2000

Strategic Disclosure in the Patent System

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ABSTRACT

Patent applications are evaluated in light of the prior art. What this means is that patent examiners evaluate a claimed invention by comparing it with what in a rough sense corresponds to the set of ideas and inventions already known to the public. This is done for three reasons. First, the comparison helps to ensure that patents issue only in cases where an inventor has made a non-trivial contribution to the public's store of knowledge. Second, it protects a possible reliance interest on the part of the public since, once an invention is widely known, members of the public might reasonably assume that the invention is free for all to use. And third, it pressures inventors to file their patent applications promptly lest some other inventor disclose a related invention or the applicant himself inadvertently let slip some fraction of his own research result.

The prior art inquiry has a fourth policy implication, however, and while this one might not have been one of the motivating factors for establishing the inquiry in the first place, it is just as important when it comes to designing and interpreting sensible prior art rules. That additional wrinkle is simply this: the fact that patent applications are evaluated in light of the prior art gives firms a strategic incentive to create prior art. A firm can publish a journal article or engage in a public demonstration and in that way affect both a rival's ability to patent a related invention and the rival's incentive to do so. Perhaps surprisingly, this can make the disclosing firm better off even though, by revealing information, the firm is likely helping its rival and, worse, narrowing or even fully preempting the very patent it seeks.

In this Article, then, we explain the incentive for strategic disclosure. We show that a firm trailing in a given patent race has an incentive to disclose information in the hopes of preempting a rival's patent, but only if the laggard itself has little chance of leapfrogging the

leader and winning the race. We show that a firm leading a patent race similarly has an incentive to disclose, this time in an effort to reduce its rival's expected payoff and in that way encourage the rival to quit the race. We consider the possibility that private negotiations will displace public disclosures, for example with the laggard agreeing not to disclose and in exchange receiving from the ultimate patentee some form of favorable licensing agreement. Lastly, we consider the implications all this might have for the patent system overall.

INTRODUCTION

One purpose of the patent system is to encourage firms to disclose their inventions to the public. The patent system accomplishes this goal by requiring inventors to make meaningful disclosures as part of the patent process. Disclosure, in fact, is at the heart of the patent bargain: in exchange for a "full, clear, concise, and exact" disclosure that enables "any person skilled in the art" to practice the invention, the disclosing inventor is awarded a limited exclusive right to make, use, and sell the same.[1] In short, in order to earn patent protection, an inventor must teach the public how his invention works—and that, according to conventional wisdom, is how the patent system promotes disclosure.

As a recent article in the <u>Michigan Law Review</u> points out, however, the patent system encourages disclosure in more subtle ways as well.[2] In that piece, author Gideon Parchomovsky suggests that, because patent applications are evaluated in light of the prior art, a firm trailing in a given patent race has an incentive to disclose its research to the public. The incentive in this case is not the conventional lure of a possible patent monopoly; the incentive, instead, is the possibility that by disclosing information the laggard will create prior art that will in turn narrow or even fully preempt any patent application the leader might ultimately file.   This is attractive from the laggard's perspective, says Parchomovsky, since to whatever extent the strategy is successful, the laggard will

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[1] 35 U.S.C. § 112 (West 2000) (establishing enablement and best mode requirements). As the Supreme Court put it in Bonito Boats, Inc. v. Thunder Craft Boats, Inc., 489 U.S. 141, 150-51 (1989) (internal quotations and citations omitted):

> The applicant …who is willing to reveal to the public the substance of his discovery and the best mode . . . of carrying out his invention is granted the right to exclude others from making, using, or selling the invention throughout the United States for a period of [20] years. The federal patent system thus embodies a carefully crafted bargain . . . . [The inventor] may keep his invention secret and reap its fruits indefinitely. In consideration of its disclosure and the consequent benefit to the community, the patent is granted.

[2] Gideon Parchomovsky, Publish or Perish, 98 Mich. L. Rev. 926 (2000).

remain free to exploit its own research results instead of being limited by a patent possibly granted to the race leader.

Of course, disclosures of this sort are unlikely to occur in settings where the leader and laggard can bargain. As Parchomovsky himself notes,[3] in these situations the laggard would simply threaten to disclose, and then the leader and laggard would reach some sort of private agreement. For example, in exchange for a promise not to disclose, the laggard might demand from the leader a favorable licensing agreement with respect to the common invention. Such a bargain could be attractive to both sides since, unlike public disclosure, a private agreement in no way diminishes the patent's expected value. So, as long as the parties can agree on how to divide that extra surplus between them, both the laggard and the leader should prefer private negotiations over public revelations.

Does the possibility of private negotiation, then, fully undermine the disclosure benefit identified above? Parchomovsky thinks not, reasoning that in most cases leaders and laggards cannot effectively bargain. Leading firms, he writes, will typically

> be unable to ascertain which [disclosure] threats are real and which are not. A firm that agrees to pay off one competitor may find itself inundated with threats from others, all requiring the same treatment. Sifting out the real from the fake threats may often turn out to be impossible, and almost always too time-consuming. Thus, it will likely be in the patenting firm's best interest not to bargain at all, even if doing so runs the risk of being preempted.[4]

Parchomovsky ultimately draws an analogy to a classic paper by Kenneth Arrow[5] in which Arrow explained the need for patent protection by pointing out the difficulties involved in bargaining over unprotected information. Without disclosing that information, an inventor is unable to negotiate terms with a potential buyer; if the inventor discloses the information to the buyer, however, the inventor is left with nothing to sell. Parchomovsky sees a similar problem in the strategic disclosure context and therefore concludes that private negotiations will not take place.

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[3] Id. at 948.

[4] Id. at 949-50 (footnotes omitted).

[5] See id. at 949 n.68 (discussing Kenneth J. Arrow, Economic Welfare and the Allocation of Resources for Invention, in The Rate and Direction of Inventive Activity 609, 615 (1962)).

In this Article, we set out to expand, formalize, and also challenge the work Parchomovsky has begun. We start with the same basic intuition: the fact that patent applications are evaluated in light of the prior art gives firms a strategic incentive to disclose information to the public. From there, however, our work takes us in three different directions. First, with respect to strategic disclosure by laggards, our analysis of the relevant legal rules suggests that laggards will rarely be able to engage in this sort of spoiler strategy. The American patent system tends to favor the first inventor to conceive of a given invention. An inventor who is first to conceive but second to apply for the relevant patent, for example, still earns the patent under the American approach. This built-in preference for the first inventor makes it difficult for a trailing inventor to interfere with a leading inventor's patent application. In the same way the patent system would award the patent to the leader over the laggard, the patent system tends to protect the leader from the laggard's strategic disclosures. Moreover, once this factor is accounted for, the only opportunities for strategic disclosure that remain available to the laggard seem likely to be undesirable from even the laggard's perspective. This is true because the remaining opportunities tend to present themselves at times when the laggard still has a non-trivial chance of leapfrogging the leader and itself earning the patent. That possibility makes disclosure significantly less attractive to the laggard; in these settings, the patent the laggard preempts may very well have been its own.

Second, while we are not optimistic about laggard disclosures, we find (somewhat surprisingly) that a firm leading a given patent race might find it in its own interest to strategically disclose information prior to patenting. That is, even though disclosures by the leading firm might help laggards to narrow the gap, and even though disclosures by the leading firm might count as prior art against the leader's own ultimate patent application, race leaders can nevertheless benefit from strategic revelation. The intuition: while such disclosures hurt the leader, they also benefit him by driving laggards out of the race and in that way decreasing the chance that one of those laggards will leapfrog the leader and win the patent. Disclosures can drive laggards out of the race in two ways: they can so lessen the expected value of the patent that the laggards no longer have sufficient incentive to continue the race; and they can signal the leader's relative position vis-à-vis the laggards, sobering information that might not otherwise be available in the often secretive competitive research process.[6]

Third and finally, unlike Parchomovsky, we remain concerned that in certain cases private negotiations might displace the various types of strategic

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[6] Note that disclosure can benefit the leader even in cases where the laggard remains in the race but, because of the disclosure, chooses to pursue the patent less vigorously.

disclosure discussed above. Arrow's work does not seem to apply. Arrow was considering negotiations where, if no deal could be consummated, the parties hoped to maintain the secrecy of their information. Here, by contrast, if negotiations fail one party is typically willing to reveal its information publicly. Thus, if the laggard's threat is, say, that it is about to publish a scientific article disclosing relevant research information, then at the moment of negotiation the laggard need only place that article on the negotiating table. Should the deal fall through, the laggard has lost nothing; after all, the laggard was planning to make that information public anyway, and it still can even now. If, instead, an agreement can be arranged, the laggard can shred the document and share in the surplus created by the patent. This is not to say that bargaining is straightforward in this setting—there are still issues related to credibility, enforcement, and so on—but only to say that the issue is more complicated than it at first appears.

Our analysis proceeds as follows. Part II sets out the basic legal framework for the prior art inquiry as it applies to strategic disclosure by both laggards and leaders. Part III considers disclosure strategies that might be appealing to laggards, modeling the incentives these firms face, evaluating the possibility of private bargains, and highlighting the various benefits and harms from a societal perspective. Part IV does the same for disclosure strategies as they might appeal to leaders; and Part V concludes with some comments on directions for possible future work.

II. Prior Art in the Patent System

Prior art plays a complicated role in the patent system, largely because so many different types of disclosures, by so many different parties, and at so many different times in the inventive process, can all under appropriate circumstances affect patentability. Disclosures, for example, can come in the form of published journal articles, unpublished but publicly available doctoral dissertations, public demonstrations, and even certain offers of sale. They can originate with the applicant as well as unaffiliated third parties. And they can occur before or after the applicant invents its claimed invention, the disclosures being relevant to the prior art inquiry so long as they occur before the applicant files its patent application. The need to specify how all these factors interact gives rise to an intricate web of statutory provisions, patent office regulations, and court interpretations.

