)	(0.001)	(0.001)
Examiner claims workload	-0.033***	-0.033***	-0.033***
	(0.003)	(0.003)	(0.003)
Applicant self-citations	0.028***	0.028***	0.028***
	(0.001)	(0.001)	(0.001)
Examiner applicant repeated ties	-0.009***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)
Examiner law firm repeated ties	0.002+	0.002*	0.002*
	(0.001)	(0.001)	(0.001)
Forward citations	-0.024***	-0.023***	-0.023***
	(0.001)	(0.001)	(0.001)
Legal service experience	1.248***	1.248***	1.248***
	(0.005)	(0.005)	(0.005)
Year fixed effects	Included	Included	Included
Examiner fixed effects	Included	Included	Included
chi2	13067.008	13130.380	13134.776
AIC	1720688	1720649	1720658
BIC	1720558	1720508	1720507
N Patents	356037	356037	356037
N Examiners	2388	2388	2388

Significance levels: * p<.05, ** p<.01, *** p<.001

Figure 1: Relationship between Technology breadth, applicant technological reputation, and reduction in patent scope with 90% confidence intervals



*Graphic assumes fixed effect for examiners as 0