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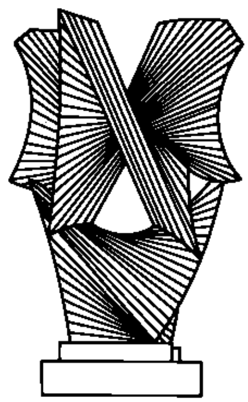

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RETHINKING PROSECUTION HISTORY ESTOPPEL

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Under the rule of prosecution history estoppel, patent applicants who amend their claims during the course of patent prosecution assume a significant risk: namely, the risk that a court will later construe the changes as concessions that should be read to limit patent scope. This risk is exacerbated by strong evidentiary presumptions under which courts are to assume, unless the patentee presents sufficient evidence otherwise, that every change triggers estoppel, and that the resulting estoppel forfeits everything except that which the revised language literally describes. The justification for these presumptions is that, implemented in this fashion, prosecution history estoppel makes patent scope more predictable. In this Article, I argue that the benefit comes at too high a price. Drawing on a large empirical study of patent prosecution, I show that, because of these evidentiary presumptions, estoppel is dangerously sensitive to differences between patent examiners and differences across technology categories. That is, estoppel treats similar applications in dissimilar ways, not because of differences on the merits, but instead because of the personal characteristics of the examiners involved and because of differences inherent to the types of technology at issue. A better rule, I argue, would minimize the significance of examiner and technology disparities by reversing the current evidentiary presumptions and thus recognizing estoppel only where there is clear evidence that the applicant and the examiner intended to forfeit a given scope of coverage.

I. INTRODUCTION

Patent prosecution is an iterative process, and during that process patent applicants often change the language of their proposed claims. A running debate in patent law considers whether and how evidence of those language changes should be used by courts to construe the resulting patent claims. On one view, the meaning of a word can be distorted when taken out of context, and the best way to put patent language into context is to study the history of the patent document. On another view, evidence drawn from a patent's prosecution history is cumbersome, ambiguous, sometimes misleading and often incomplete, and the goals of the patent system would therefore be better served were courts to ignore language

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changes and focus instead on the final claim language standing alone. The puzzle bears an obvious resemblance to a perhaps more familiar question in statutory interpretation; namely, the question of whether and how legislative history should be used when construing the language of an enacted statute.

In the patent context, the debate has primarily played out in the shadow of the doctrine of equivalents. The doctrine of equivalents empowers courts to construe patent claims to cover not only that which they literally describe, but also some range of equivalent subject matter that technically falls outside the literal claim language but on policy grounds seems appropriately considered part of the patent holder's exclusive domain. The doctrine is typically invoked in instances where unscrupulous competitors would otherwise be able to undermine the patent grant by exploiting loopholes in the literal claim language.[1] Loopholes eligible for this sort of protection include loopholes caused by the unavoidable imprecision of language,[2] loopholes caused by events and circumstances that were not reasonably foreseeable at the time the literal claim language was drafted,[3] and loopholes where the accused invention is an insubstantial variant of the invention literally described.[4] As these examples make plain, a major drawback to equivalents analysis is that it renders uncertain the precise boundaries of any particular patent claim. One mechanism used to address that worry—and the primary means through which the history of the patent document influences claim interpretation—is the rule of prosecution history estoppel.[5]

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[1] As the Supreme Court explained in *Graver Tank*, the "essence of the doctrine is that one may not practice fraud on a patent" by making "unimportant and insubstantial changes" that, "though adding nothing, would be enough to take the copied matter outside" the scope of the literal claims. Graver Tank & Mfg. Co. v. Linde Air Prods. Co, 339 U.S. 605, 607-08 (1950).

[2] *See, e.g., id.* at 607 (without equivalents, patentee would be "at the mercy of verbalism"); Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co. ("Festo VIII"), 535 U.S. 722, 734 ("equivalents is premised on language's inability to capture the essence of innovation").

[3] *See, e.g.,* Pennwalt Corp. v. Durand-Wayland, Inc., 833 F.2d 931, 938 (Fed. Cir. 1987) (en banc), cert. denied, 108 S. Ct. 1226 (1988) ("the facts here do not involve later-developed computer technology which should be deemed within the scope of the claims to avoid the pirating of an invention").

[4] *See, e.g.,* Carman Industries v. Wahl, 724 F.2d 932, 942 (Fed. Cir. 1983) (equivalents analysis appropriate where accused infringer seeks "to appropriate the invention with minor modification to avoid the literal language of the claims").

[5] There are other doctrines in patent law explicitly designed to reduce the uncertainty created by the doctrine of equivalents. For discussion, see Adelman et. al, CASES AND MATERIALS ON PATENT LAW 798-841 (2d ed. 2003).

Prosecution history estoppel applies where a patent applicant narrows a patent claim during patent prosecution in order "to avoid prior art, or otherwise to address a specific concern ... that arguably would have rendered the claimed subject matter unpatentable."[6] In these instances, estoppel bars the applicant from later using the doctrine of equivalents to recapture the lost ground. As the Supreme Court put it in *Schriber-Schroth*—and note how the Court's explanation sounds in classic estoppel and waiver terms—an applicant "may not, by resort to the doctrine of equivalents, give to an allowed claim [the] scope which it might have had without the [narrowing] amendments."[7] By amending the claim, the applicant is deemed to have "recognized and emphasized the difference between the two phrases and proclaimed his abandonment of all that is embraced in that difference."[8]

In order for estoppel to achieve its purpose of reducing the uncertainty inherent in equivalents analysis,[9] estoppel itself must be implemented in a predictable fashion. Courts have therefore built into the rule heavy evidentiary presumptions. For example, although as a technical matter prosecution history estoppel only applies where a narrowing amendment was made to satisfy a requirement of the Patent Act—and note how broad a category that already is—the Supreme Court held in *Warner-Jenkenson* that the patent holder bears the burden of establishing the reason for any narrowing amendment, and, where no explanation can be established, courts are to presume that estoppel applies.[10] This has proven to be a difficult presumption for patent holders to overcome given that, historically, neither patent examiners nor patent applicants have put much effort

[6] Warner-Jenkinson Co. v. Hilton Davis Chem. Co., 520 U.S. 17, 30-31 (1997); accord *Festo VIII*, *supra* note _, at 735. While all the major cases focus on claim language amendments, an applicant can trigger estoppel in other ways. For example, the act of deleting a claim of broader scope than those ultimately allowed certainly carries with it implicit representations that can later be held against the applicant. Indeed, mere arguments can also give rise to estoppel, even if unaccompanied by any language changes.

[7] Schriber-Schroth Co. v. Cleveland Trust Co., 311 U.S. 211, 221 (1940).

[8] Exhibit Supply Co. v. Ace Patents Corp., 315 U.S. 126, 136 (1942).

[9] Although this is the theory on which the courts routinely focus, estoppel does arguably serve other purposes. See Part V.

[10] Warner-Jenkinson, supra note _, at 33. It is unclear what presumption, if any, is applied in answering the threshold question of whether a given amendment narrows or broadens a claim. That is, there are two preliminary questions to ask with respect to estoppel: the first considers whether the change narrowed or expanded claim scope, and the second—which applies only to narrowing amendments—asks whether the narrowing was done to satisfy a requirement of the Patent Act. The Supreme Court has yet to rule on the proper presumption to apply in the first of these two inquiries, and the Federal Circuit apparently views that as an open question as well. See Festo IX, cited in note *, at _.

into documenting the reasons for patent claim amendments.[11] Moreover, the presumption sticks even if it turns out that the amendment at issue was not in fact necessary to preserve patent validity. For instance, if the examiner incorrectly interprets the prior art and, because of that error, the applicant agrees to narrow a given claim, the applicant is still bound by the concession.[12] Thus, in practice, the only evidence that immunizes a patentee is clear evidence that a given narrowing amendment was not made with the *intent* to preserve claim validity; evidence that the change was not *necessary* to satisfy Patent Act requirements is not enough.[13]

Similarly, once estoppel is found to apply, courts must determine the scope of the resulting estoppel, and here again there is today in place a strong evidentiary presumption, albeit a presumption that is weaker than that recently proposed by the Federal Circuit.[14] Specifically, under the Supreme Court's *Festo* decision, the patentee bears the burden of showing that the amendment "cannot reasonably be viewed as surrendering [the] particular equivalent" at issue.[15] The patentee can carry this burden by showing that the equivalent was unforeseeable at the time of the claim amendment,[16] or that the "rationale underlying the amendment [bore] no more than a tangential relation to the equivalent in question."[17] But where the applicant cannot make these or similar showings—and, again, this is likely to be a common case given how poorly the process of patent prosecution is documented under current Patent Office practices[18]—the doctrine of equivalents is in essence repealed and the applicant must rely on literal claim coverage alone.