Many of these rules, of course, have little to do with strategic disclosure. For example, a traditional discussion of the prior art inquiry would start with section 102(a) of the Patent Act. That section in part establishes the so-called

novelty requirement,[7] denying patent protection in any case where the claimed invention "was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant."[8] Courts have interpreted this provision such that, today, patent applications are rejected for a lack of novelty if, at the time the applicant invented the claimed invention, there existed a single prior art reference that disclosed "each and every element" of the claimed invention[9] and did so in such a way as to enable a skilled practitioner to practice the invention without undue experimentation.[10] In other words, the novelty requirement preempts applications that claim inventions that literally were already known. This means that the novelty requirement does not matter much in the context of strategic disclosure. If one party actually has identified each and every element of a given invention and is able to disclose the invention in such detail that a skilled practitioner could practice the invention, that party typically will not disclose for the purposes of influencing another firm's ability to patent, but will instead itself seek the patent.[11]

The subsections that follow focus on the two aspects of the prior art inquiry that are most relevant to strategic disclosure. The first subsection considers the so-called "statutory bars" of section 102(b) of the Patent Act; the second examines section 103's nonobviousness requirement.[12]

A. Statutory Bars

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[7] A fuller discussion of the novelty requirement would consider other provisions as well, for example 35 U.S.C. § 102(e) (anticipation by previously filed patent application).

[8] 35 U.S.C. § 102(a) (West 2000).

[9] *See*, *e.g.*, Structural Rubber Prod. Co. v. Park Rubber Co., 749 F.2d 707, 709 (Fed. Cir. 1984) ("the defense of lack of novelty (i.e., 'anticipation') can only be established by a single prior art reference which discloses each and every element of the claimed invention").

[10] *See*, *e.g.*, Ciba-Geigy Corp. v. Alza Corp, 1995 U.S. App. Lexis 28214, 11 (Fed. Cir. 1995) (a reference is not anticipatory if "it would have required undue experimentation for one of ordinary skill in the art to have made the claimed invention based on the . . . reference").

[11] In certain cases, such a party might not desire patent protection and might therefore disclose as a way of stopping others from patenting. This might happen, for example, in cases where the inventor is unsure of the invention's commercial value and is therefore reluctant to incur the expense of applying for a patent. It might happen, too, in cases where the inventor believes that any patent application is likely to be rejected. The inventor might also prefer trade secret protection over patent protection, in this case not disclosing at all or perhaps disclosing just enough to thwart other firms' patent applications but beyond that keeping its research secret so as to qualify under trade secret law.

[12] For more general discussions of the prior art inquiry, *see* Adelman et al., Cases and Materials on Patent Law 203-566 (1998); Robert Merges, Patent Law and Policy 221-656 (2d. ed. 1997). For a narrower discussion of the prior art rules as they specifically apply to the possibility of laggard disclosures, *see* Rebecca Eisenberg, The Promise and Perils of Strategic Prior Art Creation Through Publication: A Response to Professor Parchomovsky, Mich. L. Rev. (forthcoming 2000) (draft available from author).

Whereas the novelty requirement mandates that a claimed invention literally add something new to the public's store of knowledge, the statutory bars pressure an inventor of something new to file his patent application promptly. The relevant provision is section 102(b):

> A person shall be entitled to a patent unless . . . the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States.[13]

Section 102(b) is one of the few provisions in the Act under which the first party to conceive a given invention can be harmed by the actions of a later inventor. Specifically, that later inventor can disclose information sometime between the first inventor's moment of conception and the first inventor's actual date of filing, and while that disclosure would not at all affect the invention's novelty under 102(a) (after all, the invention came first and so it was literally new at the time of invention), that disclosure could under 102(b) bar the first inventor from patenting. This is an important departure in patent law since the American approach generally favors the first to invent. Section 102(b) also creates one of the few scenarios under which a disclosure by the patent applicant himself can ultimately be found to restrict the applicant's own ability to patent. The policy rationale in both instances is that these rules encourage original inventors to file their patent applications as soon after conception as possible. This early filing ensures that other inventors do not needlessly invest resources reinventing an invention that has already been accomplished; that the public begins to learn from the inventor's accomplishment as soon as possible; that the clock promptly starts to run on the inventor's exclusive rights; and that the public does not learn of the invention by accident before it is patented and think, incorrectly, that the invention is free for all to use.

At first blush, all this might seem irrelevant to strategic disclosure since the language of the statutory bars, like the language of the novelty requirement, requires that "the invention" be disclosed, and it was argued above in the context of the novelty requirement that any party with enough information to actually disclose the invention may as well apply for the patent instead of attempting strategic disclosure. That argument does not render 102(b) irrelevant, however, and the reason derives from the priority the American patent system gives to the first inventor to conceive a given invention. Conception under the United States patent system is a mental step, described as the formation "in the mind of the inventor of a definite and permanent idea of the complete and operative invention,

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[13] 35 U.S.C. § 102(b) (West 2000).

as it is thereafter to be applied in practice."[14]   The date of conception is the date when the invention is "crystallized in all of its essential attributes and . . . so clearly defined in the mind of the inventor as to be capable of being converted to reality and reduced to practice by the inventor or by one skilled in the art."[15]   The actual building and testing of a physical embodiment, by contrast, is termed "reduction to practice,"[16] although if an inventor files a patent application that enables one skilled in the art to practice the invention, courts recognize that application as a "constructive" reduction to practice even if the applicant never physically reduced.[17]   Time might pass between conception and reduction to practice for any number of reasons, for example difficulties in the process of building the invention, a lack of resources, or uncertainty as to the commercial viability of the invention.

Many of the world's patent systems reward the first inventor to apply for a given patent, irrespective of whether that party actually conceived first.[18]   This is done mostly for administrative convenience, since having the critical date be the somewhat subjective date of conception introduces complexity and uncertainty into the patent system, complexity and uncertainty that would be avoided were the critical date instead the relatively easy to determine date of filing.   But the United States patent system is a first-to-invent regime; thus, if the first party to conceive can show evidence of an earlier conception date and of "reasonable diligence" from its rival's date of conception through until its own reduction to practice, that earlier inventor will be awarded the patent even over a rival who has both reduced first and applied for the patent first.[19]   This sets up the opportunity for strategic disclosure under section 102(b).   In certain cases, there will be an inventor who will have reduced the invention to practice and thus be capable of disclosing in appropriate detail "each and every element" of the claimed invention but who will not himself be able to use that information to patent the invention because of patent law's priority scheme.   This inventor—ahead in the development of the invention but behind in the official patent race—has the incentive and ability to trigger the 102(b) bar.

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[14] Coleman v. Dines, 754 F. 2d 353, 359 (Fed. Cir. 1985) (quoting Gunter v. Stream, 573 F. 2d 77, 80 (CCPA 1978)).

[15] Technitrol, Inc. v. United States, 440 F.2d 1363, 1369 (Ct. Cl. 1971).

[16] *See*, *e.g.*, UMC Elecs. Co. v. United States, 816 F. 2d 647, 652 (Fed. Cir. 1987) (definition of "reduction to practice").

[17] Constructive reduction to practice is discussed in Merges, *supra* note 12, at 425.

[18] *See generally*, Adelman et al., *supra* note 12, at 204-06.   There is a vast literature on the relative benefits of first-to-file versus first-to-invent regimes, as well as continued pressure in the United States to adopt the first-to-file approach.

[19] 32 U.S.C. § 102(g) (West 2000).

Strategic disclosure under 102(b) is, however, difficult to accomplish. Even if a laggard discloses the invention in full detail, section 102(b) gives the favored inventor one full year from the time of the disclosure to apply for the patent. Thus, in many cases, the disclosure will not preempt the patent application, but will instead spur, and perhaps help, the original inventor to file. This is not always true, however, because under modern interpretations an inventor can sometimes disclose in such a quiet way that the original inventor will not even be aware of the disclosure. For example, there is some authority to suggest that publishing a paper in a foreign language and then making that paper available in only a single foreign library nevertheless constitutes sufficient disclosure for section 102(b) purposes.[20] Similarly, at least one court has found that there can be a "public use" of an invention even if the invention is never removed from the laboratory where it was first developed, the wrinkle being that the laboratory itself must be "public" in the sense that uninvolved employees have access to the laboratory and are under no explicit duty of confidentiality.[21] To whatever extent these forms of "quiet" disclosure are sufficient to trigger section 102(b) bars, the provision can be an effective strategic tool for laggards.[22]

B. Nonobviousness

Section 103 establishes what is perhaps the most significant hurdle to patenting, the requirement that an invention not only be new, but also be a nonobvious advance over what was known before. The section specifically provides:

> A patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was

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[20] In re Hall, 781 F. 2d 897 (Fed. Cir. 1986).

[21] Baxter International v Cobe Laboratories, 88 F.3d 1054 (Fed. Cir 1996).

