

Do inventors value secrecy in patenting?
Evidence from the American Inventor's Protection Act of 1999

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Abstract

This study examines the revealed preferences of inventors towards secrecy in patenting by analyzing their disclosure choices before and after the enactment of the American Inventor's Protection Act (AIPA) of 1999. We find that 7.5% of U.S. patent applications use AIPA's provisions to keep their inventions secret before patent grant. Small U.S. inventors, in particular, are more likely than large corporations to prefer *disclosure over secrecy* for their most important inventions. Our findings question the conventional wisdom—which seems to have shaped important policy—that the disclosure of patent applications harms U.S. invention by increasing the risk of imitation for small inventors.

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1. Introduction

The patent system is built on a grand bargain: In order to gain the exclusive right to make, use, and sell their inventions during the term of the patents, inventors are required to disclose their inventions to the public. Consistent with the tradeoff between exclusivity and disclosure reflected in this bargain, theoretical work in economics assumes that inventors value secrecy for their inventions, and that they choose among different appropriability mechanisms, such as patents and trade secrecy, based on the costs of patent disclosure (*e.g.*, Horstmann *et al.* 1985; Friedman *et al.* 1991; Gallini 1992; Anton and Yao 2004; Aoki and Spiegel 2009). This paper empirically examines, for the first time, assumptions about inventors' preferences regarding secrecy versus disclosure in patenting.

Historically, inventors were allowed to keep their U.S. patent applications secret until the final patent was granted—in theory, for up to 20 years.¹ With the passage of the American Inventor's Protection Act of 1999 (P.L.106-113; henceforth, "AIPA" or "the Act"), Congress harmonized U.S. patent laws with those of the rest of the world by requiring—in general—public disclosure of patent applications at 18 months from their filing date (see Figure 1). However, the Act also provided an important exception not available to applicants in other countries: U.S. applicants could opt out of 18-month disclosure by declaring that they would not seek patent protection in a foreign jurisdiction.²

Figure 1 here

The consequences of disclosing inventions in patent applications, and, the implications of AIPA, are not well understood. Some scholars argue that disclosure before patent grant discourages inventors who value secrecy from patenting, especially small inventors with insufficient resources to secure their inventions from imitation, to the detriment of society. For example, 24 Nobel laureates (in economics and the sciences) protested against Congress passing the 18-month disclosure requirement for U.S. patent applications, claiming that

¹ For U.S. patent applications filed after June 08, 1995, the term of a patent is 20 years from its earliest application date and applicants can meaningfully delay patent issue and publication till patent expiry.

² Technically, the applicant may opt out of 18-month publication if a request and certification are made to the USPTO that the invention is not the basis for an application in another country, or under a treaty, requiring 18-month publication. 35 USC 122(b)(2)(B).

[pre-grant disclosure] will prove very damaging to American small inventors and thereby discourage the flow of new inventions that have contributed so much to America's superior performance. . . . It will do so by curtailing the protection they obtain through patents relative to the large multi-national corporations (Modigliani et al. 1999).

Conversely, other economists argue that pre-grant disclosure benefits innovation because it allows inventors to signal their inventions' existence and scope to potential licensors early; preempts duplicative R&D investments; facilitates rapid diffusion of scientific knowledge; and supports consistency with international patent procedures (Scotchmer and Greene 1990; Johnson and Popp 2001; Hegde and Luo 2012).

Do inventors prefer pre-grant secrecy over disclosure? How do inventors' preferences for secrecy vary with the characteristics of inventors and inventions, and, in particular, are small U.S. inventors more likely to value pre-grant secrecy for their important inventions? We address these questions by analyzing novel data on inventors' disclosure choices before and after the Act's effective date.

Inferring the value inventors place on secrecy by analyzing data is difficult because those who opt for secrecy do not leave behind a paper trail of their preferences. Lacking empirical evidence, influential theoretical models and important policy decisions, such as AIPA's enactment, have been based on untested assumptions regarding inventors' preferences for secrecy and disclosure in patenting. Our analysis investigates inventors' responses to the widely debated 18-month publication requirement, and establishes systematic facts about the population of U.S. patent applicants which show that the benefits and costs of patent disclosure depend on the size of inventors, technological fields, and value of inventions in unexpected ways. Hence, we contribute to a better understanding of the importance of secrecy and disclosure in the patenting process.

2. Institutional details and identification strategy

Prior to AIPA, the disclosure of a U.S. patent application, containing detailed technical descriptions and drawings of the invention, occurred when the patent was issued. Applications that were either rejected by the patent office or withdrawn by their applicants were never published. However, pre-grant secrecy of U.S. applications before AIPA was not complete since, for patent applications filed in foreign jurisdictions that claimed "priority" over U.S. patent applications (*i.e.*, disclosed the same invention), the invention was made public through a pre-grant disclosure in the foreign country (most foreign countries

had the 18-month public-disclosure rule long before AIPA). Hence, for inventors pursuing patent applications covering the same invention in the U.S. and foreign nations simultaneously, international norms ensured the invention's disclosure at 18 months from its earliest application date.³ 51% of U.S. applications simultaneously pursued foreign protection between January 1, 1995 and November 28, 2000 and, thus, were subject to disclosure in the foreign jurisdictions.

AIPA required US patent applications filed on and after November 29, 2000 to be published by the government 18 months after application date. Since most foreign countries' patent systems already required 18-month publication of patent applications, AIPA's enactment harmonized the US patent system's disclosure policies with international norms. However, in response to concerns that pre-grant disclosure particularly stifles the breakthrough inventions of small inventors (see Nobel laureates' letter to the Senate, cited above), the Act departed from international norms by providing U.S. applicants with a loophole: They could opt out of 18-month disclosure under the condition that they forgo foreign protection. Thus, applicants that opted out of foreign protection post-AIPA—akin to applicants that did not pursue foreign protection before the Act—could keep both the presence of their patent application and the application's content secret till patent grant. For patents that take a long time to issue, the additional period of pre-grant secrecy beyond 18 months can be substantial; for example, among U.S. patent applications filed in 2005, 50% took more than 38 months, 25% more than 51 months, and 10% more than 61 months to issue. Patent applications in these groups could gain at least an additional 20 months, 33 months, and 43 months of secrecy, respectively, by opting out of foreign protection.