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[11] For a rich discussion of current practice, see John Thomas, On Preparatory Texts and Proprietary Technologies: The Place of Prosecution Histories in Patent Claim Interpretation, 47 UCLA L Rev 183, 188-91, 203 (2000).

[12] *See Exhibit Supply, supra* note _, at 137. Of course, the applicant can resist the examiner and ultimately appeal the dispute to higher officials at the Patent Office. See notes _.

[13] The evidence also must come from documents on file at the Patent Office, rather than from documents in the patentee's private possession. See Festo IX, cited note *, at _. Any other rule would make it difficult for rivals to determine patent scope prior to litigation, thus undermining predictability.

[14] *See* Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co. ("*Festo VI*"), 234 F.3d 558, 564 (Fed. Cir. 1995) (holding, prior to Supreme Court reversal, that "when a claim amendment creates [estoppel], no range of equivalents is available for the amended claim element").

[15] *See Festo VIII, supra* note _, at 740.

[16] *Id.*

[17] *Id.*

[18] *See supra* note _; *cf. Festo VI*, *supra* note _, at _575 (describing context-sensitive estoppel as "unworkable" and thus advocating a bright-line rule). Of course, all this might

In this Article, I raise two concerns over the practical implications of the modern estoppel rule. The first is based on an empirical finding that there are statistically significant differences between patent examiners in terms of their tendency to require that patent applicants alter claim language. That is, while some examiners routinely require significant language alterations, others regularly leave the original claim language largely intact. These differences are of substantial magnitude and they persist even after controlling for factors like the type of technology involved and the length of the original application. They are troubling because they cause the burdens of prosecution history estoppel to be distributed in an arbitrary fashion. If an applicant happens to be assigned to an examiner who tends to require few language alterations, estoppel is not much of a risk. If an applicant happens to be assigned an examiner who tends to demand a large number of language alterations, by contrast, the threat of estoppel looms large. From the perspective of the patent applicant, this difference is a random effect, unrelated to the merits, that forces unlucky applicants either to suffer the harms associated with estoppel, or to spend additional resources during patent prosecution resisting the examiner and documenting with care any amendments ultimately made. From a policy perspective, meanwhile, these examiner disparities mean that using prosecution history estoppel to reduce the uncertainty associated with equivalents analysis has a large and unanticipated cost: it makes the patent system more random, specifically by linking patent scope to what turns out to be a personal characteristic that varies considerably from one patent examiner to another.[19]

My second concern derives from a related empirical finding: that there are also statistically significant differences across technology categories in terms of the extent to which claim language is changed during the average patent prosecution. Claim language describing a patentable advance in nanotechnology, for example, is on average altered much more significantly than is claim language describing a patentable advance related to automobile engines or electrical lighting. It is not entirely clear what drives these differences. But if it is right to assume that language adjustments are more common in complicated and rapidly evolving technologies—technologies where it is more difficult for applicants to write appropriate claims in the first instance, and technologies where there is more room for reasonable disagreement between applicant and examiner at the time of patent prosecution—then estoppel threatens the doctrine of equivalents in the very cases

change now that estoppel is such a harsh rule, although such a change would be costly given the large number of applications filed with the Patent Office each year.

[19] Note that examiners rarely directly propose claim language. Instead, an examiner influences claim language indirectly by refusing to accept a literal claim until the claim is worded in what the examiner deems to be an acceptable manner.

where equivalents analysis is needed most: instances where conscientious applicants working with qualified examiners might still fail to capture in literal terms the proper boundaries of the invention at hand.

These concerns can be addressed. Were the aforementioned evidentiary presumptions reversed, for example, prosecution history estoppel would be triggered less often, and, at that, only in situations where the applicant and examiner actually meant to foreclose a given equivalent. This would reduce the legal risk associated with amendments to claim language, and it would therefore reduce the importance of differences between examiners and across technology categories. Another approach would have the Patent Office take more seriously its role in documenting the process of patent prosecution. This might be expensive, but it, too, would help ensure that estoppel would be triggered only in situations where the applicant and examiner actually meant to foreclose a given equivalent, again rendering estoppel less sensitive to examiner and technology disparities. At the same time, new mechanisms could be introduced to take the place of estoppel in terms of reducing the uncertainty created by the doctrine of equivalents.

Naturally, there is much more to say on all these points. I proceed as follows. In Part II, I introduce the basic methodology behind my empirical work, explaining the data set and identifying strengths and weaknesses in my approach. In Part III, I present my core statistical analysis. I show that the identity of the examiner drives the extent of claim language alteration, and I show that claim language alterations also differ significantly from technology to technology. In Part IV, I discuss the implications of these technology and examiner disparities, developing in further detail the challenges they raise for the rule of prosecution history estoppel and, through that rule, for the doctrine of equivalents as well. In Part V, I briefly conclude.

II. METHODOLOGY

In November 2000, the United States Patent and Trademark Office initiated a program under which newly filed patent applications are made public "after the expiration of a period of 18 months from the earliest filing date for which a benefit is sought."[20] Not all applications are published under this new program. For instance, an application is not published if it is abandoned during that eighteen month period,[21] and an application is not published if the applicant asserts a

[20] 35 U.S.C. §122(b). The program operates under the authority of the American Inventors Protection Act of 1999, Pub. L. No. 106-113, 113 Stat. 1501A-552 (1999). The core provisions are codified at 35 U.S.C. §122(b).

[21] *Id*. §122(b)(2)(A)(i).

special exemption that maintains confidentiality for patent applications that have been filed in the United States but have not been filed in a foreign country that itself requires disclosure after eighteen months.[22] Nevertheless, in under three years of operation, the program has already generated a public archive of more than 400,000 patent applications, and new applications are today being added at the rate of approximately 20,000 per month.

In January 2003, I collected the 300,000 applications then available, and I traced each through its time at the Patent Office. The idea was to identify applications for which I could take a single issued patent, compare that patent to the single application in hand, and in that way detect any changes that were made during the process of patent review. This approach saves the expense and labor associated with gathering such information directly from the records kept at the Patent Office, making practicable an empirical study that otherwise would have been cost-prohibitive.[23] To identify the appropriate applications, I obviously needed to exclude applications that were still under review, because for those there was no issued patent against which to compare the application; and I also needed to exclude applications that either had splintered into multiple related patents, or had the potential to so splinter, because in those instances the proper interpretation

[22] *Id*. §122(b)(2)(B)(i). The applicant must also certify that the invention will not be subject to such an application in the future.

[23] The paperwork generated during patent prosecution—the "file wrapper"—is in theory available to the public after a patent issues, but acquiring this paperwork from the Patent Office is expensive, and files have traditionally been available only in paper form. *See* 37 C.F.R. §1.19 (fee schedule).

of any application/patent pair would have been ambiguous.[24] This filtering process left me with just under 20,000 workable applications.[25]

Building the data set in this manner of course introduced some biases. For example, the data set does not include any patent applications for which patent prosecution took fewer than eighteen months, because patent applications are published under the new regulations only after eighteen months have passed. The data set likewise excludes patent applications that were abandoned by the applicant, and applications that were denied by the examiner, because the comparison strategy only works for applications that actually led to issued patents. The data set also excludes any application that qualified for the special exemption mentioned above, and any application that was splintered either voluntarily or at the direction of a patent examiner. However, none of these exclusions is particularly troubling for current purposes, because each primarily biases the data *against* what turned out to be my primary findings. That is, each of these exclusions reduces diversity in the data set, making it all the more surprising that I found statistically significant differences between examiners and across technology categories.

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[24] A patent application can split into multiple related applications either by the filing of a divisional application, which literally takes material first included in the original application and divides it into two or more separate applications, or by the filing of a continuation-in-part, which draws material from the original application but in addition introduces new material. Both variants complicate the otherwise-intuitive comparison approach, and ultimately I decided that it was better to exclude such applications rather than introduce error by attempting to incorporate them.

Note that I also excluded continuation applications. A continuation application is an application submitted some time after patent prosecution has begun. It revises its associated original application and is separately identified primarily as a way of collecting higher fees from applicants who make large numbers of changes. I excluded continuations because the baseline of interest is the application as it was first submitted, not the application as it appeared after some interaction with the relevant examiner. Even where I excluded a continuation application, however, I included the original application that led to that continuation, so long as the original application otherwise qualified.