[22] A related form of "quiet" disclosure can be accomplished through the Statutory Invention Registration (SIR) procedure, codified at 35 U.S.C. § 157 (West 2000). That procedure allows an inventor to file with the PTO a document describing his invention and then use that document as prior art against any later patent application. This is a form of quiet disclosure since the SIR is effective as prior art as of the date that document is filed even if administrative delays or strategic play mean that the document is not made public until some time long thereafter. To be specific, the application is prior art under section 102(e) from the moment it is filed until the moment the SIR is published, and prior art under 102(b) from that point onward. The SIR is rarely used in practice today, most likely because under European law there is no equivalent to "secret" section 102(e) prior art, and so this form of quiet disclosure only has effect domestically. For further discussion of the strategic use of SIRs, *see* Eisenberg, *supra* note 12.

made to a person having ordinary skill in the art to which said subject matter pertains.[23]

Strategic disclosure is easier to accomplish under the nonobviousness requirement than it is under the statutory bars, mainly because the provision is applicable even if a disclosure does not capture "each and every element" of the claimed invention. An inventor, in other words, can use this provision to render a rival's invention obvious without actually having accomplished the invention himself. Indeed, the inventor can in theory affect patentability simply by adding one bit of information to the stockpile of information already available in the prior art. Phrased another way, whereas it is difficult for a firm to raise a statutory bar against its rival because statutory bars must be established by a single qualifying reference, a firm can more easily render a rival's patent application obvious since obviousness can be established by combining the firm's disclosure with the teachings of several other references. One caveat here is that there must exist in the prior art "some teaching, reason, suggestion, or motivation" to combine the references;[24] obviousness, in other words, is not an invitation to cobble information together the way a kidnapper might cut and paste newspaper letters to form a ransom note.

Two complexities limit strategic use of the nonobviousness requirement: the fact that, according to the statutory language at least, nonobviousness is judged "at the time the invention was made;" and the increased importance of certain objective factors that are today used to indirectly measure obviousness. These limitations are considered in turn below.

To run afoul of the nonobviousness requirement, the statute requires that an invention must have been obvious "at the time [it] was made."[25] Consistent with the language of section 102(a) and the patent system's rules with respect to conception and reduction to practice, this phrase would seem to require that, in order to render an invention obvious, a reference or group of references must have been in existence at the time the inventor conceived of his invention. However, at least since *Application of Foster*,[26] courts have interpreted this phrase more broadly. Today, obviousness is judged by examining the prior art as it existed at the moment of conception and, in addition, as it existed one year before the

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[23] 35 U.S.C. § 103 (West 2000).

[24] In re Oetiker, 977 F.2d 1443, 1447 (Fed. Cir. 1992) (Nies, J., concurring); accord Pro-Mold & Tool Co. v. Great Lakes Plastics, Inc., 75 F.3d 1568, 1573 (Fed. Cir. 1996).

[25] This is the text of section 103.

[26] Application of Foster, 343 F.2d 980 (C.C.P.A. 1965). For evidence that this same idea predates *Foster*, *see infra* note 28.

relevant patent application was filed.[27] This seems to depart from the language of section 103 and also seems to blur the distinction between section 102(b) and section 103, but the Federal Circuit has adopted this view and even goes so far as to label certain references "102(b)/103" prior art.[28]

All this is reflected in Patent Office Rule 131.[29] That rule allows an inventor to "swear behind," and thus eliminate for the purposes of section 103, a given prior art reference by showing that the inventor conceived the invention before the reference came into existence and worked diligently from the date the reference came into existence until either a subsequent reduction to practice or the inventor's actual filing of its patent application.[30] Implementing the *Foster* interpretation, however, the rule explicitly states that it does not apply to references dated "more than one year prior" to the date on which the patent application was filed.[31]

Where does that leave things? First, even if section 103 were interpreted so as to include only those prior art references that were in existence at the moment of conception, strategic use of the nonobviousness provision would still be possible. Conception, after all, is a technical concept, and so inventors can never be sure that their progress up to a given point—let alone the evidence thereof[32]—constitutes adequate "conception" for the purposes of establishing priority in the patent system. Inventors must therefore take into account the possibility that they have not yet legally conceived when they react to disclosures by other inventors. Also, conception takes place late in the inventive process, and thus much of the "patent

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[27] There are some exceptions to this broad statement, but none are relevant to strategic disclosure. For a more nuanced discussion, *see* Adelman et al., *supra* note 12, at 531-66.

[28] *See*, *e.g.*, LaBounty Mfg., Inc. v. United States, 958 F.2d 1066, 1071 n.3 (Fed.Cir.1992) (using phrase); Lough v. Brunswick Corp., 86 F.3d 1113, 1121 n.5 (Fed. Cir. 1996) (explaining 102(b)/103 relationship). The modern cases ultimately trace back to Dix-Seal Corp. v. New Haven Trap Rock Co., 236 F. Supp. 914 (D. Conn. 1964), where the court allowed a reference to trigger a section 102(b) bar even though the reference did not anticipate "each and every element" of the claimed invention. To require literal identity under 102(b), explained the court, would be to make the section a "paper defense" (id. at 919), too easily evaded by clever inventors. The modern approach accomplishes this same policy goal, albeit articulating the principle under section 103 as opposed to explaining it in the context of section 102(b).

[29] Codified at 37 C.F.R. § 1.131 (West 2000).

[30] In fact, the applicant need only show that, as of the date the prior art reference came into existence, the applicant had conceived of as much of the invention as the reference itself discloses. *See* In Re Stryker, 435 F.2d 1340 (C.C.P.A. 1971).

[31] 37 C.F.R. § 1.131(a)(1) (West 2000).

[32] On the difficulties and importance of corroboration, *see*, *e.g.*, Woodland Trust v. Flowertree Nursery, 148 F.3d 1368 (Fed. Cir. 1998).

race" is in fact a race to conceive. During this part of the race, obviousness is an issue and section 103 can be used strategically.[33]

Second, to whatever extent obviousness can be established by prior art that comes into existence after conception but a year or more before filing, the discussion from the preceding subsection applies: like prior art under 102(b), prior art of this sort gives the earlier inventor one full year from the time of disclosure to apply for the patent. This limits the strategic value of this sort of prior art, both because it does not take effect for an entire year, and because during that year the rival can use the disclosed information and in that way possibly progress more quickly toward the patent. Moreover, if the inventor cannot successfully file within one year of the disclosure, the inventor likely will have a strong argument that the invention was not, in fact, made obvious by that disclosure.[34]

Even where obviousness is open to strategic manipulation, disclosure can be a double-edged sword. The courts measure obviousness in part by turning to several "objective" or "secondary" factors,[35] some of which might interact with strategic disclosure to make an invention look less obvious, not more. For instance, one of the objective factors is whether other inventors have attempted to accomplish the same invention but failed.[36] The Federal Circuit has gone so far as to call this factor "virtually irrefutable" evidence of nonobviousness,[37] and even commentators critical of other objective factors have been largely supportive of

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[33] The uncertainty inherent in the concept of conception, and the fact that conception typically occurs late in the inventive process, are both illustrated by Gould v. Schawlow, 363 F.2d 908 (C.C.P.A. 1966), a case involving one of the inventors of basic laser technology. The inventor at issue kept detailed notes of his invention as he developed it, even going so far as to have each page dated and notarized. But when it came time to enforce his patent, the inventor was unable to establish a sufficiently early date of conception because his notebook, while describing the invention in great detail, neglected to make explicit the fact that one particular component was transparent. The court ruled that the notebooks, which inarguably described the invention to a significant degree, were nevertheless too ambiguous on this one point and therefore conception was deemed not to have occurred.

[34] One caveat here: as it was under section 102(b), under section 103 firms do have some ability to disclose quietly, making disclosures that are "public" in the eyes of the law but are so obscure that a rival is unlikely to detect them. Disclosures of this sort do not inform rivals, something that might be appealing to laggards (who disclose merely to block rival patent applications) but is likely unappealing to leaders (who typically want laggards to know of and react to any disclosures).

[35] A well-known and somewhat critical discussion of the objective factors is Edmund Kitch, Graham v. John Deere Co.: New Standards for Patents, 1966 Supreme Court Rev. 293.

[36] See, e.g., Dow Chem. Co. v. American Cyanamid Co., 816 F. 2d 617, 622 (1987) (that defendant "tried but failed" to develop patented invention is evidence of its nonobviousness).

[37] Panduit Corp. v. Dennison Mfg. Co., 774 F. 2d 1082, 1099 (Fed. Cir. 1985), vacated on other grounds, 475 U.S. 809 (1996).

using "failure of others" as an indicator of patentable invention.[38] In the context of strategic disclosure, a disclosure designed to make a later patent claim seem obvious might therefore backfire, itself providing evidence that another firm was competing to accomplish the same invention but had failed to do so at the time of the disclosure.

Other objective factors might limit the effectiveness of strategic disclosure as well. For instance, copying is often considered strong evidence of nonobviousness.[39] Combined with "failure of others," this creates a catch-22: if a firm discloses information in an attempt to make a rival's invention look obvious but then continues to struggle to achieve the invention, that activity might be interpreted as evidence of nonobviousness under "failure of others"; if, instead, the firm does not continue to work on the invention but simply waits and copies its rival's accomplishment, that too might be interpreted as evidence of nonobviousness, this time as copying. A firm's only safe strategy, in fact, is to stop pursuing the invention entirely—in many instances an unattractive alternative. In short, the objective factors make strategic disclosure for the purposes of rendering an invention obvious a somewhat difficult task.

The above analysis primarily focuses on 103 prior art as it might be used by a trailing inventor seeking to spoil a leading firm's patent application; but 103 also has features that affect a leading firm's ability to strategically disclose information. As was mentioned in the Introduction, a firm leading a patent race might want to disclose information (among other reasons) as a way of signaling to other firms that the leader is in fact so far ahead that the other firms may as well exit the race. Doing so can benefit the leader in a variety of ways; for example, it might decrease the danger that one of those trailing inventors will leapfrog the leader and win the patent. Section 103 makes this signaling less costly by, in certain situations, allowing a patent applicant to disclose information without that disclosure at all affecting the applicant's own ability to patent. The most prominent example here is the exception[40] recognized under 103/102(b)[41] for certain disclosures that are part of the inventor's experimental process. In *City of Elizabeth v. American*

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[38] *See*, e.g, Robert Merges, Economic Perspectives on Innovation: Patent Standards and Commercial Success, 76 Cal. L. Rev. 803 (1988).