Consider the following benefit-cost calculus of patent secrecy and disclosure. Let V_s be the expected value of pre-grant secrecy, V_d the expected value of pre-grant disclosure, and V_f the expected value from foreign patent protection to a U.S. patent applicant. After AIPA's enactment, the applicant faces the following three options: (1) pursue a U.S. patent application and corresponding foreign protection with mandatory 18-month disclosure; (2) pursue a U.S. patent application alone and 18-month disclosure; and (3) pursue a U.S. patent application alone with pre-grant secrecy. Value-maximizing inventors will choose (1) if $V_f + V_d > V_s$, (2) if $V_d > V_s$ and (3) if $V_s > V_d + V_f$. Hence, by analyzing the sorting of patents

³ The Paris Convention (1883) requires that a patent application filed in any nation can claim priority over a previous patent application in a different nation only if the application is filed within 12 months of the related previous application. The Patent Cooperation Treaty (1970) extends this period to 18 months under special circumstances.

into one of the above three options after AIPA came into force, we can infer the frequency and large-sample characteristics of inventors and inventions that value pre-grant secrecy over disclosure.⁴

Our data consist of every successful U.S. utility patent application with a filing date at the U.S. Patent and Trademark Office (USPTO) between January 1, 1996 and December 31, 2005 and a grant date by June 30, 2012. For each U.S. application, we gathered information on corresponding foreign patent applications, disclosure choices and various patent characteristics such as important dates, applicant identity, and technology fields. We identified the corresponding foreign applications associated with U.S. applications by using the PATSTAT database maintained by the European Patent Office (EPO). The PATSTAT database identifies international patent families, or the complete set of equivalent patent applications filed across different foreign nations. According to the Paris Convention, patent applications filed across different foreign nations are considered equivalents if they claim the same prior applications as priorities. This method of identifying U.S. patent applications with corresponding foreign applications is comprehensive, and, we believe, identifies as many U.S. patents with foreign applications as materially plausible (by tracking foreign priorities of not only original applications, but also continuations, divisions, and other related non-provisional applications; Graham and Harhoff (2010) carefully validate this method of identifying equivalent patents in different countries).

According to the Patent Cooperation Treaty (PCT), applicants are required to pursue foreign prosecution of patent applications no later than 18 months from filing an application in any of the signatory countries, or else forgo protection in the countries of later filing. We checked and confirmed that all U.S. patents with foreign equivalents in our sample adhered to the 18-month publication requirement after AIPA. While previous efforts report that roughly 33% of all U.S. patent applications seek corresponding foreign protection (*e.g.*, Johnson and Popp 2001), we are able to identify equivalent foreign protection for 50% of all U.S. patents. U.S. patents for which we were able to find corresponding foreign applications identify, after AIPA, patents for which $V_f + V_d > V_s$. For U.S. patent applications filed after November 29, 2000, we separated the patent applications that were disclosed after 18 months (patents for which $V_d > V_s$) from those that chose pre-grant secrecy (patents for which $V_s > V_f + V_d$).

⁴ We emphasize that our quasi-experimental setup does not identify V_f , V_d , and V_f *per se*, but the likely rank ordering of these parameters as a function of inventor and invention characteristics. Further, our empirical setup does not identify $V_d > V_s$ if valuable inventions always have $V_f + V_d > V_s$, but in this case, we can still infer whether the value of foreign protection is greater than the value of secrecy—*i.e.*, whether $V_f + V_d > V_s$.

3. Do inventors value pre-grant secrecy over disclosure?

Table 1 shows the number of successful U.S. patent applications filed between 1996 and 2005; the percentage of applications with corresponding foreign applications; the percentage of applications that remained secret before grant; and the percentage of applications that chose 18-month publication despite not pursuing foreign protection. About 51% of all U.S. patent applications filed before AIPA have corresponding foreign applications, and this proportion drops only slightly after AIPA comes into force. In addition to patents with foreign applications that are disclosed 18 months after application, 42.5% of applications that did not have corresponding foreign patents opted for pre-grant disclosure, and only 7.5% of the applications filed during 2001-2005 chose pre-grant secrecy. While international patent protection can be valuable, preserving the option to file internationally is not a likely explanation for the large share of US-only applications that chose disclosure because under the Patent Cooperation Treaty (1970), applicants can initially choose pre-grant secrecy while filing their U.S. applications and then opt out of secrecy by submitting a request to the USPTO any time before 18 months from application date.⁵

Table 1

The above numbers mask significant heterogeneity among technology fields in inventors' disclosure choices. Figure 2 shows that 3.5% and 4.3% of post-AIPA patent applications in Drugs and Chemicals, respectively, chose secrecy. In Computers and Communications technologies, 10% of post-AIPA patents issued from pre-grant secrecy. These latter technological fields are sometimes referred to as "complex product industries" by patent scholars, who point out that patents in these fields are more likely to be used for strategic reasons, such as cross-licensing, fencing, litigation, and "submarine patenting" (Cohen *et al.* 2000). Hence, it is plausible that these technology-level differences reflect a positive correlation between the use of pre-grant secrecy and the strategic use of patents. Still, a significantly greater fraction of applications in each of the technology categories chose pre-grant disclosure over secrecy.

Figure 2

4. Who values pre-grant secrecy?

⁵ It is noteworthy that the option to file a patent in many foreign jurisdictions ends at 12 months, unless the applicant had begun the Patent Cooperation Treaty application *ex ante*, in which case the limit can be extended to 18 months.

Opponents of pre-grant disclosure argue that small American inventors have limited resources to protect their inventions from larger rivals who might force them out of patenting by imitating or inventing around their inventions if disclosed early. In fact, AIPA's secrecy safe harbor provision was crafted specifically to protect these small and individual inventors (Ergenzinger 2006). Are small U.S. inventors, indeed, more likely than other applicants to prefer pre-grant secrecy?

We classified all applicants into one of the following four organizational types based on their ownership and size, as reported to the USPTO, at the time of patent application: (i) large U.S. inventors (defined as U.S.-owned for-profit entities having more than 500 employees); (ii) small U.S. inventors (U.S.-owned for-profit entities having fewer than 500 employees and U.S.-based individual inventors); (iii) foreign large inventors (foreign-owned for-profit entities having more than 500 employees); and (iv) others (including U.S.- and foreign-owned government and not-for-profit entities, foreign-owned small businesses and individual inventors, and unassigned patents). The four applicant types accounted for 34.2%, 9.5%, 38.2% and 18%, respectively, of all successful U.S. patent applications filed between 1996 and 2005.

Both before and after AIPA's enactment, large U.S. inventors were more likely than small U.S. inventors to pursue foreign protection (40.8% versus 30.2% between 1996 and 2000, and 34.5% versus 21.6% between 2001 and 2005). Under AIPA, small U.S. inventors are more likely than large U.S. inventors to choose pre-grant secrecy (13.3% versus 10.8%), but when small inventors do not pursue foreign protection, they are more likely than large U.S. inventors to opt for 18-month disclosure (65.1% versus 54.7%). Hence, conditional on forgoing foreign protection, small U.S. inventors are not more likely than their larger counterparts to choose pre-grant secrecy over disclosure (16.9% versus 16.4%; difference not statistically significant at $p < 0.01$).⁶ Indeed, all types of inventors overwhelmingly opt for disclosure over secrecy when they forgo foreign patent protection.⁷

We also investigated technological-field level differences in the disclosure choices of small and large inventors and found that conditioned on not seeking foreign protection, small U.S. inventors are

⁶ The probability of secrecy conditional on not seeking foreign protection is $P_s/(1-P_f)$ where P_s and P_f are, respectively, the unconditional probability of pre-grant secrecy and the unconditional probability of seeking foreign protection for a post-AIPA patent.