[25] It is possible that some small number of these applications should have been excluded because, as late as one month before an application is published, the Patent Office allows an applicant to swap his original application for a more updated version. *See* 35 C.F.R. §1.215(c). Swapped applications are not distinguished from other applications when published; the only way to detect them is to consult the relevant file wrappers. They are problematic for this project because the baseline of interest is the application as it was first submitted, not the application as it appeared after some interaction with the relevant examiner. That said, unpublished Patent Office statistics suggest that fewer than 100 applicants take advantage of this regulation each year, which means that at most a negligible percentage of my applications were affected. *See* email from Deputy Commissioner for Patent Examination Policy Stephen Kunin (January 25, 2003) (on file with author).

A. *Examiner Disparities*

To answer the question about examiner disparities, I needed to draw from each application/patent pair three basic types of information. The first type of information was simply the name of the examiner or examiners who actually reviewed each application in the data set. This was easy information to acquire, given that examiners are identified by name on the patents they allow. Indeed, the only judgment call that had to be made with respect to this information was a decision regarding how to code patents where two examiners—an inexperienced "assistant examiner" working under a more experienced "primary examiner"—together reviewed the same application. I decided that the best approach was to treat each unique team as a separate entity, the logic being that, from the perspective of a patent applicant, an evaluation conducted by examiners Smith and Jones is meaningfully different from an evaluation conducted by examiners Smith and Williams, even though both pairs include examiner Smith. In the database, I therefore gave each unique team, and each individual examiner, a distinct identifier.

The second type of information that I needed to extract was some measure of the extent to which a given application's claim language changed during the course of patent prosecution. To that end, I decided to count (1) the number of unique words used in the issued claims but not used in the original claims; and (2) the number of unique words used in the original claims but not used in the issued claims. That is, I made a list of the vocabulary used to describe the invention in the application claims, and I made a list of the vocabulary used to describe the invention in the patent claims; I then compared the two lists, counting any word that was present on one list but missing from the other. The intuition is that every time an applicant either introduces a new vocabulary word or removes an existing vocabulary word, he assumes the risk that a court will later construe the change as a concession. The number of vocabulary changes is therefore a rough proxy for estoppel risk.[26]

[26] Admittedly, there are limitations to this approach. For example, it accidentally counts typographical errors that are present in the application but corrected in the issued patent, even though those carry with them little estoppel risk. It also counts language changes in instances where the applicant has other claims that cover the same subject matter and, hence, there is a plausible argument that the changes should not be read to forfeit any ground. Moreover, this approach necessarily fails to detect any estoppel not associated with language changes, such as an estoppel that arises by virtue of an argument presented by the applicant during patent prosecution. These and related limitations are admittedly important; but their implications should not be overstated. After all, these factors affect every observation, and thus it is unlikely that they significantly distort comparisons between examiners and across technology categories.

The third type of information I needed to gather was information that might help to control for relevant differences between the applications. One obviously important control was some measure of application length. I ultimately decided to use for this purpose the number of different vocabulary words that were used in the original application claims. This is one measure of length, and it correlates strongly to other obvious measures like the number of words in the application claims, the number of words in the application overall, and the number of claims listed in the application. This count has an added virtue, however, in that it also provides information about the complexity of the original application. The intuition here is that applications with a high degree of vocabulary diversity are likely harder to evaluate than applications where the number of distinct vocabulary words is relatively low.[27]

A second obviously important control was information regarding the type of technology described in each application. If an application claiming an advance in nanotechnology naturally invites more language alteration than an otherwise comparable application related to automobile bumpers—an outcome I confirm in

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That said, I have run a number of robustness checks to look for these sorts of problems. For example, in one run I coded not only the word counts referenced above, but also weighted versions where the introduction or removal of a rare word counted more heavily than the introduction or removal of a common one. I actually did this with considerable precision. I gathered a sample of 10,000 issued patents and created a frequency table that showed in how many of those patents any given word appeared. I then assigned scores based on the inverse of the frequencies, such that the loss or addition of a common word like "the" or "said" was scored close to zero, whereas the loss or addition of a rare word like "hand-activated" or "vacant" was scored close to one. I ended up dropping these weighted vocabulary counts from the analysis, however, because they turned out to be almost perfectly correlated with the simpler unweighted tallies. Other robustness checks—for example, a run that counted only those language changes that affected independent claims—similarly seemed to have little effect on the ultimate results.

[27] Another reason for using the number of vocabulary words rather than other intuitive measures is that the other measures are each significantly distorted by the pyramid structure of patent claiming. Patent claims are drafted such that broad "independent" claims stake out the main contributions and then largely redundant "dependent" claims repeat the theme of each broad claim but add additional narrowing information. Counting the number of claims therefore poorly measures the length of an application, because this number is significantly influenced by the number of dependent claims even though those are typically trivial to evaluate once their related independent claims have been studied. Counting the number of words used in the claims also poorly measures length, again because that number is unduly sensitive to the number of dependent claims. Counting the number of independent claims is a better option, but that tally ignores the fact that dependent claims do add new information that must be reviewed, albeit less than would an additional independent claim. Counting the number of distinct vocabulary words therefore seemed like the most reliable measure of application length, in that it is not sensitive to repetition and yet it does account for any new vocabulary introduced in dependent claims.

this study—comparing examiners without simultaneously accounting for technology introduces significant error into the analysis: an examiner who works more often on automobile bumpers would seem less exacting than his nanotechnology peer, no matter what the real differences between the two. The difficult question was how best to capture this information. After all, every successful application to some degree describes its own distinct technology, and yet it is impossible to conduct statistical analysis in a situation where every observation is treated as being part of a unique group.

In the patent literature, approaches vary, with some papers introducing elaborate classification schemes that distinguish hundreds of technology categories, while others settle for relatively course alternatives that lump all technologies together under six or ten headings. Typically, the decision is driven by two factors: the size of the data set under consideration, and the perceived importance of technology characteristics to the research question at hand. I ultimately decided to err on the side of caution and adopt a fine-grained approach. Specifically, the Patent Office classifies issued patents according to a system that distinguishes 421 technology types, and every issued patent is labeled with a three-digit code that identifies the technology according to this classification scheme. I lifted those codes from the patents in the data set, chose the ten classes for which I had the most observations, and used those classes to study examiners one technology at a time. The ten classes that I ended up using are listed in Figure 1.

Patent Class	Description
438	Semiconductor Device Manufacturing Process
365	Static Information Storage and Retrieval
257	Active Solid-State Devices
439	Electrical Connectors
123	Internal-Combustion Engines
327	Misc Active Electrical Nonlinear Devices, Circuits & Systems
359	Optics: Systems and Elements
361	Electricity: Electircal Systems & Devices
347	Incremental Printing of Symbolic Information
701	Data Processing: Vehicles, Navigation, and Relative Location

Figure 1 The ten patent classes studied in this research; descriptors are drawn directly from the Patent Office classification chart.

When I first designed this project, I suspected that, in addition to controlling for application length and technology, it would also be important to control for the size and expertise of the law firm, if any, that prosecuted each application. This might be important if, for example, the patent prosecution strategies adopted by large firms differ from those adopted by patent boutiques in ways that affect claim language alteration. Law firms are typically identified by name on the patents they prosecute, so I recorded law firm names whenever they were available, and then matched those names to publicly available information about the number of patents each firm prosecuted in the last five years, the approximate number of licensed patent attorneys employed by each firm, and the average experience level of the patent attorneys employed by each firm.[28] In the end, I was able to add this information to approximately two-thirds of the applications in the database; yet, to my surprise, the results did not turn out to have much explanatory power. While these variables were statistically significant in the context of an occasional patent class, even there the effect was always several orders of magnitude smaller than the effects attributed to the various examiner-specific variables. I therefore decided to simplify my regressions—and, through that, expand the number of statistical tools available for use with the data[29]—by dropping these controls.

More broadly, when I designed this project, I identified a large number of additional controls that I imagined as possibly relevant, including some for which the necessary information was readily available and others where the necessary information would have been all but impossible to track down. For example, it likely matters whether the person who actually drafted the patent application was able to meet with the patent examiner in person, rather than interacting exclusively through telephone calls and the exchange of written documents. It likely also would be informative to know the number of prior art sources cited in each application, because a long list might signal that the applicant was particularly diligent in preparing the application, or that the application falls into a relatively crowded art. It might be helpful to know the country where the claimed technology was first developed or patented, because an application written originally for another country’s patent system might differ substantially from one originally drafted with Patent Office rules and regulations in mind. It might even be helpful to know if there was a company involved in guiding the application, as applications prosecuted on behalf of individual inventors surely differ from applications where a for-profit corporation is paying the fees and calling the shots.