[39] *See*, *e.g.*, Specialty Composites v. Cabot Corp., 845 F.2d 981 (Fed. Cir. 1988).

[40] There is some controversy in the case law over whether this should be thought of as an "exception" to the general rule with respect to public uses or a "negation" of what would otherwise be a public use. *See* Adelman et al., *supra* note 12, at 243-44.

[41] Technically, the experimental use exception is a 102(b) concept; but, since *Foster*, this 102(b) prior art is prior art for 103 purposes as well; hence the text discussion. Note that a leading firm is unlikely to use the experimental use exception under 102(b) directly; after all, a leader capable of doing so may as well go ahead and patent.

Nicholson Pavement Co.,[42] for instance, the inventor of a particular type of pavement made a public (and credible) display of his invention by allowing it to be tested on a major avenue in Boston for a period of six years. This use was deemed to not create prior art against the inventor's ultimate patent application, however, on the grounds that the use was designed to confirm the pavement's utility.[43] That was likely true, but the use had another important effect: it served to warn rival inventors of this inventor's accomplishment.[44]

Prior art rules are not always so forgiving of disclosures by the ultimate patent applicant; in certain cases, signaling will come at the cost of partial preemption. Suppose, for example, that an inventor develops a process for changing the properties of a certain type of metal, but that—while access to the changed metal is credible evidence that the inventor has developed the process— access to the changed metal in no way reveals how the process itself works.[45] Under current law, if the inventor sells or makes public use of the changed metal, that sale or use counts as 102(b)/103 prior art even though the innovative process is not thereby made public. The policy rationale is that an inventor should not be permitted to in essence "extend the period of his monopoly"[46] by profiting from the output of an innovative process while keeping the process itself secret.[47] This rule severely limits what would otherwise be an appealing method of signaling. After all, in these cases the output of the process effectively informs rivals of the inventor's accomplishment but does so without helping them to emulate it.

III. STRATEGIC DISCLOSURE BY LAGGARDS

The legal analysis presented in the preceding section now allows us to define more rigorously the incentives and opportunities faced by trailing firms. We do that here in three steps. First, we present a formal model. The purpose of the model is both to show that strategic disclosure can indeed benefit the laggard and to better isolate the factors relevant to the laggard's disclosure decision. Next, we integrate that understanding back into the richer legal analysis, arguing not only

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[42] 97 U.S. 126 (1877).

[43] Id. at 136.

[44] The Court's summary of the law makes clear that the experimental use exception can be used for signaling: "[i]t is not a public knowledge of [an] invention that precludes the inventor from obtaining a patent for it, but a public use or sale of it." Id. at 136.

[45] The fact pattern discussed in the text is a simplified version of the facts in Metallizing Engineering Co. v. Kenyon Bearing & Auto Parts Co., 153 F. 2d 516 (2d. Cir. 1946).

[46] Id. at 519.

[47] D.L. Auld Co. v. Chroma Graphics Corp., 714 F. 2d 1144, 1147 (Fed. Cir. 1983).

that strategic disclosure is difficult for laggards to accomplish under current legal rules, but also that, where strategic disclosure is possible, it likely will be undesirable from the laggard's own perspective. Recognizing that legal rules are subject to change, we consider in the third and final subsection whether strategic disclosure by trailing firms might be socially desirable. Critically important to this analysis, it turns out, is the question of whether trailing firms would actually engage in disclosure or whether they would, instead, simply threaten to disclose as a way of extracting from the leader a favorable licensing agreement or some other form of Coasean bribe.

A. A Game Theoretic Model of Laggard Disclosure

Denote as A and B two firms engaged in a patent race. Let x represent the expected value of the patent assuming no disclosures prior to patenting, and let αx represent the expected value of the patent if one of the firms uses disclosure to narrow or fully preempt the patent. Naturally, $\alpha \in [0,1]$. Throughout the patent race, each firm is unsure of its rival's progress, and thus the game is one of incomplete information. The patent race proceeds in three successive stages. There is an initial research stage; during this stage, a firm that chooses to invest c_{1i} (where $i \in \{A,B\}$) completes a certain amount of research with probability p_1. Then there is a disclosure stage where each firm simultaneously decides whether to disclose some fraction of the information it learned in the first stage. Finally, there is a second research stage where the firms can each invest c_{2i} and have some probability of earning the patent, with each firm's exact probability depending both on its rival's position and on the firm's own results from the first stage.[48]

This model focuses on disclosures by trailing firms, so in this game only a firm that attempts but fails to complete the first stage of research is given the option to disclose its (incomplete) results. Later in the Article, we present a parallel model where a firm that successfully completes the first stage of research has the option to disclose. Disclosure in this model has two effects: it reduces the expected value of the patent from x to αx; and it allows the laggard to compete with the leading firm in some subset market, specifically the market consisting of all products that are no longer eligible for patenting. Of course, if the laggard ends up being just one of many firms working in this subset market, that ability to compete will be of little worth. However, there is some chance that the laggard's

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[48] For a model similar to the one presented here, *see* Fudenburg et al., Preemption, Leapfrogging, and Competition in Patent Races, 22 European Economic Review 3 (1983). A more general overview of the patent race literature can be found in Jennifer F. Reinganum, The Timing of Innovation: Research, Development, and Diffusion, in 1 Handbook of Industrial Organization at Chapter 14 (Richard Schmalensee & Robert D. Willig, eds., 1989).

involvement in the research process will give it a special advantage in the subset market and thus it will earn above-market returns. Let v represent the expected value of those returns.

Payoffs, then, work as follows. After a laggard disclosure, the laggard is guaranteed a payoff of v from the subset market. In addition, if the laggard chooses to pursue the partially preempted patent and is successful in that attempt, it earns an additional payoff of αx. The leader similarly expects a payoff of v from the subset market after a laggard disclosure; and the leader also has a chance of earning αx from the partially preempted patent. Because the patent is more valuable intact than it is when partially preempted, we know that

$$x > 2v + \alpha x$$

or, rearranging the terms, that $v \in [0, \frac{1}{2}(1-\alpha)x]$.

Whether a firm wins the patent race depends upon its relative position vis-à-vis its rival. The rival's position, however, is private information. The likelihood, then, that a firm that invests c_{2i} in the final stage of the race receives the patent can be represented as follows:

$$\text{prob}\{\text{firm } i \text{ receives patent} \mid \text{invested } c_{2i}\} = \begin{cases} p_a \text{ if rival has not completed stage one and firm } i \text{ has} \\ p_s \text{ if both firms have completed stage one} \\ p_f \text{ if neither firm has completed stage one} \\ p_b \text{ if rival has completed stage one and firm } i \text{ has not} \end{cases}$$

where the subscript "a" indicates that firm i is a̲head, "b" indicates that firm i is b̲ehind, "s" indicates that both firms have s̲uccessfully completed stage one, and "f" indicates that both firms have f̲ailed to complete stage one. These probabilities are obviously related; specifically:

$$1 > p_a > p_s > p_f > p_b > 0.$$

Note that, even if its rival has not completed the first stage of research, a firm's probability of receiving the patent is not one. There is always some chance that the leading firm will fail to receive the patent either because (a) the leader gets leapfrogged by the rival firm or (b) the leader's research results at stage two do not qualify for patent protection. Moreover, even if both firms fail to successfully complete stage one, at the second research stage each still has a chance of earning the patent. That is, completion of the first research stage is not a necessary precondition for patenting. What completion of the first research stage does is

serve as a place marker; if firm *i* has completed stage one and its rival has not, firm *i* is ahead in the patent race.

In order to solve this game of incomplete information, we use the perfect Bayesian equilibrium solution concept.[49] That is, we assume that at each node where a player makes a decision, the player maximizes its expected payoff given the strategy choices and beliefs of all players. The beliefs of any given player are derived according to two rules: (1) whenever an information set is on the equilibrium path, the beliefs are based on the equilibrium strategies and the observed actions, with updates according to Bayes' rule; and (2) whenever an information set is off the equilibrium path, the beliefs constitute a probability distribution over all possible types.

Our purpose here, then, is to show that there exists a separating equilibrium, by which we mean a set of strategies for each firm from which neither can deviate (taking as given the actions and beliefs of its rival) and increase its payoff. An equilibrium is said to be separating if a player's observable actions perfectly reveal that player's private information. In our game, a separating equilibrium would have every firm that fails to complete stage one disclose; each firm would thus learn from its rival's disclosure decision whether or not the rival has successfully completed stage one. Other types of equilibria—for example, pooling equilibria and semi-separating equilibria—are also possible for this game; we focus here on separating equilibria, however, because a pooling equilibrium would identify only those cases where disclosure is not attractive to laggards, and a semi-separating equilibrium would identify only those cases where laggards are indifferent between disclosing and not disclosing. The separating equilibrium, then, highlights what are likely to be the most interesting and relevant cases.

As is the case with most games of incomplete information, however, in our game there is more than one separating equilibrium. Specifically, there are two separating equilibria where a firm always discloses upon failing to complete the first research stage. In one, the firm discloses and then stays in the patent race, hoping to leapfrog its rival and receive the now partially preempted patent. In the other, the firm discloses but then exits the patent race. To formally state and prove both of these equilibria would be somewhat redundant, thus we restrict our focus here to the first of the two. Both, of course, are related. As is made clear below, what turns out to be critical in each is the relationship between the probability of leapfrogging (p_b), the value of being to able to compete in the subset market (v),

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[49] *See* Drew Fudenberg & Jean Tirole, *Game Theory* (MIT Press 1991) at 325-26.

and the extent to which disclosure reduces patent value (α). With all that in mind, we now pose and prove the following proposition:

Proposition 1: There exists, for certain parameter configurations, a separating equilibrium where a firm that fails to complete stage one engages in strategic disclosure. In this equilibrium, each firm invests at the first research stage; a firm that fails to complete stage one discloses information; and both firms invest at the second research stage.