⁷ Foreign large applicants are the least likely to pursue secrecy and do so for less than 1% of their U.S. applications.

significantly more likely than large U.S. applicants to opt for pre-grant secrecy in Chemicals, Mechanical, and Other Technology fields (see Table 2). For patents in Computers and Communication technologies, conversely, large U.S. inventors are more likely to opt for secrecy than are their small U.S. counterparts. Still, in every technological field and for both large and small U.S. inventors, we find that $V_d > V_s$ is more likely than $V_d + V_f > V_s$, followed by $V_s > V_d$.

Table 2

Hence, small U.S. inventors prefer 18-month disclosure over secrecy after AIPA, and their higher unconditional propensity to use pre-grant secrecy relative to large inventors appears to be due to a lower likelihood of pursuing foreign patent protection.

5. Do small inventors value secrecy more for their important inventions?

The analysis above reveals that all types of inventors are substantially more likely to prefer 18-month disclosure over pre-grant secrecy whether or not they pursue foreign patent protection. According to opponents of early disclosure, though, small U.S. inventors of “new inventions that have contributed so much to America’s superior performance” are particularly harmed by the 18-month disclosure requirement. This suggests that small inventors of *breakthrough* inventions specifically prefer pre-grant secrecy because their inventions take longer to progress from application to issue and, thus, risk imitation by larger rivals during this period (Johnson and Popp 2003). We test this claim by comparing the Post-AIPA disclosure choices of large and small U.S. inventors as a function of their inventions’ importance. We use the following three measures of importance, each of which has been validated as a proxy for patent value by several scholars: (i) the time lag between application and grant; (ii) the number of claims in a patent; (iii) information on whether the patent owner pays a fee to maintain the patent exclusivity four years after grant; and (iv) the number of later-granted U.S. patents that cite the focal patent as prior art. Each of these measures individually suffers from important limitations, but if all four point in the same direction, we can infer that the results are unlikely to be due to idiosyncratic measurement errors. Each of the four is described in detail below.

(i) The patenting process is a “give-and-take” affair between the applicant, who typically wants to maximize the scope of her patent, and the patent examiner, who tries to narrow the applicant’s exclusive rights by searching for prior art that limits the claims in the application. Since protracted negotiations consume the resources of both parties, both examiner and applicant are likely to expend a

longer time and greater resources while prosecuting more-important and novel applications. Hence, the time between a patent's application and issue, sometimes called "pendency lag," can be an indicator of the patent's importance.

We find that, overall, post-AIPA applications that submit to 18-month disclosure without seeking foreign protection take longer to issue (42.2 months, on average, from first application date) than those emerging from secrecy (40.5 months, on average, from first application date). Table 3 reveals the heterogeneity in pendency lags for the different types of inventors: In particular, small inventors' patent applications that are disclosed after 18 months are subject to longer pendency lags because their more-important patents associated with disclosure require longer for scrutiny and examination at the patent office. This finding is inconsistent with the assertions of the opponents of disclosure that small inventors whose valuable applications require a longer time to go through the patenting process are more likely to value secrecy.

(ii) The claims in a patent are written descriptions of the technology that both delineate and indicate the boundaries of inventors' property rights (called "scope"). Prior research has associated a greater number of claims with broader patent scope and importance (Lerner 1994). We find that for granted patents filed between 1996 and 2005, the average number of claims in small U.S. inventors' patents is higher (21.7) than in the patents held by other types of inventors (20.7 for large U.S. inventors, 15.2 for large foreign inventors and 15.6 for miscellaneous "others"). Among small U.S. inventors' patents filed after the AIPA effective date, those with equivalent foreign patents have the highest number of claims (24.4), followed by patents that issue after pre-grant disclosure (22.2) and patents that issue after pre-grant secrecy (20.6). These differences are statistically significant at $p < 0.01$ and suggest that patents filed by small U.S. inventors choosing early disclosure are broader in scope. By contrast, for large U.S. and foreign inventors, U.S. patents issuing from pre-grant secrecy have a higher number of claims than those that choose disclosure (see Figure 3). These differences in the number of claims, as a function of inventors' disclosure choices, are qualitatively similar for the different technology fields.

Figure 3

(iii) An inventor holding a U.S. patent is required to pay patent renewal fees, due every 3.5 years, 7.5 years, and 11.5 years after grant, to maintain the exclusive right to practice the patent. Thus, the decision to maintain a patent in force indicates its (binary) value to inventors at the three stages (Pakes

1986).⁸ Since it takes about 40 months, on average, for a U.S. patent application to be granted and 42 additional months before the first maintenance fees are due, we can observe the first-stage renewal decisions for U.S. patents filed from the AIPA effective date through 2008. For patents granted by 2004, we can observe whether the second-stage maintenance fees were paid. With these grant-year restrictions, and for patent application years starting in 2001, 3.5- and 7.5-year renewal rates are 87% and 67%, respectively. Table 4 shows that for small U.S. inventors, both 3.5- and 7.5-year renewal rates are *lowest* for patents issuing from pre-grant secrecy (in contrast, but consistent with our findings from the patent claims data, both U.S. and foreign large inventors have higher renewal rates for patents issuing from pre-grant secrecy). While overall renewal rates are different for patents in different technology fields, we find that small-entity inventors are the least likely to renew their patents issuing from pre-grant secrecy consistently across the different fields.

Table 4

(iv) Citations are commonly used proxies for patent importance based on the theory that a higher number of later patent citations indicates a larger number of follow-on inventions that build on the knowledge in the focal patent (Trajtenberg 1990). Post-AIPA patents that opt for public disclosure have the opportunity to be cited even before they issue, and the knowledge spillover patterns that influence citations to patents may be different for patents that opt for pre-grant secrecy versus disclosure (*i.e.*, a grant event may make it more likely for a patent to be cited). Hence, comparing the citations of patents associated with different disclosure choices early in their lives may not accurately capture differences in citations arising from differences in value. Hence, after restricting our analysis to the earliest cohort of post-AIPA patents (*i.e.*, patents filed in 2001), we compare citation patterns to our focal patents, as a function of their disclosure choices, over a ten-year window from the patents' application dates. For most patents, 90% of their lifetime citations are received within 9 to 10 years of filing: Our 2012 data, thus, allows us to infer the value of patents filed in 2001 from their citations without inducing significant truncation errors.