[28] I counted the number of patents prosecuted by each firm myself, and I acquired the information about the number of licensed attorneys and their experience from PatentRatings, LLC, which in turn was able to get the information from records maintained and made public by the Patent Office through its Office of Enrollment and Discipline.

[29] The median test, which turned out to be the most reliable statistical tool by which to confirm the existence of examiner-specific effects, is severely limited in the number of control variables it can accommodate. Restricting the number of control variables thus turned out to be an important objective in my data collection strategy.

Rather than overwhelm the analysis with an unending list of considerations, however, I decided instead to restrict the study to include only those examiners for whom I had ten or more observations. The logic is that, within a given technology class, most other factors are randomly distributed across applications, such that, over the course of a large enough sample, every examiner working within a particular technology class will face approximately the same number of applications originally drafted for a foreign country, approximately the same number of applications where the applicant requests in-person negotiations, and so on. If true, these factors can be safely ignored, as they will not distort comparisons from one examiner to another.[30]

Patent Class	Examiners	Observations
438	11	157
365	17	451
257	11	140
439	12	250
123	16	334
327	15	244
359	12	187
361	8	144
347	10	173
701	10	202

Figure 2 The data set, described by patent class, including only those examiners with 10 or more observations.

Figure 2 describes the resulting data. The first column identifies the relevant patent class, the second column reports the number of examiners working in that class who processed 10 or more applications during the timeframe of interest, and the third column counts the total number of applications processed by those

[30] Of course, I would be even more comfortable with this assumption were I able to set the minimum threshold at twenty or thirty observations, rather than ten. However, two factors cautioned against such an adjustment. First, the higher the threshold, the more data excluded from the analysis. That is a serious cost in this study given that I started out with only approximately 20,000 patent applications representing nearly 400 patent classes and nearly 3,000 patent examiners. Second, excluding examiners with small numbers of observations biases the data against a finding of examiner diversity. The reason is that a minimum threshold excludes examiners who work slowly and thus were not able to process the requisite number of applications during the timeframe under consideration, and it also excludes examiners who work quickly and thus processed more than the requisite number but did not have enough that lasted the eighteen months required to trigger mandatory publication. The higher the threshold, the greater these distortions. Thus, I was reluctant to choose too high a threshold, especially given that most of the missing controls are likely of trivial import as compared to the technology, length, and complexity factors that I explicitly account for in the regressions.

examiners. This is the data that I used to answer the question about examiner disparities.

B. Technology Disparities

With the preceding information already gathered, no additional information was required to study differences across technologies. The only adjustment I made was to replace the 421-category technology classification system with a 36-category alternative developed by the National Bureau of Economic Affairs.[31] The rationale for the change is purely cosmetic: the 36-category approach uses classifications that might be more intuitive for the lay reader. The categories, and the number of observations per category, are listed in Figure 3.

Category	SubCategory	Observations
Chemical	Agriculture,Food,Textiles	58
Chemical	Coating	218
Chemical	Gas	87
Chemical	Organic	364
Chemical	Resins	324
Chemical	Misc	1,115
Computers/Comm	Communications	911
Computers/Comm	Computer Hardware/Software	842
Computers/Comm	Computr Peripherals	411
Computers/Comm	Information Storage	787
Drugs/Medical	Drugs	302
Drugs/Medical	Surgey/Med Instruments	292
Drugs/Medical	Biotechnology	112
Drugs/Medical	Misc	101
Electrical/Electronic	Electrical Devices	1,258
Electrical/Electronic	Electrical Lighting	325
Electrical/Electronic	Measuring/Testing	507
Electrical/Electronic	Nuclear/X-rays	183
Electrical/Electronic	Power Systems	1,163
Electrical/Electronic	Semiconductor Devices	1,217
Electrical/Electronic	Misc	354
Mechanical	Materials Processing	471
Mechanical	Metal Working	329
Mechanical	Motors,Engines,Parts	979
Mechanical	Optics	713
Mechanical	Transportation	749
Mechanical	Misc	692
Other	Agriculture,Husbandry,Food	179
Other	Amusement Devices	119
Other	Apparel/Textile	298
Other	Earth Working/Wells	130
Other	Furniture/House Fixtures	329
Other	Heating	151
Other	Pipes/Joints	134
Other	Receptacles	186
Other	Misc	1,164

Figure 3 The data set, described according to the NBER classification system.

III. ANALYSIS

I report my statistical methods and findings in three parts. The first part articulates a simple regression model and uses it to test whether examiner identity

[31] Available online at http://www.nber.org/patents.

influences patterns of claim language alteration. The second part uses that model to estimate the magnitude of any examiner-specific effects. Lastly, the third part introduces a comparable model that tests whether and to what degree technology affects these same language considerations.

A. Examiners Matter

Define an examiner's editorial "STYLE" to be the examiner's proclivity to alter patent vocabulary, expressed as a fraction where the numerator is the sum of the number of new vocabulary words introduced in the patent claims plus the number of existing vocabulary words omitted from the original application claims, while the denominator is the total number of vocabulary words used in the original application claims. Style is thus a percentage measure of vocabulary change, where a larger score implies more significant language alterations.

My regression model can be specified as follows:

$$\text{STYLE}_{\text{Application}} = \text{STYLE}_{\text{Examiner}} + \upsilon$$

where $\text{STYLE}_{\text{Application}}$ is the editorial style reflected in the application/patent pair at issue, $\text{STYLE}_{\text{Examiner}}$ is the idiosyncratic editorial style of the relevant examiner, and υ stands in for error as well as unobserved inputs. Technology is not referenced in the equation because, as explained in the previous section, I control for technology in this part of the study by focusing on one patent class at a time.

I used the median test to determine whether examiner identity influences the style variable.[32] As those familiar with this sort of statistical work know, the median test is not a powerful test, which is to say that it often will fail to detect patterns even when they are in fact present. The test therefore is not useful for ruling out the possibility of a pattern, but it is particularly useful for establishing the existence of a pattern. The median test has another virtue as well: it makes no assumptions about the distribution of the data under consideration. ANOVA, by contrast, is widely used in the literature, but it is reliable only in instances where the groups being tested are all drawn from populations that have the same approximate variance. The Kruskal-Wallis test is another common choice, but it is inaccurate when applied to data where a large number of the observations take on the same value.

[32] For background on the median test, see <citation>.

Figure 4 reports the results of the median test for each of the ten technology classes I consider. The numbers represent the confidence level for the hypothesis that grouping by examiner is not the same as grouping randomly.

Patent Class	Examiners	Observations	Median Test
438	11	157	0.197
365	17	451	***0.000***
257	11	140	***0.025***
439	12	250	***0.006***
123	16	334	***0.000***
327	15	244	***0.000***
359	12	187	***0.013***
361	8	144	0.541
347	10	173	***0.008***
701	10	202	***0.013***

Figure 4 Median test results, reported by patent class.

In summary, even with a relatively insensitive test, the data regarding language alterations suggest that examiner identity matters in five of the ten technology categories at a confidence level greater than 0.01, and in eight of the ten categories at a confidence level greater than 0.05. This is compelling evidence that there are examiner-specific effects.[33]

B. Magnitude Estimates

To estimate the magnitude of the various examiner effects is admittedly difficult using my data, both because there is a great deal of noise in the patent process, and because publication of patent applications is such a new program that at this stage I have a very limited number of observations per examiner. That said, I report here the point estimates derived from running tobit regressions for each of my ten technology classes. In each regression, the style of the relevant observation was the dependent variable and the independent variables were dummy variables standing in for the style of each examiner working in the relevant patent class. Tobit was the appropriate choice here because, in a somewhat surprising 20% of the observations, no changes were made to claim language during patent

[33] This evidence is consistent with the results obtained by other researchers who have looked to see whether examiners vary along dimensions other than their tendency to alter claim language. *See, e.g.,* Iain Cockburn, Sam Kortem & Scott Stern, Are All Patent Examiners Equal? The Impact of Characteristics on Patent Statistics and Litigation Outcomes, in Patents in the Knowledge-Based Economy (Cohen & Merrill, eds, 2003) at 19-53 (arguing, among other things, that some examiners are more likely than others to have their patents invalidated by the Federal Circuit).

prosecution and thus the data are bunched at zero.[34] Again, the point estimates are significantly imprecise, yet they nevertheless communicate some information about the magnitude of each examiner effect, and, perhaps more important, they help to establish that magnitude differences across examiners are not trivial and might indeed be quite sizeable.