To prove that this is an equilibrium, we must show that neither firm can, given its beliefs and the equilibrium strategy of its rival, deviate from its equilibrium strategy and increase its payoff. [50] To do that, we begin at the final stage of the game, the second research stage.

At the second research stage, a firm that has neither successfully completed stage one nor observed disclosure by its rival knows that it is behind in the race. This is true because, according to the equilibrium strategies, any firm that fails to complete stage one will disclose.[51] Thus, a firm that fails to disclose must have successfully completed stage one. A firm behind in the race will nevertheless invest at the second research stage if the expected payoff from investing is greater than the expected payoff from not investing, or so long as:

(1) $p_b \alpha x > c_{2i}$.

The left-hand side of equation (1) represents the firm's expected benefit from investing at the second research stage given that it has disclosed (as per the equilibrium strategy) and is behind in the race. The right-hand side of equation (2) represents the cost of investing at the second research stage.

Recall that a firm trailing in the patent race has the smallest chance of receiving the patent. If equation (1) holds, it is optimal for this laggard to invest at the second research stage. Given that, then it must also be optimal for a firm in any other position in the race (e.g., ahead in the race or tied) to invest at the second research stage.

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[50] The equilibrium strategy for both firms is: invest at stage one, disclose upon a failure to complete stage one, and always invest at stage two.

[51] We will show later in the proof that it is indeed optimal for a firm that fails to complete stage one to disclose. But, as with most proofs in sequential games, we start with the final stage of the game and work our way backward.

Taking a step backward, we must now show that it is optimal for a firm that failed to complete stage one to disclose. The expected payoff from disclosure, taking as given the equilibrium strategy of the rival firm, is:

$$EP_{disclosure} = p_1(v + p_b \alpha x) + (1 - p_1)[v + p_f \alpha x] - c_{2i}.$$

This expected payoff consists of three terms. The first term is the payoff from competition in the subset market (v) plus the expected payoff, after there has been disclosure, from investing at stage two given that the firm is behind in the race. The firm's belief that it is behind in the race discounts this payoff.[52] The second term is the payoff from competition in the subset market (v) plus the expected payoff from investing at stage two, after there has been disclosure, and if neither firm has successfully completed stage one. The firm's belief that its rival also has failed to complete stage one discounts this payoff. The third and final term is the cost of investing in the second stage of research.

Similarly, the expected payoff from a failure to disclose, given the equilibrium strategy of the rival firm, is:

$$EP_{No\,Disclosure} = p_1(p_b x) + (1 - p_1)[v + p_f \alpha x] - c_{2i}.$$

Like the payoff to disclosure, the expected payoff from a failure to disclosure consists of three terms. The first term is the payoff if the firm ends up behind in the race and does not disclose. The firm's belief that it is behind in the race discounts this term. The second term is the payoff if both firms fail to complete stage one. In this case, according to the rival's equilibrium strategy, it will disclose. This results in a payoff to the non-disclosing firm of v (from competition in the subset market) plus the expected payoff from investing at stage two, given that there has been disclosure (hence the αx) and both firms have failed to complete the first stage (hence the p_f). The firm's belief that its rival has failed to complete stage one discounts this payoff. The third term again represents the costs associated with stage two research.

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[52] This belief is derived from the equilibrium strategy of the rival firm in accordance with the perfect Bayesian equilibrium concept. The equilibrium strategies specify that each firm chooses to invest at stage one. Thus, the chance that the rival firm has successfully completed stage one is p_1. At the time a firm makes its disclosure decision, it has not yet observed whether its rival has disclosed since these decisions are made simultaneously. Thus, at this point, any firm that failed stage one only has a probabilistic belief that its rival has successfully completed stage one. In short, no private information has been revealed before the firm makes its disclosure decision.

Comparing these two expected payoffs, we see that disclosure is optimal for a firm that fails to complete stage one so long as:

(2) $v > p_b(1-\alpha)x$.

This is an important equation for understanding strategic disclosure; but, before we discuss it, let us complete the final stage of the proof and show that, given the equilibrium strategies, it is optimal for a firm to invest in stage one in the first place. Investment at stage one is optimal so long as the expected payoff to investing is greater than the cost; in other words, so long as the following condition holds:

(3) $p_1 p_1 [p_s x] + p_1(1-p_1)[v + p_b \alpha x] + (1-p_1)p_1[v + p_a \alpha x]$
        $+ (1-p_1)(1-p_1)[v + p_f \alpha x] - c_{2i} > c_{1i}$.

Although somewhat inelegant, equation (3) is easy to understand. It simply states that the sum of the expected payoffs given the four possible states of the world—both firms complete stage one; the firm in question fails to complete stage one whereas its rival succeeds; the firm in question succeeds whereas its rival fails; and neither firm completes stage one—minus the costs of investing in stage two add up to something more than the costs of entering the patent race in the first place. If equation (3) holds then firms will enter the race; and if equations (1) and (2) also hold, then firms in the race cannot increase their expected payoffs by deviating from the equilibrium strategy of disclosing if they fail the first stage and, no matter what, investing in stage two. Under these conditions, the strategies specified in proposition 1 constitute a perfect Bayesian equilibrium.

Now, what does all this mean for our overall understanding of strategic disclosure by laggards? Equations (1)-(3) are the conditions that must be satisfied for disclosure to be optimal in the current equilibrium. Equation (3) is messy but trivial; again, all that it requires is that the firms find it attractive to invest at the outset given the costs of stage one research. Equation (1) can also be set aside. That equation stipulates that a laggard finds it worthwhile to continue the patent race even after disclosing—a condition that must hold in the particular equilibrium we chose to examine, but a condition that, if violated, would simply send us to the other equilibrium articulated in the discussion just before proposition 1.

The real insight of the model, then, comes from equation (2). That equation makes clear that, ultimately, it is the relationship between v, αx, and p_b that determines whether strategic disclosure will be in the laggard's interest. The greater the chance that the laggard can leapfrog the leader and himself earn the

patent (that is, the larger p_b), the less likely it is that strategic disclosure will be attractive to the laggard. Indeed, in the extreme case, if the chance of leapfrogging exceeds fifty percent the condition can never be satisfied—intuitively because in that case the laggard is not a laggard in any meaningful sense.[53] All else held constant,[54] smaller values for v lower the critical leapfrog probability, so as the guaranteed payoff from the subset market diminishes, the attraction of strategic disclosure lessens, exactly as intuition would suggest. Similarly, all else held constant, higher values for αx make strategic disclosure more attractive, this time because the higher values mean that disclosure does not cost the laggard much in terms of destroyed patent value.

B. The Incentive and Opportunity for Strategic Disclosure by Laggards

At the start of the Article, we made the intuitive point that a firm trailing in a given patent race might disclose information in the hopes of narrowing or even fully preempting a rival's patent application. As we argued then and the above model now makes more precise, the allure to the laggard is that, to whatever extent the strategy is successful, the laggard will be free to make use of any research results it had in common with its rival, competing in some subset market based on the products and services now no longer eligible for patenting. The main cost to the laggard is that its disclosures will undermine its own ability to patent just as the disclosures undermine its rival's ability to do so, although there is probably a secondary cost associated with the fact that the laggard's disclosures will in some cases help other firms, including the rival, pursue related projects. To weigh these competing effects in the context of the law introduced in Part II, this section begins by considering separately two types of laggards: the conventional laggard who is a laggard only because it trails its rival in terms of their relative research accomplishments but who can, in theory, leapfrog the rival and earn the patent itself; and the legal laggard, who may or may not trail in a literal sense but who cannot patent because a rival has legal priority thanks to an earlier date of conception and appropriate diligence.[55]

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[53] The condition cannot be satisfied in this instance because, as we explained at the start, $v \in [0, \frac{1}{2}(1-\alpha)x]$.

[54] Of course, α and v are at least loosely related, since the larger the subset market carved out by a given disclosure, the larger the payoff from working in that market (v) and the smaller the residual patent value (αx).

[55] The firm must show diligence from the moment its rival conceived through to either the time of its own reduction to practice or the filing of its own patent application. 35 U.S.C. § 102(g) (West 2000).

The conventional laggard is conducting research at a time when neither it nor its rivals have conceived. This firm thus has the broadest options when it comes to strategic disclosure. It can raise a statutory bar under section 102(b) if one of its disclosures turns out to describe identically the leader's invention. It can also render the invention obvious under even a literal interpretation of section 103, at least so long as the objective factors do not cut the other way. While the spoiler strategy is thus legally permissible in this setting, the model presented in the previous section raises serious doubt as to whether disclosure would ever actually be attractive to a conventional laggard. After all, the gains to the laggard are modest at best: by blocking the patent, the laggard—as well as any other firm—is free to compete in the subset market consisting of all products no longer eligible for patenting. True, the laggard might be in an especially good position to capitalize on this opportunity, having actually engaged in research related to this market; but the laggard's lack of intellectual property rights, combined with the public disclosures that are part of the strategy,[56] would seem to invite competition and thus severely limit the value of this opportunity for the laggard. The upside to strategic disclosure, then, is limited in this setting; but the downside to strategic disclosure might be significant. After all, the conventional laggard has not yet lost the patent race. There is still at this point a chance that the laggard will leapfrog the leader, be first to conceive, and himself earn the patent. Even if this were only a small chance, from an ex ante perspective it seems likely that a small chance at a big payoff would be worth more to the laggard than a guaranteed opportunity for a small to modest payoff—an intuition that equation (2) confirms.