Overall, the patents of small U.S. inventors receive more citations than those filed by large U.S. and foreign inventors, on average, in comparable citation windows. Figure 4 restricts attention to the citations made by future patents filed each year after 2001 to the 2001 cohort of small U.S. inventors'

⁸ For utility patents, the current fees are \$1,130, \$2,850 and \$4,730 for renewal at 3.5, 7.5 and 11.5 years, respectively; small and individual inventors pay half the corresponding amounts.

patents. Each year, patents issuing from pre-grant secrecy receive fewer citations than patents issuing from 18-month disclosure, such that after ten years of filing, patents issuing from pre-grant secrecy have, on average, 8.0 citations, while U.S.-only patents issuing after disclosure have 14.6 citations, and U.S. patents filed concurrently outside the U.S. receive 16.7 citations.⁹ Indeed, for all types of inventors, patents associated with pre-grant secrecy have the lowest average number of citations.¹⁰

Figure 4

Although citations are just one measure of importance that we use, one could argue that the higher number of citations received by patents that opted for 18-month disclosure reflects not their superior quality, but also greater spillovers associated with these patents. That is, follow-on inventors may be more likely to cite patents that are disclosed early not because they are higher-quality, but because the inventors find it easier to learn from, build on, and, thus, cite inventions that are disclosed early by applicants who value secrecy less. We address this potential confounding of the selection and treatment effects of disclosure choice by restricting citations to those inserted by patent examiners and then comparing the frequency of examiner citations for the different types of patents starting from their disclosure date rather than their application date. Since examiners conduct their own prior art search and identify material that might contest applicants' claims, examiner citations are less likely to be influenced either by applicants' strategic considerations or by the original inventors' actions to restrict the spillovers of their patented inventions (Alcacer *et al.* 2009). If anything, to the extent that applicants avoid citing patents emerging from pre-grant secrecy, examiners may be more likely to cite such patents, thus understating our inferences about the higher quality of disclosed patents.

We find that about 35% of citations to the patents in our sample are inserted by examiners. Next, we restrict attention to the citations made by examiners in future patents filed each year after their disclosure (18 months from application date for patents that opt for disclosure, and issue date for those that emerge from pre-grant secrecy) to the cohort of US small inventors' patents filed in 2001. Figure 5 shows that in each year except the first one after disclosure, patents issuing from pre-grant secrecy receive fewer citations than patents issuing from pre-grant disclosure, such that after 11 years of filing,

⁹ Figure A1 of the Appendix plots the average number of cumulative citations for patents filed in 2001 by disclosure status.

¹⁰ For large U.S. inventors, the corresponding numbers of citations are 9.04 (pre-grant secrecy), 12.9 (18-month disclosure) and 12.7 (foreign protection).

patents issuing from pre-grant secrecy have, on average, 2.9 citations, while U.S.-only patents issuing after disclosure have 3.8 citations, and U.S. patents filed concurrently outside the U.S. receive 4.1 citations.¹¹ Indeed, for all types of inventors, patents associated with pre-grant secrecy have the lowest average number of examiner citations.¹² The higher number of citations to patents emerging from pre-grant secrecy in the first year of their disclosure could be due to the advanced stage of their corresponding technological fields relative to the technologies that are disclosed after 18 months.

Figure 5

Patent value tends to be notoriously skewed, with a large share of important inventions concentrated in the tails of the distribution (Harhoff, *et al.* 1999). Are small U.S. inventors' inventions at the right tail of the patent citations distribution—or “breakthrough inventions”—more likely to value secrecy? For patents filed in 2001, 13% of small U.S. inventors' patents in the 10th percentile of citations, 10.6% in the 50th percentile and 5.1% in the 90th percentile issued from pre-grant secrecy. In the 99th percentile, only 0.5%, or one out of small inventors' 198 most important patents, issued from pre-grant secrecy (citations are cumulated across an 11-year window after 2001). Hence, the most highly cited patents of small U.S. inventors are least likely to emerge from pre-grant secrecy. Figure 6 shows that the probability of using pre-grant secrecy decreases with patent citations, not only for small U.S. inventors, but also for the other applicants.

Figure 6

Tables 5A and 5B report Maximum-Likelihood Multinomial Logit estimates of the relationship between inventors' Post-AIPA disclosure choices and the attributes of inventors and inventions discussed above. The estimates reveal that small inventors' preference for pre-patent disclosure over secrecy for their most important inventions remains substantial and significant (at $p < 0.01$), holding constant unobserved technology-field and inventor-type specific characteristics.

Table 5A and 5B

¹¹ Figure A2 of the Appendix plots the average number of cumulative examiner citations for patents filed in 2001 by disclosure status.

¹² For large U.S. inventors, the corresponding numbers of citations are 3.3 (pre-grant secrecy), 3.7 (18-month disclosure) and 3.3 (foreign protection).

6. Concluding thoughts

We find that less than 8% of U.S. applications after AIPA opted for pre-grant secrecy of patent applications. Our analyses of patent pendency lags, patent claims, renewal-fee payments, and patent citations do not reveal a positive correlation between invention value and the choice of pre-grant secrecy for small U.S. inventors and, thus, do not support the claim that small U.S. inventors value secrecy for their most important inventions. Instead, they are more likely to disclose their important inventions early in the patenting process, even when they are not pursuing foreign protection for their inventions. We find a more ambiguous relationship between the use of pre-grant secrecy and the value of inventions for other types of inventors, although all inventors predominantly prefer to disclose their inventions even when not bound by the disclosure rules associated with pursuing foreign protection.

Why are small inventors, in particular, more likely to prefer early disclosure for their most important inventions? Although our analysis does not uncover the motives behind the inventors' choices, we speculate that pre-grant disclosure benefits small inventors by allowing them to publicize their inventions' existence, quality and scope to competitors, external investors and potential licensees.¹³ These benefits of early disclosure may be lower for large firms, which depend on internal resources to finance and commercialize their inventions. Regardless of the motives for disclosure, our findings raise questions concerning recent policy prescriptions to restrict pre-grant disclosure by requiring the publication of patent abstracts rather than the entire applications (*cf* Federal Register 2012, H.R. 5980). Such moves appear unwarranted, given our findings that small U.S. inventors overwhelmingly prefer disclosure for their inventions. Such policy might unnecessarily interfere with a more harmonized international patenting regime advocated by experts over the years (*e.g.*, National Research Council, 2004), and undermine the exclusivity-for-disclosure bargain at the heart of the patent system.

¹³ This explanation is consistent with previous findings on the importance of patents to entrepreneurs in preventing copying, securing capital and experiencing successful acquisitions or initial public offerings (Graham, *et al.* 2010). Owners of published applications also receive provisional rights to pursue royalties from licensees for the period between the date of publication and the issue date of the patent (U.S. Patent Law, 35 U.S.C. § 154(d)).