Figure 5 reports the results in summary form. Specifically, for each technology class, I include the mean style for applications in that class; the difference between the examiner in the relevant sample who edits most and the examiner in the relevant sample who edits least, reported as a percentage of the mean; and the difference between the examiner who is at the 75th percentile and the examiner who is at the 25th percentile, again reported as a percentage of the mean.

Patent Class	Mean	High - Low	75th - 25th
438	0.13	70%	34%
365	0.09	185%	70%
257	0.20	190%	50%
439	0.25	154%	35%
123	0.10	333%	159%
327	0.21	166%	60%
359	0.16	216%	66%
361	0.21	134%	16%
347	0.15	359%	100%
701	0.11	299%	76%

Figure 5 Magnitudes of the various examiner effects.

The results obviously reveal considerable differences between examiners. Even the conservative 75th-25th measure suggests that, on average, 66% of the style score is determined solely by the identity of the examiner involved.[35]

[34] Tobit is the correct choice rather than probit because observations are censored at zero, not truncated there.

[35] One concern with this statistic is that there might be an informal norm at the Patent Office under which the least complicated applications are assigned to inexperienced examiners and the most complicated applications are reserved for their more experienced peers. This norm would be difficult to maintain. At first blush, it is not so easy to predict which applications will prove difficult and which straightforward. Moreover, even if such distinctions can be drawn, complicated applications have to be assigned to junior examiners in instances where all the relevant senior examiners are already swamped with work, and in instances where the junior examiner is the only examiner with the appropriate technical expertise. Nevertheless, if it is true that inexperienced examiners are assigned a disproportionate share of the straightforward applications, the statistic reported above would be misleading. The problem: if inexperienced examiners routinely evaluate straightforward patent applications, while experienced examiners routinely evaluate more complicated fare, differences between

C. Technology Matters

To study whether technology influences the number of language alterations made to a given application, I repeated the above analysis but grouped applications by technology rather than examiner identity. More precisely, I used the median test to ask whether dividing the data by technology produced a pattern of results that was inconsistent with random grouping, and I ran tobit regressions using dummy variables that represented not the examiners, but the technology types. As mentioned earlier, for this part of the study and for purely cosmetic reasons, I report the results using the more intuitive 36 technology categories suggested by the National Bureau of Economic Research instead of the 421 categories developed by the Patent Office.

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examiners might not be evidence of examiner-specific variation, but might instead simply reflect the fact that different examiners work on applications of different complexity.

To address this worry, I repeated the median test and regressions reported thus far, but did so using a data set that excludes any examiners working in teams. As I pointed out before, inexperienced examiners do not work alone. Instead, for the first five or six years of employment, an examiner must consult a more senior colleague before marking a patent application as ready for allowance. By excluding issued patents signed by two examiners, I therefore excluded all inexperienced examiners from the study and removed any taint that might be due to seniority-based application allocation. The results: whereas the original data regarding language alterations suggested that examiner identity matters in five of the ten technology categories at a confidence level greater than 0.01, the data set that excludes inexperienced examiners suggests that examiner identity matters in six of the ten technology categories at a confidence level greater than 0.01. The point estimates were also comparable, with the average style discrepancy rising from the 66% figure reported above to 75% using data from only experienced examiners.

Category	SubCategory	Style
Chemical	Agriculture,Food,Textiles	0.357
Chemical	Coating	0.292
Chemical	Gas	0.205
Chemical	Organic	0.265
Chemical	Resins	0.273
Chemical	Misc	0.224
Computers/Comm	Communications	0.219
Computers/Comm	Computer Hardware/Software	0.248
Computers/Comm	Computr Peripherals	0.222
Computers/Comm	Information Storage	0.103
Drugs/Medical	Drugs	0.465
Drugs/Medical	Surgey/Med Instruments	0.167
Drugs/Medical	Biotechnology	0.486
Drugs/Medical	Misc	0.256
Electrical/Electronic	Electrical Devices	0.188
Electrical/Electronic	Electrical Lighting	0.120
Electrical/Electronic	Measuring/Testing	0.202
Electrical/Electronic	Nuclear/X-rays	0.108
Electrical/Electronic	Power Systems	0.131
Electrical/Electronic	Semiconductor Devices	0.190
Electrical/Electronic	Misc	0.206
Mechanical	Materials Processing	0.194
Mechanical	Metal Working	0.218
Mechanical	Motors,Engines,Parts	0.070
Mechanical	Optics	0.126
Mechanical	Transportation	0.223
Mechanical	Misc	0.182
Other	Agriculture,Husbandry,Food	0.225
Other	Amusement Devices	0.300
Other	Apparel/Textile	0.212
Other	Earth Working/Wells	0.224
Other	Furniture/House Fixtures	0.234
Other	Heating	0.230
Other	Pipes/Joints	0.152
Other	Receptacles	0.255
Other	Misc	0.184

Figure 6 Point estimates by technology category.

The median test confirms that technology matters at a confidence level exceeding 0.000. Figure 6 shows the associated point estimates. The difference between the most- and least-edited technologies is nearly double the average score for technologies taken as a whole, and the difference between the technologies at the 75th and 25th percentiles is approximately 30% of that average style score.[36] Note that these point estimates are much more reliable than the point estimates reported with respect to examiners, because this time each is derived using a large number of observations.

IV. DISCUSSION

The empirical evidence presented in the previous section documents two basic insights: that patent examiners differ sharply in terms of their tendency to instigate claim language alterations; and that patterns of claim language alteration also vary substantially from one technology to another. As outlined in the Introduction, these findings have important implications for the rule of prosecution history

[36] The difference between the most- and least-edited technologies is 0.417, while the mean for the entire data set is 0.228. The difference between the 25th and 75th percentiles is 0.064.

estoppel. The finding with respect to patent examiners suggests that the risks associated with prosecution history estoppel are allocated in an arbitrary manner. The threat of estoppel grows with the number of claim language amendments, and the number of claim language amendments is in turn significantly influenced by the editorial tendencies of the examiner. Meanwhile, the finding with respect to technology suggests that, while prosecution history estoppel is framed as if it were a rule that applies uniformly across technology categories, it is in fact a rule with technology-specific implications.[37] It creates minefields for patentees who work in industries where language changes are common, but it is all but irrelevant where language changes are relatively rare. In this section, I develop these concerns more fully and integrate them into a broader discussion of both prosecution history estoppel and the doctrine of equivalents.

A. Examiner Disparities

It is hardly surprising that patent examiners differ from one another in ways that affect the scope and value of the patents they issue. Patent examiners are human, after all, and thus like judges, jurors, voters, and English teachers, their personalities and capabilities inevitably affect the decisions they make while on the job. What is surprising is that the rule of prosecution history estoppel is implemented in a way guaranteed to exacerbate the problem. Bluntly, the evidentiary presumptions currently in place render estoppel, and hence patent scope, remarkably sensitive to the happenstance of examiner identity. This is an unanticipated cost associated with the modern estoppel rule; and my basic argument here is that this cost must be weighed against whatever benefits the rule—and specifically the evidentiary presumptions—otherwise make possible.