The legal laggard, by contrast, is in a significantly different position from the conventional laggard since, for the legal laggard, there is little downside to disclosure. By definition, the legal laggard cannot patent the common invention because its rival has priority. Thus, even if the legal laggard were to leapfrog its rival and reduce the invention to practice first, it would have no chance of earning intellectual property rights. Disclosure, then, can be attractive to the legal laggard. The upside is again the ability to compete in some subset market, and the downside is only that any disclosure might help other firms, including the rival, understand the common invention.

For the legal laggard, however, strategic disclosure is almost impossible to accomplish. Because its rival has already conceived, Rule 131 applies and in essence gives the leading firm one full year from the time of a laggard disclosure

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[56] We intentionally assume here that there will be public disclosure instead of private bargaining. This is the correct assumption because we are trying to determine whether a laggard's disclosure threat is consistent with the laggard's own interests. If it is, that credible threat might indeed lead to private negotiations instead of public disclosures—a possibility we turn to in due course, *infra* Section III.c.

before section 103 kicks in. Section 102(b) also gives the rival a full year to file, so strategic disclosure for the legal laggard unavoidably involves a one year delay. During that year, the earlier inventor is free to file its patent application and claim exclusive rights to the disclosed invention, fully thwarting the laggard's strategy. Worse, it is possible that the laggard's disclosure will help the leader complete that application, and, as was explained above, because of the objective factors the laggard's disclosure might in certain cases itself be treated as evidence that the leader's accomplishment was, in fact, nonobvious.

The distinction between the conventional laggard and the legal laggard should not be taken too literally, of course. In practice, uncertainty likely means that laggards recognize that there is some chance that they are legal laggards and some chance that they are conventional laggards. The firms surely adjust their strategies accordingly. Similarly, because conception is such a subjective legal concept, leading firms can never be sure that they have conceived. Thus, they, too, will react to disclosures by taking into account both possibilities. All of the costs, benefits, and legal limitations discussed above, then, are likely factored in each time a laggard considers employing the spoiler strategy and each time a leader then reacts to that disclosure.

C. Policy Implications and Private Bargaining

While strategic disclosure by laggards is thus overall somewhat unlikely to occur under current legal rules, changes in the prior art inquiry could make the strategy both more workable and more attractive to laggards. In this final subsection, we conclude our analysis of the strategy by asking whether such changes deserve consideration; that is, we ask whether a patent system that gave trailing firms more opportunities for strategic disclosure might better serve patent system goals than the current, less tolerant regime.

From a societal perspective, the main benefit to the spoiler strategy is the obvious one, namely that it furthers one of the patent system's basic goals, encouraging firms to disclose their inventive accomplishments to the public. Traditionally, the patent system has accomplished this goal through the lure of patent protection: in exchange for a sufficiently informative disclosure, inventors are given a limited legal monopoly over their disclosed inventions. But monopoly is an expensive way to promote disclosure. Monopolists, after all, maximize their own welfare by restricting the use of their invention and selling rights to make, use, and sell the invention at prices in excess of marginal cost. This is why strategic disclosure might be attractive from a societal perspective. Unlike disclosures purchased at the cost of monopoly, the disclosures that come as part of strategic disclosure immediately place the relevant ideas into the public domain,

free for all to use and free for all to further develop. These disclosures also occur much earlier in the inventive process than do typical patent system disclosures. Those disclosures await not only the filing of a patent application but also the actual approval of that application and the issuance of the related patent. While an amendment to the Patent Act slated to take effect in November of 2000 will accelerate this process by making patent applications public eighteen months after their filing regardless of the status of the underlying patents,[57] strategic disclosure still in most cases represents an opportunity for significantly accelerated disclosure. True, the disclosures made under the spoiler strategy might be slightly less complete than the disclosures that would have taken place as part of the normal patent process; but they cannot be too incomplete. If they were, they would not preempt under sections 102(b) or 103.

All this suggests that strategic disclosure by laggards *might* be attractive from a societal perspective. To know for sure, two other issues have to be addressed. First, the patent system is today a winner-take-all incentive system in which the firm that wins the patent race is awarded a patent and even a close second-place finisher earns no reward whatsoever from the patent system.[58] Strategic disclosure would reshape this structure a bit, changing incentives by increasing the expected payoff to laggards (who would now have the option of using strategic disclosure to earn profits in the subset market) and decreasing the expected payoff to ultimate patentees (who would now have to account for the possibility that their patents would be partially preempted). Whether these shifts are desirable, harmful, or even significant is hard to know. On the one hand, winner-take-all regimes typically induce excessive entry,[59] and, in the patent system in particular, they also seem to encourage firms to select research paths that are more risky than is socially desirable since, for the firms, "what matters is to be first, not how far behind one finishes in the patent race."[60] On the other hand, the

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[57] The change will be reflected in 35 U.S.C. § 122, effective November 29, 2000, as per Act of Nov. 29, 1999, P.L. 106-113, Div B, 1000(a)(9), 113 Stat. 1536 (enacting into law 4502(a) of Subtitle E of Title IV of S. 1948 (113 Stat. 1501A-561)).

[58] Second-place finishers of course do not leave the race empty-handed; they surely enjoy some educational benefits from the process of competing, they have the possibility of pursuing spin-off research, and so on. Nevertheless, for a criticism of the winner-take-all nature of the patent system, *see* Douglas Lichtman, The Economics of Innovation: Protecting Unpatentable Goods, 81 Minnesota L. Rev. 693, 717 n.67 (1997).

[59] This point was first made in Sherwin Rosen, The Economics of Superstars, 71 Am. Econ. Rev. 845 (1981). A more accessible discussion can be found in Robert H. Frank & Philip J. Cook, The Winner-Take-All Society 9, 102-26 (1995).

[60] Jean Tirole, THE THEORY OF INDUSTRIAL ORGANIZATION 396 (1989). For a fuller articulation of the somewhat controversial claim that the patent system might cause firms to choose excessively risky research paths, *see* P. Dasgupta & J. Stiglitz, *Uncertainty, Industrial Structure, and the Speed of R&D*, 11 BELL J. OF ECON. 1 (1980).

patent system is self-consciously designed as a winner-take-all regime, and so—without a richer theory of how the patent system works, something far beyond the scope of this project—we cannot be sure whether the shift in the incentive structure weighs in favor or against strategic disclosure.

Second, and more relevant to the current Article, if the only clear societal benefit from strategic disclosure is that it brings research into the public domain earlier than the patent system otherwise would, an important question in the normative analysis is to ask whether the incentive to engage in strategic disclosure would actually lead to public disclosure or whether, instead, the incentive would simply form the backdrop for private negotiations between laggards and leaders. As we explained in the Introduction, such private negotiations might be appealing to the parties since public disclosure destroys patent value, value that the parties could share if they were to resolve their differences privately.[61] Private negotiations would, however, eliminate much of the allure of strategic disclosure from a policy standpoint. Indeed, where private negotiations displace public disclosures, the spoiler strategy would not only fail to deliver on the promise of accelerated public disclosures, it would also likely delay disclosure since, with the laggard and leader in essence colluding, the pace of the patent race would surely be diminished.

In theory, private negotiations between leaders and laggards are possible. For example, if a laggard were planning to publish a journal article and in that way preempt a rival's patent, the laggard could first bring a copy of that article to its rival's attention and offer to commit by contract not to disclose that information in exchange for, say, a favorable licensing agreement on the related technology. One might object that, in certain settings at least, the laggard would have trouble identifying its rival; but that is surely a manageable problem since, in the worst case, the laggard can always publicly reveal some tiny fraction of its research and thereby attract the leader's attention. One might further object that Arrow's oft-cited concern about the difficulty of negotiating over unprotected information would derail any negotiation attempt. Arrow's concern was that, without disclosing its research information, an inventor is unable to negotiate terms with a potential buyer; but, if the inventor discloses its research information to the buyer, the inventor is left with nothing to sell. As was pointed out in the Introduction,

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[61] We say that private negotiations *might* be appealing, as opposed to being confident that they will be appealing, because in cases where new firms can still enter the patent race, the current leader might prefer public disclosure. The reason is that private bargains increase the expected payoff to race participants. That extra payoff might attract entry, and those entrants might ultimately either leapfrog the current leader or themselves demand bribes. Knowing this, the leader might be better off simply allowing laggards to disclose. (The effect is difficult to predict without further modeling since entry has other effects as well, for example it likely decreases v, the expected payoff in the subset market.)

however, Arrow's concern does not apply in this setting. The laggard loses nothing by showing its rival the article; the laggard is prepared to reveal that information anyway if the negotiation falls through.[62]

Several limitations make negotiations like these unlikely, however. For one thing, standard impediments to bargaining—for example, private information, bilateral monopoly, and free-rider problems—all can interfere with negotiations of the sort described above. That is, the parties might have trouble negotiating a deal because they disagree on the effects any given publication might have or on the commercial value of the disputed patent.[63] Even if they agree on the size of the surplus, they might have trouble agreeing on how to split it, with each firm holding out for a larger share.[64] And, in cases where there are more than two firms involved in the patent race, some firms might be less than forthcoming in the bargaining process, hoping to free-ride on other firms' efforts.[65] All of these standard problems are exacerbated in this setting due to the extreme time pressure laggards would feel during any negotiations. Delay, after all, gives the laggard's rivals time to advance their research, possibly far enough to file for the patent and in that way nullify the laggard's threat.