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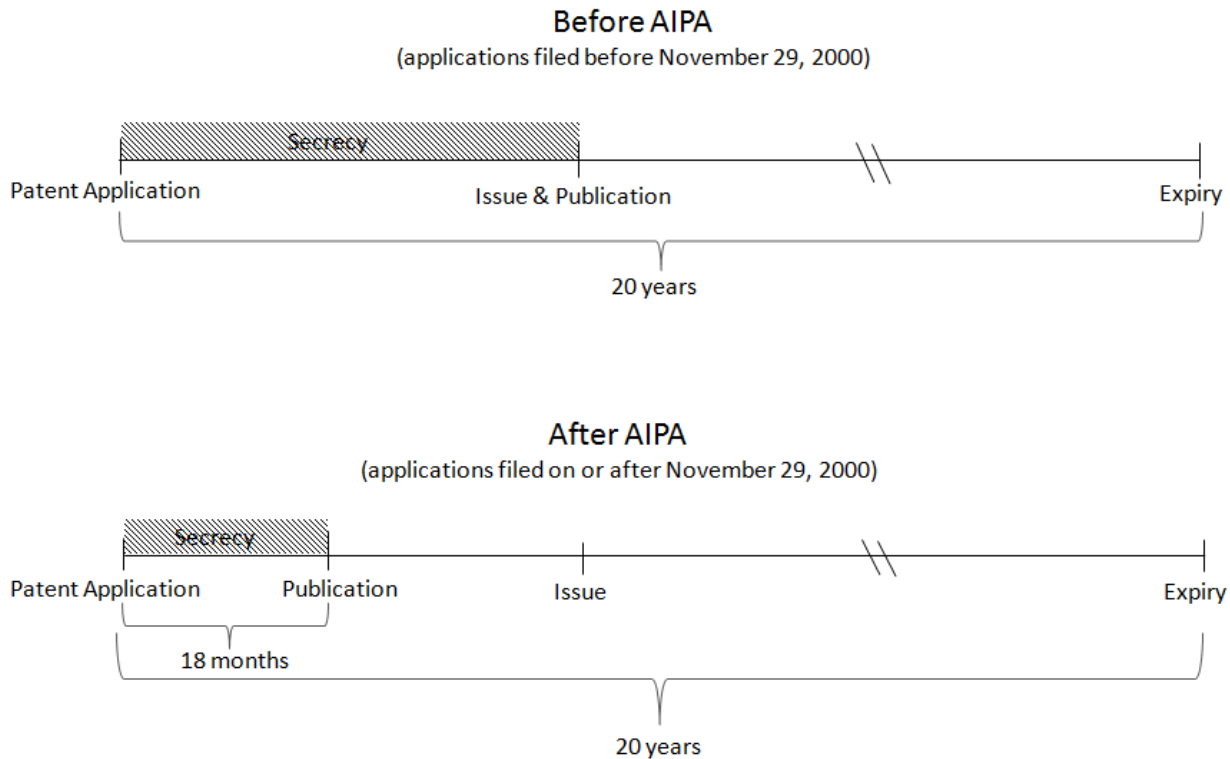
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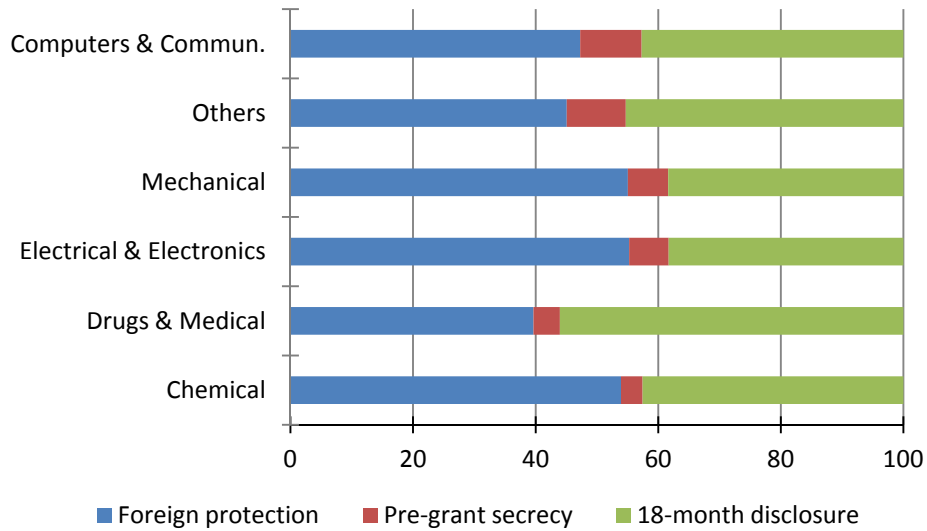
Figures and Tables

Figure 1: Patenting and disclosure before and after AIPA



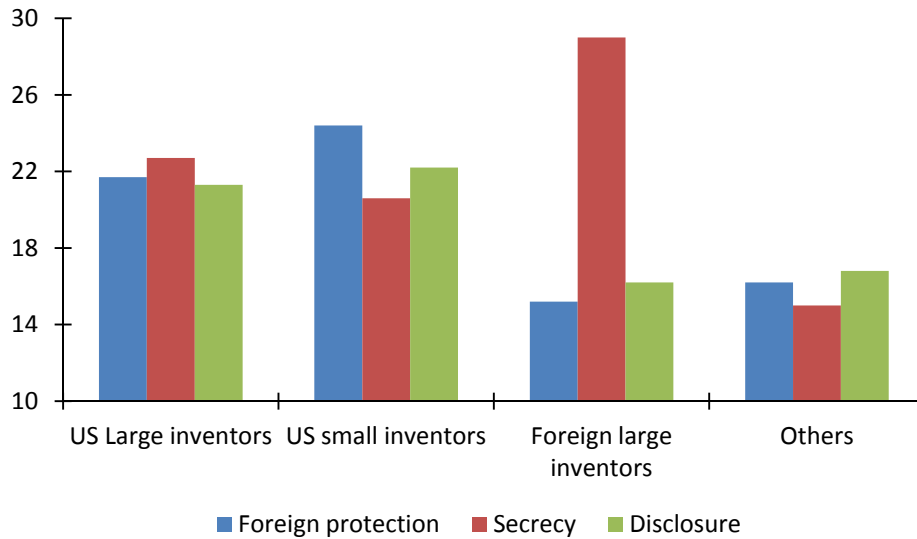
The figure compares major events associated with a U.S. patent application before and after AIPA came into force on November 29, 2000. Before AIPA, a U.S. patent application remained secret until issue, at which time the U.S. government published it. U.S. patent applications filed in 2000 took 34 months, on average, to issue and be published (patent applications in 2005, the last year in our study, took 39 months, on average, to issue). Before AIPA, pre-grant secrecy was not complete for U.S. applications because those applications with corresponding foreign applications were subject to 18-month disclosure under the laws of the foreign jurisdictions. Under AIPA, a U.S. patent application is published by the government 18 months after filing, unless the inventor requests secrecy by forgoing foreign patent protection for the invention, in which case the application is published after the patent issues. The term of all U.S. patents in this study (applications filed after 1995) is 20 years from application date.

Figure 2: U.S. patents and their disclosure choices post-AIPA, by technology field