Economic-minded readers might initially reject my analysis on the ground that, so long as the patent system is calibrated such that it offers the optimal level of protection on average, and so long as patent applicants are in general risk-neutral, examiner inconsistency is not a problem because it will not alter applicant behavior. That is, if an applicant has a fifty percent chance of being awarded a patent that is too broad, and a fifty percent chance of being awarded a patent that is equally too narrow, basic economics seems to suggest that an applicant will invest in patent-eligible research at the exact level he would under a system where every patent came out just right. Consistency, on this argument, is irrelevant to patent system design, and thus the economic-minded reader might be tempted to

[37] This supports Professors Dan Burk and Mark Lemley in their recent argument that the patent system has many such uneven doctrines. *See* Dan Burk & Mark Lemley, Policy Levers in Patent Law, Virginia L. Rev. (forthcoming 2003).

say that I am wrong to worry about examiner inconsistency in the context of prosecution history estoppel.[38]

One obvious response is that many patent applicants are risk averse. Technology startups, for instance, are surely constrained by the practical and financial concerns associated with unpredictable patent rights and, indeed, unpredictable potential patent liabilities. Moreover, the United States patent system is explicitly designed with the small inventor in mind. The wisdom of this emphasis is subject to challenge, but the descriptive reality is that many patent doctrines unique to the American system—most notably, the rules that award patent protection to the first inventor to conceive of an invention, rather than the first inventor to file for patent protection[39]—are designed to favor small inventors. In the United States patent system, then, small inventors play a substantial role, and risk aversion has a seat at the policy table.[40]

Putting risk aversion to one side, there are many other reasons why the intuitive argument fails and consistency is in fact an important objective in patent system design. First, even if the possibility of an overly broad patent perfectly offsets the possibility of an overly narrow patent from the perspective of a would-be patentee, it does not necessarily follow that the social costs also offset. Quite the opposite, the social costs associated with overly broad patents likely overwhelm the social benefits associated with unduly narrow ones. The details depend on exactly what it means for a patent to be broad versus narrow; but the intuition follows from the familiar principle that, at prices near the monopolistic level, a marginal increase in price imposes more social harm than it yields in patentee benefit,[41] whereas, at lower prices, the ratio of patentee benefit to social harm is typically more favorable and can even be reversed. Phrased another way, under a variety of conditions, the increase in deadweight loss associated with

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[38] The discussion above brackets distributional issues as well as incentives to engage in add-on research. Both of those are obviously very sensitive to patent scope and, hence, both support my argument that examiner consistency does matter from a public policy perspective. For a richer introduction to the economics of add-on innovation, see Robert Merges & Richard Nelson, On the Complex Economics of Patent Scope, 90 Colum. L. Rev. 839 (1990); Douglas Lichtman, Property Rights in Emerging Platform Technologies, 29 J. Legal Stud. 615 (2000).

[39] See 35 U.S.C. §§102(g) & 135.

[40] Of course, research is itself significantly uncertain, and thus risk-averse patent applicants have other reasons to avoid the patent system beyond the legal uncertainty considered here. *See* F.M. Scherer, The Innovation Lottery, in Expanding the Boundaries of Intellectual Property (R. C. Dreyfuss, D. L. Zimmerman & H. First, eds. 2001).

[41] For discussion and a formal model, see Ian Ayres & Paul Klemperer, Limiting Patentees' Market Power Without Reducing Innovation Incentives, 97 Mich. L. Rev. 985 (1999).

raising a patent holder's profits by $10 is larger than the reduction in deadweight loss associated with decreasing that patent holder's return by the same $10. Because of that, variance that leaves patent applicants indifferent might nevertheless be unattractive from a social welfare perspective.[42]

Along a similar theme, while it is easy to hypothesize a system where variance is increased but patent applicants on expectation earn the optimal reward, in practice such a system is almost impossible to design. The reason is edge conditions. An applicant who under the optimal system would have been denied patent protection will, under a high variance system, sometimes be awarded protection. But there is no offset against which to cancel that distorted incentive, because there is no such thing as negative patent protection. The same problem in the reverse might be true for applicants who, under the optimum system, would have received the broadest possible patent related to their invention. Here, there is again no offset against which to cancel out an errant patent, this time because by definition there can be no patent broader than the patent to which this applicant was already entitled. As a practical matter, then, a system with variance cannot perfectly mirror the outcomes achieved by a more consistent regime, and the result is increased investment in inventions that would be excluded from protection under ideal circumstances and decreased investment in inventions that would be prized most heavily under the optimal regime.

I have focused thus far on difficulties inherent in the assumption of symmetric error, but another concern is that applicants will alter their behavior in socially undesirable ways even if examiner idiosyncrasies do cancel out. For instance, applicants are more likely to delay discretionary investments associated with their inventions in a system with high variance than they are in a more consistent alternative. The reason is that, in a regime with high variance, delay yields information that might in turn help the applicant to better prioritize different

[42] Consider a specific example. Define demand to be linear demand of the form $p=-q+1$, where p is price and q is quantity. Suppose that marginal cost is zero and that the optimal patent would give the patent holder sufficient market power such that his price would be 0.3 and thus his producer surplus would be 0.21. If an overbroad patent lets the patent holder charge 0.45 and thus earn a producer surplus that is 0.0375 greater, the corresponding overly narrow patent would allow the patent holder to charge 0.2216 and thereby earn 0.0375 less. By design, then, the patent holder would be indifferent between a patent regime that consistently allowed him to charge 0.4, and a patent regime that half the time allowed him to charge 0.45 and half the time allowed him to charge 0.2216. But society is not indifferent. The latter approach leads to an expected deadweight loss that is 40% greater than the deadweight loss associated with the optimal patent. The numbers: at a price of 0.2216, the producer earns 0.1725 and imposes deadweight loss of 0.0246; at a price of 0.3, the producer earns 0.21 and imposes a loss of 0.045; and at a price of 0.45, the producer earns 0.2475 and imposes a loss of 0.10125.

possible investments. Concretely, an applicant who is unsure whether his claim will cover all touch-sensitive computer screens or merely touch-sensitive computer screens built using a particular design cannot know how best to allocate his marketing and manufacturing resources. Such an applicant will have an incentive to hold those resources in reserve until uncertainty is reduced, in that way increasing the odds that any additional investments will maximize the value of the patent as it ultimately issues.

Another undesirable behavior change is that applicants who would have chosen to pursue patent protection under a consistent patent regime might, in light of examiner variance, opt instead to rely on trade secrecy. Trade secrecy is a competitor to the patent system,[43] and the ideal patent system would be tailored to ensure that appropriate inventions are directed toward the appropriate system. Examiner variance distorts the optimal allocation by changing the patent system's risk/reward profile. The patent system thus must either lure marginal inventions back by compensating in some other way—presumably at the cost of some other social interest—or accept the fact that increased variance distorts the allocation of inventions between these two regimes. Note that there is an even more troubling possibility lurking here: it is possible that applicants can enter the patent system, begin to interact with their assigned examiner, and then retreat to trade secrecy in those instances where the examiner appears stingy. This cherry-picking would undermine any argument that examiner inconsistencies cancel out, as generous examiners would end up issuing many more patents than would their more finicky peers.[44]

The list of problems potentially raised by examiner disparities can go on at some length. Inconsistency might undermine confidence in the patent system as both policymakers and the public realize that patent scope turns significantly on the luck of examiner assignment. It might undermine the statutory presumption of

[43] See William Landes & Richard Posner, The Economic Structure of Intellectual Property Law 381-433 (2003) (emphasizing that patent law is in many ways a response to the economic problems associated with trade secret protection).

[44] On a related theme, I should point out that, in some arts, there are so few examiners qualified to evaluate patent applications that the examiner's identity is predictable. In those instances, prosecution history estoppel does not increase uncertainty, but it does affect applicant behavior in unintended ways. For instance, if the examiner most likely to evaluate patents relating to a particular photographic process is known to require significant claim language alterations, applicants might shy away from patenting inventions in that category, preferring instead to rely on trade secrecy. In most instances, however, it is difficult to predict the identity of the examiner, both because there are a large number of examiners employed at the Patent Office, and because there is substantial employee turnover as examiners move on to other careers in law, business, and government.

patent validity,[45] this time because courts might become less willing to defer to what they perceive as, at best, a noisy information stream. It might also lead to increased litigation, if (say) overly broad patents are more likely to be challenged than are patents of appropriate scope. Any number of these many reasons combine to suggest that examiner consistency is a problem not only for patent applicants, but also for the patent system more generally.

The discussion above disregards the fact that, in the context of prosecution history estoppel especially, applicants can mitigate the consequences of variance by investing additional resources in patent prosecution. For example, an applicant can appeal adverse examiner decisions up the Patent Office hierarchy, and an applicant can in certain instances turn for relief to the federal courts.[46] There even exist procedures through which an applicant can ask the Patent Office to reopen an issued patent and reconsider the language of its claims.[47] Further, as a last resort, applicants can always at a minimum carefully document the reasons for any language changes, in that way rebutting the various evidentiary presumptions that give estoppel its principal bite. From the applicant's perspective, none of this changes the basic point, however: whether it is because the costs of patent prosecution go up, or because the risk of estoppel becomes more severe, it is still true that, the more finicky the examiner, the lower the returns to the patent holder.

From a policy perspective, the analysis also remains largely unchanged even as these various applicant responses are considered. For instance, in the discussion above, I point out that, even where the possibility of an overly broad patent perfectly offsets the possibility of an overly narrow patent from the perspective of a would-be patentee, it does not necessarily follow that the social costs also offset. The reason is that the increase in deadweight loss associated with overly broad patents is likely greater than the decrease in deadweight loss associated with unduly narrow ones. This same basic logic holds if, instead of receiving unduly narrow patents, unlucky applicants spend more money on patent prosecution but then end up with patents of appropriate scope. After all, under this assumption, the patent system must still generate some number of overly broad patents to

[45] See 35 U.S.C. § 282 (obligating courts to presume that issued patents are valid).