Moreover, for negotiations like this to work, the laggard would have to develop a mechanism by which it could credibly commit to go ahead and disclose its research should the negotiations fail. That is, just because a laggard has research information that might preempt a rival's patent application, and even if the laggard is able to prove the existence of that information (for example, by bringing to the negotiating table a copy of some ready-to-publish research article), the laggard still has to show that publicly disclosing the information is consistent with the laggard's own interests. Phrased another way, the leader needs assurances that this is indeed a laggard who has such a small chance of leapfrogging that it is willing to destroy patent value in order to guarantee itself the ability to compete in the subset market, rather than an opportunistic laggard who would not actually go ahead with public disclosure were that its only option.

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[62] Although, to whatever extent the laggard has the option of triggering a 102(b) or 102(e) bar by "quietly" disclosing research information (*see supra* notes 20-22 and accompanying text), Arrow's dilemma is to some degree reintroduced.

[63] *See* Fudenberg & Tirole, *supra* note 49, at 243-318 (games of private information).

[64] *See* Tirole, *supra* note 60, at 21-25 (bilateral monopoly); Robert D. Cooter, The Cost of Coase, 11 J. Legal Stud. 1, 23 (1982) (breakdowns in negotiation).

[65] *See* Andreu Mas-colell et al., Microeconomic Theory 359-64 (1995) (free-rider problem). Note, too, that in multi-firm settings transaction costs might also become a more significant problem. A single public disclosure has the same cost no matter how many parties are affected; the transaction costs for private negotiations, by contrast, grow with the number of parties involved.

Lastly, in various ways the legal system limits the viability of private negotiations of the sort considered here. There is the obvious concern that these agreements among rivals might in certain factual settings either violate antitrust law or constitute patent misuse, especially in cases where the patent will ultimately give the patentee significant market power.[66] More interestingly, however, the prior art rules themselves might make private negotiations precarious. Specifically, private negotiations might raise prior art concerns under section 102(b)'s "on sale" bar. A laggard engaged in one of these private negotiations is in essence offering to sell its rights and interests in an invention. True, under conventional interpretations, the on-sale bar does not apply to transactions concerning patent rights, but only to transactions concerning products (that is, embodiments of patent rights.) However, there is little case law support for this distinction;[67] and, if the policy behind the on-sale bar is to prohibit early commercialization, it would seem that payments from leader to laggard should trigger the bar—especially given that, in the cases under consideration here, the laggard has reduced the invention to practice and is playing a laggard strategy only because its rival has legal priority in the American first-to-invent scheme.[68]

IV. STRATEGIC DISCLOSURE BY LEADERS

The previous section focused on disclosure strategies as they might be used by trailing firms; this section turns its attention to leaders. Because the incentives here are perhaps less intuitive than they were in the laggard case, we begin this section with a discussion of why leaders might disclose, including two simple numeric examples to help explain the concept. Then we present a formal model that both generalizes our numeric examples and isolates more clearly the factors critical to a leading firm's decision. Third and finally, we consider whether strategic disclosure by leaders furthers patent system goals and, in the course of that discussion, again confront the possibility of private negotiations.

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[66] It might turn out that patent misuse is inapplicable here because the negotiations are taking place before any patent issues. However, patent misuse is an equitable doctrine, and thus courts might find that negotiations in anticipation of a patent are sufficiently linked to that patent so as to make misuse analysis appropriate. This would certainly be the case where the negotiations result in the laggard being given a license to use what later becomes the patented technology. For discussion, *see* Merges, *supra* note 12, at 1151-52 (differential royalties as possible patent misuse).

[67] *See* Merges, *supra* note 12, at 312 (discussing *Moleculon* case); Adelman *et al.*, *supra* note 12, at 248 (same). *Cf. Ferag AG v. Quipp, Inc.*, 45 F.3d 1562 (Fed. Cir.), *cert denied*, 116 S.Ct. 71 (1995) (on sale bar implicated when one firm sold on-going research to independent second firm).

[68] Prior art rules might interfere with private negotiations in another way as well: the very act of sharing secret research information with a rival—even as part of a negotiation—might be deemed to be a "public use" under section 102(b). *Cf., e.g., Baxter, supra* note 21. This concern could be mitigated, however, through the use of confidentiality agreements, hence we relegate the issue to this footnote.

A. Two Simple Examples

A firm that is "leading" a patent race in the sense of having already conceived the invention at issue has no reason to engage in strategic disclosure. Having conceived, such a firm need not worry about trailing researchers; the patent system accords priority to the first party to conceive an invention even if another party is first to reduce it to practice or first to apply for a patent. Thus, to whatever extent a leader is confident that it has conceived, the leader should focus not on strategic disclosure, but instead on pursuing its research with appropriate diligence.[69]

For a firm that is ahead in its research but has not yet conceived, however, strategic disclosure might be attractive. Disclosure can drive laggards from the race in either of two ways: it can so lessen the expected value of the patent that the laggards no longer have sufficient incentive to continue the race; or it can signal to the laggards exactly how far behind they really are, which is sobering information that might not otherwise be available in the often secretive competitive research process. Driving laggards from the race—or, in less extreme cases, reducing laggards' incentives to pursue the patent vigorously—benefits the leader by decreasing the danger that one of the laggards will leapfrog the leader and claim the patent. It also benefits the leader by allowing the firm to slow its research to a more efficient pace, the exact speed determined more by the relative costs and benefits of bringing the invention to market sooner, and less by the fear of losing the patent race. Disclosure has its costs, however: disclosures might inadvertently help trailing firms gain ground on the leader, and disclosures might also limit the scope of any patent the leader might ultimately obtain.[70]

Two numeric examples help clarify this dynamic.[71] First, suppose that two inventors each face a cost of thirty-five to continue a given patent race, but that one inventor (the leader) has a sixty percent chance of being first to conceive while the other inventor (the laggard) has only a forty percent chance of being first.

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[69] *See supra* note 55 (discussing diligence). One qualification here is that there is always some risk that a court will disagree with the firm regarding its evidence with respect to conception, diligence, or both; to whatever extent that is true, these firms should continue to consider the possibility of strategic disclosure.

[70] Parchomovsky for the most part does not consider the possibility of strategic disclosure by leaders in his article, cited *supra* note 2. His only reference to the concept comes in his Part IV, where he argues that a leader might disclose information so as to somehow preempt laggard disclosures. That argument is in error; if a leader were to disclose information in the way Parchomovsky suggests in his piece, those disclosures would not preempt laggard disclosures, they would instead simply start the clock on a one-year section 102(b) bar.

[71] Note that these are just toy examples, the numbers specifically chosen so as to make clear the intuitions. Different numbers can of course lead to different conclusions. We present our case more rigorously in the formal model that follows.

Assume the expected value of the patent to be one hundred. On these numbers, both firms are willing to remain in the patent race so long as no strategic disclosure takes place. The leader's expected payoff is twenty-five, while the laggard's expected payoff is five. The top panel of figure 1 captures this state of affairs.

Patent Race Before Publication by Leader

	Cost to Continue	Likelihood of Winning	Expected Patent Value
LEADER	35	60	100
LAGGARD	35	40	100

And After

	Cost to Continue	Likelihood of Winning	Expected Patent Value
LEADER	35	55 ↓	70 ↓
LAGGARD	35	45 ↑	70 ↓

FIGURE 1. STRATEGIC DISCLOSURE FOR THE PURPOSE
OF DIMINISHING PATENT VALUE.

Were the leader to disclose information, the payoffs would change in several dimensions, as shown in the bottom panel of figure 1. First, the disclosure would likely decrease the expected value of the patent since there would be some chance that the disclosure would ultimately be deemed to have raised a statutory bar or rendered some aspect of the invention obvious. For the purposes of the example, imagine that this effect lowers the expected value from one hundred to seventy. Second, the disclosure might narrow the gap between the leader and the laggard; this would happen if the disclosure communicated to the laggard helpful information that the laggard did not already know. The extent of this narrowing likely varies sharply from case to case, but again just for purposes of the example suppose that after the disclosure the leader has only a fifty-five percent chance of being first to conceive while the laggard's chances rise to forty-five percent.

Now calculate each firm's payoff for remaining in the race. The laggard has a forty-five percent chance of winning a patent worth seventy, a chance that is on expectation worth approximately thirty-two. That is less than the thirty-five it costs to remain in the race, so the laggard now prefers to exit as opposed to continuing to pursue the patent. The leader's payoff changes, too. At the moment of disclosure, the expected value of the patent dropped to seventy from one

hundred; but now that the laggard has exited, the leader's chances of winning have risen from sixty percent to one hundred percent. The leader is not only willing to stay in the race (spending thirty-five for an expected payoff of seventy) but is now better off than it was before disclosure. Under the original scenario, the leader expected a net payoff of twenty-five; by using strategic disclosure, the leader has raised its expected payoff to thirty-five.[72]

The preceding numeric example shows how strategic disclosure by the leader might so diminish the expected value of the patent that the laggard would abandon the race. The example that follows highlights the second reason strategic disclosure might cause a trailing firm to exit: the disclosure might help the laggard better understand how far ahead the leader actually is. The top panel of figure 2 again shows two inventors who each face a cost of thirty-five to continue a given patent race. Again in this example the expected value of the patent is one hundred, but this time one inventor (the leader) has an eighty percent chance of being first to conceive while the other inventor (the laggard) has only a twenty percent chance. The laggard does not know enough about the leader's research to correctly estimate its odds of winning the race, however, so instead of thinking it has a twenty-percent chance of conceiving first, the laggard mistakenly estimates its chances to be sixty percent. Under these conditions, both inventors are willing to remain in the race. The leader has an eighty percent chance of earning one hundred, a total that offsets its costs of thirty-five and leaves an expected net gain of forty-five. The laggard mistakenly believes that it has a sixty percent chance of earning one hundred, so it too thinks it worthwhile to spend thirty-five and stay in the race.