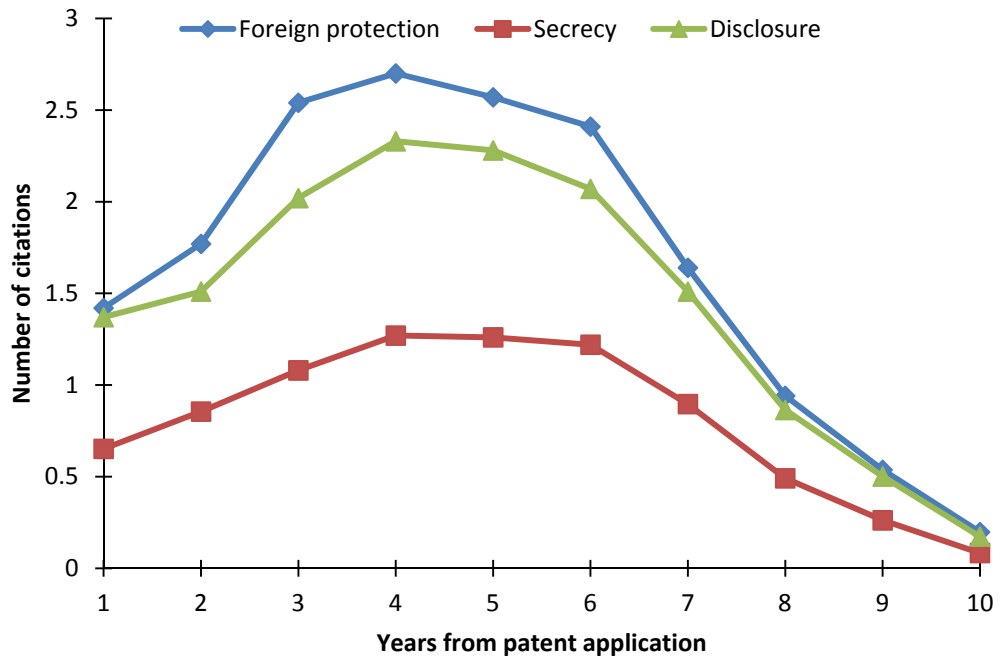
The figure shows the percentage of successful U.S. patent applications by their disclosure choices for applications filed from November 29, 2000 through the end of 2005 (and granted between November 29, 2000 and mid-2012) for the six broad technological fields. The three disclosure choices are: (i) to pursue foreign applications and disclose pre-grant (at 18 months from application date); (ii) to not pursue foreign applications and disclose at 18 months from application date; and (iii) to not pursue foreign applications and maintain pre-grant secrecy.

Figure 3: Average number of claims per patent by disclosure status and inventor type



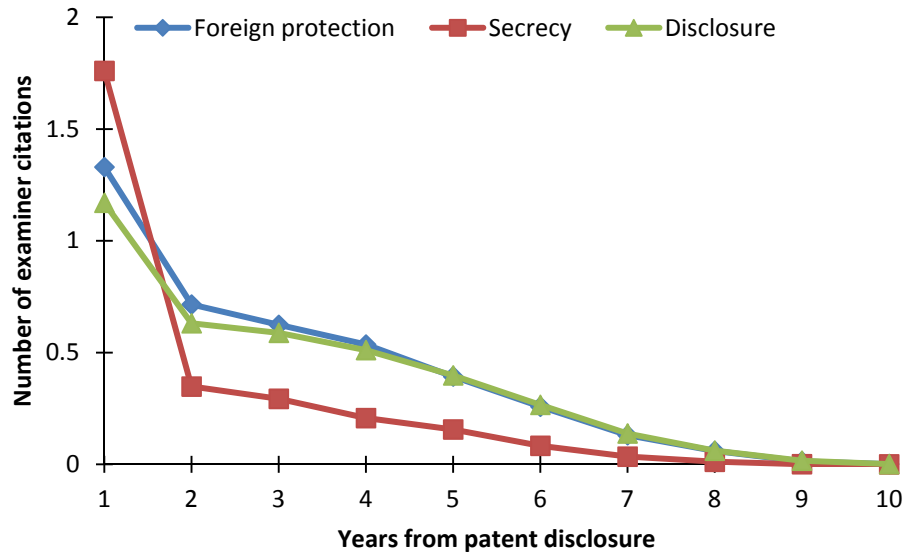
The figure shows the average number of claims per U.S. patent associated with the disclosure choices of different types of inventors. The three disclosure choices are: (i) to pursue foreign applications and disclose pre-grant (at 18 months from application date); (ii) to not pursue foreign applications but disclose pre-grant (at 18 months from application date); and (iii) to not pursue foreign applications and pre-grant secrecy. The last two options became available after AIPA became effective on November 29, 2000. The numbers in the graph are calculated from the 978,139 successful U.S. utility patent applications filed between November 29, 2000 (AIPA's effective date) and the end of 2005 (granted between 1995 and mid-2012).

Figure 4: Citations to small U.S. inventors' 2001 application year patents by disclosure status



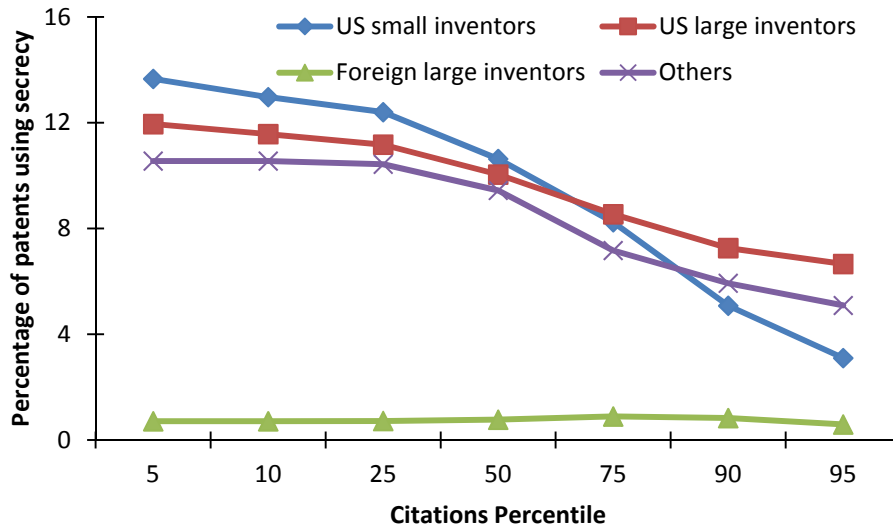
The figure shows the average number of citations received by the 19,608 patents belonging to small U.S. inventors each year after their filing in 2001.

Figure 5: Examiner-citations to small U.S. inventors' 2001 application year patents by disclosure status



The figure shows the average number of examiner-inserted citations received by the 19,608 successful patent applications filed in 2001 belonging to small U.S. inventors each year after their disclosure. For patents choosing pre-grant secrecy, disclosure is at issue (about 36 months, on average, for applications filed in 2001), and for patents choosing foreign protection or pre-grant disclosure, disclosure is at 18 months from application date.

Figure 6: Citations to small U.S. inventors' 2001 application year patents by disclosure status



The figure shows the percentage of patents filed in 2001 that opted for pre-grant secrecy by the various percentiles of citations received by the patents (in a ten-year window from 2001) for each of the four types of patent applicants in our dataset. Higher percentiles indicate patents receiving the higher number of citations and, therefore, of higher value.

Table 1: Disclosure choices of U.S. patent applicants, 1996-2005

Application year	Number of US applications	% pursuing foreign protection	% opting for disclosure	% kept secret
1996	144,796	52.0	0	48.0
1997	169,233	50.1	0	49.9
1998	167,695	52.3	0	47.7
1999	178,424	52.3	0	47.7
2000	190,877	51.6	4.1	44.3
2001	197,793	49.7	42.7	7.6
2002	197,778	49.8	42.1	8.2
2003	191,274	48.9	43.6	7.5
2004	188,581	49.8	43.1	7.1
2005	183,481	51.4	42.1	6.5

The table shows the number of successful U.S. patent applications filed between 1996 and 2005 (for which patents were granted between 1996 and mid-2012) and the percentage of applications by their disclosure choices. The three disclosure-related choices available to U.S. applicants after AIPA came into force (on November 29, 2000) are: (i) to pursue foreign applications and disclose at 18 months from application date; (ii) to not pursue foreign applications and disclose at 18 months from application date; and (iii) to not pursue foreign applications and maintain pre-grant secrecy. Before AIPA, U.S. applications pursuing parallel protection under foreign jurisdictions were subject to 18-month disclosure in the corresponding foreign nations, and those that did not pursue foreign protection were published on grant.