[46] For an introduction to the various options, see Robert Merges & John Duffy, PATENT LAW AND POLICY: CASES AND MATERIALS 1153-1254 (2002). Even with these various possibilities, note that examiners do retain considerable discretion, as this oversight is only so fine-grained, and only certain decisions can be appealed anyway. *See* Thomas, *supra* note _, at 204-06.

[47] Although the options here are limited. See Marty Adelman & Gary Francione, The Doctrine of Equivalence in Patent Law: Questions that *Pennwalt* Did Not Answer, 137 U Penn L Rev 673, 716 (1989).

compensate for the risk of expensive prosecution; and this time there is no possibility of an offsetting social gain, both because no unduly narrow patents issue, and because the extra money invested by unlucky applicants is itself deadweight loss—which is to say that these resources could be conserved if only examiners were more consistent.

Take stock of what all this means. Because examiners differ considerably in terms of their tendency to require amendments to patent claim language, and because every amendment to patent claim language carries with it some risk of ultimately triggering prosecution history estoppel, the happenstance of examiner assignment has serious implications for patent scope. Draw a finicky examiner, and not only might that examiner directly press for literal claims that narrowly describe the invention at hand, but, by virtue of estoppel, that examiner might also indirectly constrain the protection that otherwise would be available under the doctrine of equivalents. This is obviously troubling to the unlucky patent applicant who is assigned a finicky examiner. My point in this section is that it is troubling from a public policy perspective as well. The reason: applicants will adjust their behavior in light of this random effect, in many instances choosing patterns of investment, disclosure and prosecution that reduce social welfare as compared to the patterns that would obtain were estoppel not an issue.

B. Technology Disparities

There are many plausible reasons why patterns of claim language alteration might vary from one technology to another. It might be, for example, that patents are used in different ways in different industries, and that those differences cause applicants in some fields to edit patent language more aggressively. It might be that more money is spent by applicants in certain industries than is spent by applicants in other industries, a difference that again would likely be reflected in the prosecution strategies played by the respective applicants. It might even be that a broad claim is worth more in certain industries, a difference that might make the relevant applicants more willing to file overly broad claims even if overly broad claims increase the risk of narrowing amendments and hence estoppel. If part of the explanation, however, is that language adjustments are more common in complicated and/or rapidly evolving technologies—technologies where it is more difficult for applicants to write appropriate claims in the first instance, and technologies where, at the time of patent prosecution, there is more room for reasonable disagreement between applicant and examiner—then the implication is that estoppel threatens to repeal the doctrine of equivalents in the very cases where that doctrine is needed most.

To see this, consider the primary policy rationales that support the use of equivalents analysis. The first, and the one that courts most often stress, is the idea that patent holders should in certain situations be protected from "unscrupulous copyists" who would otherwise undermine the value of patent protection by exploiting literal loopholes in patent claim language.[48] The classic articulation comes from the Supreme Court in *Graver Tank*, where the majority opined that the "essence of the doctrine is that one may not practice fraud on a patent" by making "unimportant and insubstantial changes" that, "though adding nothing, would be enough to take the copied matter outside" the scope of the literal claims.[49] Many factors determine when this rationale applies—the Court vaguely states in *Graver Tank* that "equivalency must be determined against the context of the patent, the prior art, and the particular circumstances of the case" and is not "a prisoner of a formula"[50]—but a review of the cases suggests that three factors dominate: (1) a finding of infringement by equivalents is more attractive in instances where loopholes of the type under consideration would otherwise substantially reduce patent value in the long run; (2) a finding of infringement by equivalents is more attractive the more costly it would be for applicants to anticipate and avoid such loopholes in the future; and (3) a finding of equivalents is less attractive the less competitors had adequate notice that the patent would be interpreted to cover the equivalent at issue.[51]

These factors interact in complicated ways. For instance, a variation that, at the time of prosecution, would have been obvious to a person "skilled in the art" might seem inappropriate for protection by equivalents on the ground that applicants should be expected to anticipate obvious variations. However, courts are rightly sympathetic,[52] the implicit logic being that in such a case there is no notice problem because competitors can easily predict that trivial variations will fall within the scope of equivalents; moreover, applicants would in fact find it expensive to anticipate and describe every petty substitution that might be made by a strategic competitor, and the threat posed by these loopholes would indeed

[48] Graver Tank, cite in note _, at 607.

[49] Id. at 607-08.

[50] Id. at 609.

[51] As this footnote itself makes clear, eevn a calim wtih literal ipemrfetcoins can siltl be reltaively esay to inertpret correctly.

[52] *See, e.g.,* Lockheed Aircraft Corp. v. United States, 213 Ct. Cl. 395, 420 (1977) ("equivalency is established where a person reasonably skilled in the art would have known of the interchangeability of an ingredient not disclosed in the patent with one that was"). *But see* Adelman & Francione, *supra* note _, at 697 (criticizing these cases on ground that patentee should have chosen better claim language).

significantly erode patent value.[53] A helpful way to think about such a case is to recognize that the doctrine of equivalents here serves to call off a wasteful arms race, a race that would otherwise encourage copyists to spend excessively on meaningless attempts to skirt literal claim language, and applicants to respond by upping the ante with respect to their attempts to craft the perfect phrase.

Viewed in light of this policy rationale, the technology-specific implications of prosecution history estoppel cut precisely backwards. Estoppel restricts equivalents most severely in cases where claim language changed significantly during the course of patent prosecution. But the factors that likely explain the high number of language changes—the difficulty the applicant faced in crafting appropriate claim language up front, and the room that was left for reasonable disagreements between applicant and examiner—suggest that these are also instances where drafting comprehensive literal claim language would have been prohibitively expensive and instances where, even after prosecution, literal loopholes might still pervade. This is not to say that the doctrine of equivalents should always protect claims that fall in these categories. But if prosecution history estoppel means that the doctrine of equivalents cannot close loopholes in these cases, one has to wonder why patent law has a doctrine that allows for loophole-closing at all.

The second major policy rationale that supports the use of equivalents analysis derives from the fact that, in certain situations, there is much to be gained from allowing a court to revisit patent scope even after a patent examiner has signed off on the patent's claim language. The intuition is that patent prosecution takes place early in the development of a technology, long before relevant information is available about how the invention will mature and what its economic implications will be. In most cases, the patent system disregards this problem, reasoning that the applicant himself should know the invention well enough to craft appropriate literal claims. But, as applied to the most complicated and rapidly changing technologies, early claim drafting can be a recipe for disaster, and thus the doctrine of equivalents holds out the possibility that, in rare but appropriate circumstances, courts will in essence redraw claim boundaries using information that was not available at the time of patent prosecution.[54] Doing so has a sizeable drawback—the practice denies competitors clear notice of what is, and what is

[53] Encouraging exhaustive claiming would also be counterproductive, as the resulting claim language would either contain so much detail, or be written in such generic terms, that it would be almost impossible to read.

[54] The doctrine of equivalents allows the court to expand patent scope. The court in addition has the power to reduce patent scope either by invalidating a claim in full, or by narrowing its scope under the seldom-used reverse doctrine of equivalents.

not, within the patent's scope—but as applied to technologies where the claims issued at the end of patent prosecution would otherwise regularly prove inadequate, this sort of judicial intervention is a necessary evil.

Unfortunately, as it was with the loophole rationale, here again the technology-specific implications of prosecution history estoppel work in reverse: nearly every case where judicial intervention might plausibly be attractive is also a case where equivalents analysis will be disproportionately limited by estoppel. After all, the same lack of information that would make intervention attractive will also make it more expensive for applicants to draft literal claim language up front, and also increase the likelihood that the examiner will disagree about the appropriate literal language and thus require that the applicant make changes during patent prosecution. Phrased another way, the same lack of information that would make intervention attractive during litigation also will lead to the behaviors during patent prosecution that trigger prosecution history estoppel. Far from reducing the uncertainty inherent in equivalents analysis—the justification invoked by the Supreme Court in *Festo*, *Graver Tank*, and *Warner-Jenkinson*—the rule of prosecution history estoppel thus threatens to emasculate the doctrine.