Table 2: Disclosure choices of different applicant types after AIPA, by technology field

	<i>Before AIPA</i>		<i>After AIPA</i>		
	Foreign protection	Pre-grant secrecy	Foreign protection	Pre-grant secrecy	18-month disclosure
<i>Chemical</i>					
US Large inventors	50.3	49.8	42.9	3.4	53.7
US small inventors	33.5	66.5	23.6	9.4	67.0
Foreign large inventors	74.7	25.3	75.3	0.2	24.6
Others	41.8	58.2	39.0	9.1	52.0
Total	57.2	42.8	53.9	3.5	42.6
<i>Computers and Communication</i>					
US Large inventors	34.6	65.4	28.5	16.6	55.0
US small inventors	30.5	69.5	19.0	17.1	64.0
Foreign large inventors	74.7	25.3	75.1	1.3	23.6
Others	35.0	65.0	34.7	12.2	53.1
Total	50.1	50.0	47.3	10.0	42.7
<i>Drugs and Medical instruments</i>					
US Large inventors	41.5	58.5	32.5	5.3	62.2
US small inventors	38.5	61.5	28.3	5.3	66.4
Foreign large inventors	71.8	28.2	63.5	0.4	36.1
Others	39.7	60.3	34.4	6.0	59.6
Total	47.4	52.6	39.6	4.3	56.1
<i>Electrical and Electronics</i>					
US Large inventors	37.5	62.5	33.6	12.2	54.2
US small inventors	28.1	71.9	20.4	15.1	64.4
Foreign large inventors	74.2	25.8	77.8	0.7	21.5
Others	38.1	61.9	36.7	10.8	52.5
Total	54.1	45.9	55.3	6.5	38.3
<i>Mechanical</i>					
US Large inventors	45.4	54.7	41.0	6.4	52.6
US small inventors	26.8	73.2	20.0	15.2	64.9
Foreign large inventors	80.9	19.1	81.6	0.3	18.2
Others	36.7	63.3	35.3	15.5	49.3
Total	55.6	44.4	55.1	6.6	38.4
<i>Other technologies</i>					
US Large inventors	46.7	53.3	43.4	4.6	52.0
US small inventors	24.0	76.0	19.5	15.4	65.1
Foreign large inventors	80.7	19.3	80.8	0.3	18.9
Others	30.1	70.0	29.5	18.4	52.2
Total	45.5	54.5	45.1	9.6	45.3

The table displays the percentage of each type of inventor's patents that opted for the different types of disclosure in each of the six broad technology fields, both before and after AIPA. Before-AIPA patents were filed between 1996 and November 29, 2000. After-AIPA patents were filed between November 29, 2000 and end-2005.

Table 3: Pendency lags for different applicant types after AIPA

<i>Application-Grant lag</i>	Foreign protection	Pre-grant secrecy	18-month disclosure
US Large inventors	43.2	47.2	46.2
US small inventors	45.8	42.1	46
Foreign large inventors	37.1	46.9	48.3
Others	37	32.8	40

The table displays the average time in months between the first application date and issue date of patents (pendency lag) for each type of inventor and disclosure choice. The pendency lags are calculated from the 978,139 successful U.S. utility patent applications filed between November 29, 2000 (AIPA's effective date) and end-2005.

Table 4: Patent renewal rates by disclosure choice and applicant type

	Foreign protection	Pre-grant secrecy	18-month disclosure
<i>3.5-year renewal rate</i>			
US Large inventors	0.92	0.96	0.90
US small inventors	0.91	0.85	0.86
Foreign large inventors	0.87	0.95	0.89
Others	0.81	0.70	0.78
<i>7.5-year renewal rate</i>			
US Large inventors	0.78	0.86	0.75
US small inventors	0.72	0.61	0.65
Foreign large inventors	0.68	0.86	0.73
Others	0.55	0.35	0.47

The table displays renewal rates for U.S. patents by disclosure choice and applicant type. 3.5-year renewal rates are based on the 828,195 patents filed after November 29, 2000 (AIPA's effective date) and granted by the end of 2007. 7.5-year renewal rates are based on the 290,198 patents filed after November 29, 2000 (AIPA's effective date) and granted by the end of 2004.

Table 5A: Relationship between disclosure choice and invention characteristics

Dependent variable = Disclosure Choice	Foreign Protection	18-month disclosure	Foreign Protection	18-month disclosure
US Small X Pendency Lag	0.01** [0.001]	0.01** [0.001]		
Pendency Lag	0.00* [0.000]	0.00* [0.000]		
US Small X Ln Claims			0.37** [0.035]	0.20** [0.031]
Ln Claims			-0.10** [0.015]	-0.14** [0.014]
US Small	-0.98** [0.052]	-0.40** [0.050]	-1.78** [0.108]	-0.69** [0.095]
Foreign Large	3.63** [0.045]	1.96** [0.046]	3.60** [0.046]	1.91** [0.046]
Other Inventors	-0.08** [0.024]	-0.05* [0.023]	-0.11** [0.024]	-0.10** [0.023]
Chemical	0.70** [0.043]	0.65** [0.042]	0.72** [0.043]	0.67** [0.042]
Computers & Communication	-0.68** [0.031]	-0.50** [0.030]	-0.62** [0.029]	-0.43** [0.028]
Drugs & Medical Devices	0.57** [0.043]	0.83** [0.041]	0.60** [0.042]	0.88** [0.041]
Electrical & Electronics	-0.31** [0.032]	-0.26** [0.031]	-0.29** [0.032]	-0.24** [0.031]
Mechanical	0.22** [0.035]	0.12** [0.034]	0.22** [0.035]	0.12** [0.034]
Constant	1.22	1.58	1.55	2.02
Model chi-square	45698.54		45798.96	
Log-likelihood	-156378.31		-156328.1	
Observations	197,793		197,793	

Table presents Maximum Likelihood Multinomial Logit estimates of inventors' choice among foreign protection, pre-grant secrecy, and 18-month disclosure (without foreign protection) as a function of inventor and invention attributes. The estimation sample consists of successful post-AIPA patent applications filed in 2001. Pre-grant secrecy is the omitted reference category or "base class." Large U.S. inventors and Others are omitted references categories for inventor type and technology-field category, respectively. Robust S.E. in brackets; ** p<0.01, * p<0.05, + p<0.1.

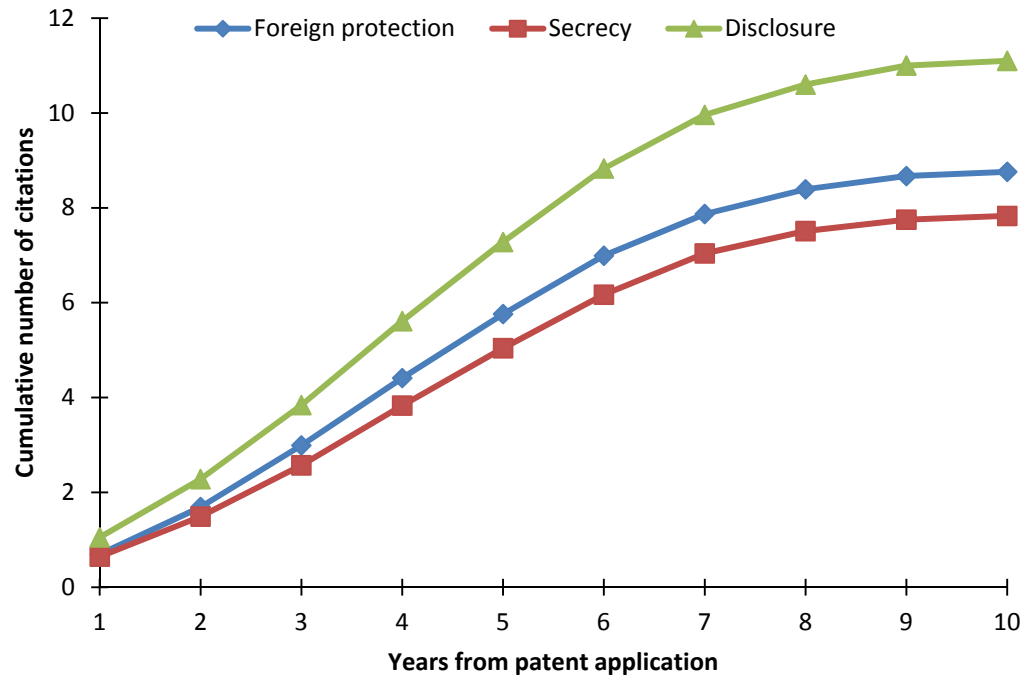
Table 5B: Relationship between disclosure choice and invention characteristics

Dependent variable = Disclosure Choice	Foreign Protection	18-month disclosure	Foreign Protection	18-month disclosure
US Small X 4-Yr Renewal	0.62** [0.085]	0.22** [0.071]		
4-Yr Renewal	-0.01 [0.033]	-0.09** [0.032]		
US Small X Ln Citations			0.24** [0.024]	0.10** [0.022]
Ln Citations			0.26** [0.010]	0.29** [0.010]
US Small	-1.25** [0.081]	-0.32** [0.067]	-1.18** [0.053]	-0.30** [0.046]
Foreign Large	3.67** [0.047]	1.98** [0.048]	3.72** [0.046]	2.06** [0.046]
Other Inventors	-0.09** [0.025]	-0.09** [0.024]	-0.01 [0.024]	0.03 [0.023]
Chemical	0.71** [0.043]	0.66** [0.042]	0.77** [0.043]	0.73** [0.042]
Computers & Communication	-0.59** [0.030]	-0.42** [0.029]	-0.77** [0.030]	-0.60** [0.029]
Drugs & Medical Devices	0.59** [0.043]	0.86** [0.041]	0.57** [0.042]	0.84** [0.041]
Electrical & Electronics	-0.30** [0.032]	-0.25** [0.031]	-0.38** [0.032]	-0.34** [0.031]
Mechanical	0.23** [0.036]	0.13** [0.035]	0.24** [0.036]	0.14** [0.035]
Constant	1.26	1.7	0.84	1.14
Model chi-square	44119.06		47049.45	
Log-likelihood	-150184.67		-155702.85	
Observations	190,986		197,793	

Table presents Maximum Likelihood Multinomial Logit estimates of inventors' choice among foreign protection, pre-grant secrecy, and 18-month disclosure (without foreign protection) as a function of inventor and invention attributes. Pre-grant secrecy is the omitted reference category or "base class." Large U.S. inventors and "Others" are omitted references categories for inventor type and technology-field category, respectively. The estimation sample consists of successful post-AIPA patent applications filed in 2001. For the model using 3.5-year renewal as an explanatory variable (Columns 3 and 4), we restrict the sample to patents granted by end-2007 since the first decision to renew patents is made 3.5 years after grant, and our renewal data is incomplete after end-2007. Robust S.E. in brackets; ** p<0.01, * p<0.05, + p<0.1.

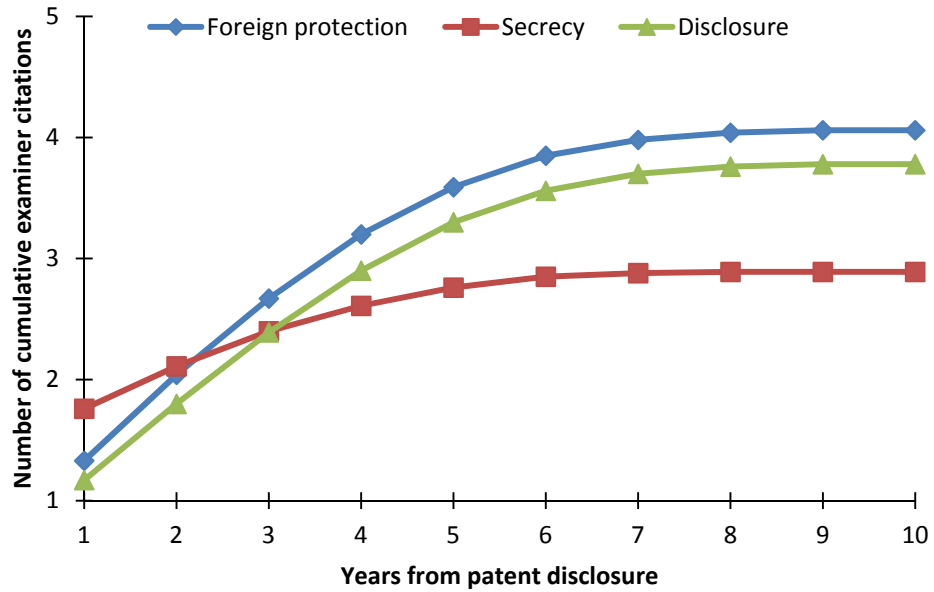
Supplementary Appendix

Figure A1: Cumulative citations to small U.S. 2001 application year patents by disclosure status



The figure shows the average cumulative number of citations received by the 19,608 patents belonging to small U.S. inventors each year after their filing in 2001.

Figure A2: Cumulative examiner citations to small U.S. inventors' 2001 application year patents by disclosure status



The figure shows the average cumulative number of examiner-inserted citations received by the 19,608 successful patent applications filed in 2001 belonging to small U.S. inventors each year after their disclosure. For patents choosing pre-grant secrecy, disclosure is at issue (about 36 months, on average, for applications filed in 2001), and for patents choosing foreign protection or pre-grant disclosure, disclosure is at 18 months from application date.