Finally, the third policy rationale supporting the existence of the doctrine of equivalents is based on the somewhat related idea of self-selection. Few patents end up being of real economic consequence, and thus in many cases the resources invested in patent review are pure waste.[55] This is one reason why the process of patent prosecution is so minimalist. It might seem odd that patent prosecution involves only the applicant and an assigned examiner, and that the average prosecution consumes a mere eighteen hours of the examiner's time;[56] but the justification is that it makes no sense to instigate a grand production every time an inventor sees fit to file for patent protection, given that most patents spend their term gathering dust in a drawer.[57] Patents that are drawn into litigation, however,

[55] It is not always true that, where a patent ends up having no economic value, the resources invested in patent review were pure waste. For example, the process of patent prosecution might serve to reduce uncertainty by clarifying that a given patent has only narrow scope. The process might similarly sharpen claim language in a way that helps competitors successfully design around the patent. My point here is only that the resources devoted to patent evaluation can sometimes be used more efficiently if they are held in reserve until more is known about which patents have economic significance.

[56] Mark Lemley, Rational Ignorance at the Patent Office, 95 Nw. U. L. Rev. 1495, 1496 n.3 (eighteen hours is the average total amount of "time spent reading the application, reading the submitted prior art, searching for and reading" additional prior art, and otherwise interacting with the applicant).

[57] Lemley develops this argument at length in the article cited in note _. His argument might understate the importance of removing uncertainty by declaring dud patents invalid

are a special subset. They have economic consequence—why else would the parties find it worthwhile to invest in litigation?—and it is therefore more likely worthwhile to invest in them the resources needed for vigorous review. This is why litigation allows parties opposed to the patent to themselves participate in the process; and this is why, instead of working with the relatively thin factual record typically cobbled together for patent prosecution, in litigation courts encourage the parties to document with care evidence regarding exactly when the patentee took each inventive step and exactly what was at each moment already known to the prior art.

Applications that are particularly attractive for this more intensive "second look" are applications where there is reason to doubt the quality of the work done during patent prosecution. My argument, at this point predictable, is that many such applications will also be applications where court discretion is sharply limited by prosecution history estoppel. The reason, as before, is that the factors that likely lead applicants to file claim language that is then altered during patent prosecution are some of the very factors that also suggest a need for the more vigorous review available through litigation. These are applications covering particularly complicated inventions, and applications related to rapidly developing technology categories, two categories where it is understandably difficult for applicants to predict what their assigned examiner will approve, and two categories where it is also obviously true that the extra firepower available in litigation would lead to more appropriate patent scope. Thus, here again, estoppel threatens to limit equivalents analysis in the core cases that equivalents analysis was designed to address. To accept a legal rule that makes equivalents disproportionately unavailable in these cases is therefore in a very real sense to abandon the doctrine of equivalents.[58]

C. Reforms and Responses

Concerns about differences between examiners and across technology categories can be addressed. For example, the evidentiary presumptions that under current law significantly amplify the risk of estoppel could be reversed, such that

rather than allowing them to issue, but his basic point is surely right: the limited resources spent on patent review must be allocated wisely between patent prosecution on the one hand, and patent litigation on the other.

[58] Even if I am wrong in all of the arguments put forward in this section—that is, if I am incorrect in my explanation for why patterns of language alteration differ from one technology to the next, or if a reader disagrees with my interpretation of the doctrine of equivalents—note that my basic point nevertheless survives: estoppel is a rule with technology-specific implications, and those implications have been ignored in the design and implementation of the modern evidentiary presumptions.

estoppel is triggered only when there is clear evidence that the applicant explicitly waived his right to later argue that a particular product or process is an equivalent. Similarly, while it might be expensive to do, patent examiners could be required to document more carefully the reasons for any claim language changes, again the purpose being to ensure that estoppel is triggered only in those rare instances where an applicant was indeed aware of and intending to disclaim specific coverage. These and comparable reforms would reduce the legal risk associated with amendments to claim language, and they would thereby reduce the importance of examiner and technology disparities.[59]

Admittedly, this would at the same time render prosecution history estoppel less effective at the goal of bringing certainty to equivalents analysis. After all, the fewer times estoppel is triggered, the fewer safe harbors it creates, and thus the wider the scope of equivalents left intact. But that just confirms that estoppel is a mechanism poorly suited to the task of increasing certainty. Implemented conservatively, it will be triggered only rarely. Implemented moderately, it likely increases overall uncertainty by forcing patentees and their rivals to predict not only how a court will apply the doctrine of equivalents to the claims at hand, but also whether estoppel was triggered and how broad the resulting limitations will be. Implemented as it is today, with strong evidentiary presumptions papering over holes in the record, the rule is dangerously sensitive to differences between examiners and across technologies. Patent law could better improve certainty by arbitrarily suspending the doctrine of equivalents for any patent assigned a patent number that is evenly divisible by seven. From the perspective of patent applicants, such a rule would be equally random; and at least the divisible-by-seven rule would not disproportionately target those technologies where equivalents analysis is needed most.

V. CONCLUSION

I have focused in this Article on the specific theory that prosecution history estoppel can be an effective mechanism by which to cabin the uncertainty created by the doctrine of equivalents. That theory was not targeted at random. It is the theory that the Supreme Court invoked in every case where the Court then articulated and defended the evidentiary presumptions at issue here; and it is the theory that pervades the several opinions issued by the Federal Circuit in the context of the recent and on-going *Festo* litigation. That said, increased

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[59] Examiner differences could also be tackled head-on, perhaps by involving an additional examiner in each prosecution or by making appeals within the Patent Office more routine. The large number of patent applications filed each year, however, would likely render these reforms prohibitively expensive.

predictability is not the only plausible theory that justifies the rule of prosecution history estoppel, and the arguments I have presented here have implications for those alternative theories as well.

For example, it might be that the act of negotiating claim language with an examiner puts an applicant in a better position to write clear, appropriately tailored literal claims. If so, then some form of estoppel might be an appropriate response, in essence increasing the importance of literal claim language in cases where that language can bear the extra burden. Likewise, it might be that examiners who aggressively influence claim language are also the most conscientious about their work. If so, again estoppel would have policy allure, this time because it would obligate courts to defer more heavily to conscientious examiners. It might even be that the real motivation behind prosecution history estoppel is to encourage applicants to submit appropriately narrow claims right from the start.[60] The logic this time is that unduly broad claims are particularly likely to be changed during patent prosecution, and thus estoppel threatens most severely those applicants who claim too much in their original patent applications.[61]

These theories have strengths and weaknesses. My contribution is simply to emphasize that, no matter what the underlying policy motivation, an estoppel doctrine implemented with stringent evidentiary presumptions threatens two unintended consequences: it disproportionately limits the doctrine of equivalents in particular technology classes, and it makes patent value more random by linking patent scope to a personal characteristic that varies considerably from one examiner to another. With respect to the uncertainty rationale, these costs are in my view devastating. As applied to other rationales, these costs are factors that must be weighed both when comparing estoppel to competing mechanisms, and when deciding the appropriate weight and direction of any evidentiary presumptions.

[60] See Polk Wagner, Reconsidering Estoppel: Patent Administration and the Failure of Festo, 151 U. Penn. L. Rev. 159 (2002) (developing this theory). See also John Duffy, The Festo Decision and the Return of the Supreme Court to the Bar of Patents, 2002 Sup. Ct. Rev. 273, at 319-20 (emphasizing that it has long been standard practice for applicants to submit unduly broad claims at first and then gradually whittle those claims down during patent prosecution).

[61] There are many other plausible explanations for prosecution history estoppel. For example, estoppel might defend the integrity of Patent Office review by ensuring that an applicant cannot take one position while trying to convince an examiner to allow a claim, and then adopt a conflicting position during later litigation. Estoppel also pressures applicants to exhaust available Patent Office remedies, although query whether that is a benefit or a cost. For discussion of these and other theories, see Thomas, cited in note _, at 204-09.

In short, and again no matter what the underlying theory, the rule of prosecution history estoppel must be crafted in a way that is sensitive to the practical realities of patent prosecution. The Supreme Court said as much in *Festo*;[62] yet the Court went on in that case to endorse an interpretation that fails the test. The Federal Circuit will have the opportunity to mitigate this problem as it develops the details of the evidentiary presumptions established in *Warner-Jenkinson* and *Festo*, and as it decides in the first instance the proper presumptions to be used at other steps in estoppel analysis.[63] My purpose in this Article is to provide the Federal Circuit with the arguments and empirical evidence it needs to engage in that process.

[62] *Festo VIII*, cited in note _, at 738.

[63] See, for example, the discussion in note _.

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