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[72] When the laggard exits the race, it might disclose its research, attempting to play the spoiler strategy analyzed in Part III. This likely will have little effect, however, since the leader already has disclosed some information and the laggard can thus only do harm, if it can do any harm at all under the law, to the extent it has information beyond that which was already disclosed.

Patent Race Before Publication by Leader

	Cost to Continue	Likelihood of Winning (Actual & Perceived)	Expected Patent Value
LEADER	35	80 / 80	100
LAGGARD	35	20 / 60	100

And After

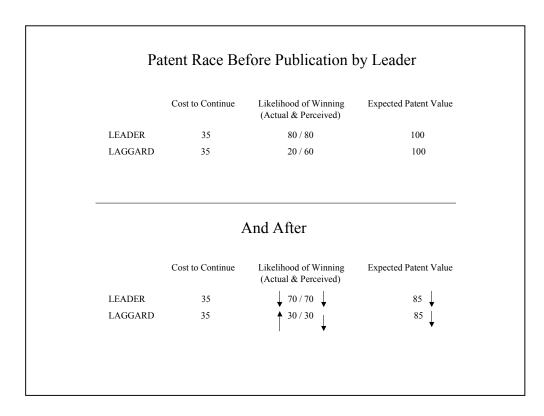|	Cost to Continue	Likelihood of Winning (Actual & Perceived)	Expected Patent Value
LEADER	35	↓ 70 / 70 ↓	85 ↓
LAGGARD	35	↑ 30 / 30 ↓	85 ↓

FIGURE 2. STRATEGIC DISCLOSURE AS SIGNALING.

If the leader discloses information, the payoffs change. For one thing, the disclosure will help the laggard more accurately estimate its own chance of winning the race to conceive. The disclosure might also inadvertently increase the laggard's ability to win, so in this example perhaps the overall effect will leave the laggard with something above a twenty percent chance of winning, say thirty percent. As prior art, the disclosure might also diminish the expected value of the patent.[73] For the sake of argument, let us assume, then, that after disclosure the expected value of the patent drops to eighty-five. The bottom panel of figure 2 reflects these updated numbers.

Calculating the incentives once more, we see that disclosure has again caused the laggard to leave the race. Better information about its odds of winning and the lower patent value have so reduced its expected payoff that continuing the race is not worthwhile. The leader, however, is better off than it was before. With the laggard gone, the leader has a greater chance of winning the patent. Even though the patent value is diminished, the net effect in this example gives the leader an expected payoff of fifty, five more than the original expected payoff of forty-five.

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[73] Perhaps not, however, since the disclosure might in some cases signal the leader's relative position without actually revealing much in the way of invention details. *See supra* notes 40-47 and accompanying text. *But see supra* note 72 (noting that the laggard might disclose upon exit).

B. A Game Theoretic Model of Leader Disclosure

As it was with the spoiler strategy discussed in Part III, the effects and interactions considered here can be modeled more formally. Denote once more by A and B two firms engaged in a patent race. Let x represent the expected value of the patent assuming no disclosures prior to patenting, and let βx represent the expected value of the patent if one of the firms engages in strategic disclosure. Note that we use β and not α in this model since the disclosures in this model implicate slightly different legal rules than did the disclosures in the previous model, and so the degree of patent degradation might differ. Naturally, $\beta \in [0,1]$.

Similar to the laggard model, we model this patent race as a three-stage game of incomplete information where everything is common knowledge except for the rival's position in the race. The game proceeds as follows. There is again a first stage of research, after which a firm that has successfully completed the stage can choose to disclose information. As before, the two firms make this decision simultaneously. If a firm does disclose, (1) the expected value of the patent decreases because of the prior art rules; (2) its rival learns that the disclosing firm has completed the first stage of research and the rival updates its own perceived likelihood of winning the patent race accordingly; and (3) the rival learns whatever information was disclosed, and in that way its research is advanced. The firms then each decide whether to incur the costs of proceeding to a second stage of research. Once a firm has completed that second stage, the race is over and the patent issues with some probability. Notice that, at the moment of possible disclosure, each firm is one of two types: either already finished with the first stage of research, or not yet finished. This is the private information.

Define the stage one and stage two investment technologies as follows. If a firm i (where $i \in \{A, B\}$) invests c_{1i}, then it completes the first stage of research with probability p_1. At stage two, whether a firm that invests c_{2i} receives the patent depends on (1) whether the rival firm completed the first stage of research and (2) whether either firm disclosed information after the first stage. More formally, if we use subscript "d" to indicate <u>d</u>isclosure, "a" to indicate that the firm is <u>a</u>head in its research, "s" to indicate that both firms <u>s</u>uccessfully completed the first stage, "f" to indicate that both firms <u>f</u>ailed to complete the first stage, and "o" to indicate that the firm is the only <u>o</u>ne remaining in the race, we can write:

$$prob\{\,firm\ i\ receives\ patent\ \mid invested\ c_{2i}\,\} = \begin{cases} p_0 & if\ rival\ exits\ race \\[4pt] p_a & \begin{pmatrix} if\ rival\ has\ not\ completed\ the\ first\ stage,\ firm\ i\ has, \\ and\ i\ does\ not\ disclose \end{pmatrix} \\[8pt] p_{ad} & \begin{pmatrix} if\ rival\ has\ not\ completed\ the\ first\ stage,\ firm\ i\ has, \\ and\ i\ does\ disclose \end{pmatrix} \\[8pt] p_s & if\ both\ firms\ have\ completed\ the\ first\ stage \\[4pt] p_f & if\ neither\ firm\ has\ completed\ the\ first\ stage \\[4pt] p_{bd} & \begin{pmatrix} if\ rival\ has\ completed\ the\ first\ stage,\ firm\ i\ has\ not, \\ and\ rival\ discloses \end{pmatrix} \\[8pt] p_b & \begin{pmatrix} if\ rival\ has\ completed\ the\ first\ stage,\ firm\ i\ has\ not, \\ and\ rival\ does\ not\ disclose \end{pmatrix} \end{cases}$$

The above probabilities are related. Most obviously, a firm enjoys its best chance of winning the patent race if the other firm drops out. Its next best chance comes when it has successfully completed the first stage but its rival has not. If a firm in that situation chooses to disclose information, it decreases its own chance of winning the race since any disclosure might reveal information that would help the rival. The firm's chances of winning are worse still if both firms successfully complete the first stage; at least in the previous case the disclosing firm was ahead in its research. A firm's chances diminish even further if neither it nor its rival has completed stage one. This might be better, but might be worse, than being behind the rival but benefiting from its disclosures. The worse case by far, though, is having failed to complete the first stage while the rival both completes the first stage and chooses not to disclose. In short,

$$1 > p_0 > p_a > p_{ad} > p_s > p_f \lessgtr p_{bd} > p_b > 0 \,.$$

As before, we solve this game of incomplete information by using the perfect Bayesian equilibrium solution concept. Again, for ease of exposition we focus on one representative separating equilibrium.

Proposition 2: There exists, for certain parameter configurations, a separating equilibrium where a firm that completes the first stage of research chooses to engage in strategic disclosure. In this equilibrium each firm invests at stage one; firms that complete the first stage of research disclose information; firms exit the race if they realize they are lagging; and all firms that remain in the race invest at stage two.

To prove this proposition we need to show that each firm is acting optimally given the equilibrium strategy of its rival and its own beliefs. We start at the second stage of research. A firm that has failed stage one and observed disclosure

by its rival will exit the race if the costs of going forward exceed the expected returns, or so long as:

(4) $p_{bd} \beta x < c_{2i}$.

A firm that has completed stage one and observed disclosure knows that both it and its rival have completed the first stage. Such a firm will invest at stage two if the benefits from investment outweigh the costs, or if

(5) $p_s \beta x > c_{2i}$.

If equation (5) holds, a firm that realizes it is ahead in the race will also choose to invest at stage two.

A firm that has failed to complete stage one and has not observed disclosure thereby knows that both firms have failed stage one because firms that complete stage one disclose. This firm will invest at stage two if the benefits from investment outweigh the costs, or so long as:

(6) $p_f x > c_{2i}$.

We have just shown the conditions under which the equilibrium strategy investment decisions at stage two are optimal. Moving backward in the game, we must now show that the expected payoff from disclosure is greater than the expected payoff from a failure to disclose. Again using the variable v to represent the value of the opportunity to compete in the subset market,[74] the expected payoff to a firm from disclosure, given its rival's equilibrium strategy, is:

$$EP_{disclosure} = p_1(p_s \beta x + v) + (1 - p_1)(p_o \beta x + v) - c_{2i} .$$

Three terms make-up this expected payoff. The first term is the firm's payoff if it discloses and it happens to turn out that the rival firm also has completed stage one. This term is discounted by the firm's belief that its rival has, in fact, completed stage one. The second term is the firm's payoff from inducing the laggard to exit. This term is discounted by the firm's belief that it is actually leading the race (i.e., that the rival firm has failed stage one). The final term represents the costs of stage two research.

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[74] In this model, given the change in variables, $v \in [0, \frac{1}{2}(1 - \beta)x]$.

The expected payoff to a firm that chooses not to disclose, given its rival's equilibrium strategy, is:

$$EP_{No\,Disclosure} = p_1(p_s\beta x + v) + (1 - p_1)(p_a x) - c_{2i}.$$

This expected payoff again consists of three terms. The first term is the payoff if this firm completes stage one, chooses not to disclose, and ends up tied with the rival firm. In this case, consistent with the equilibrium strategies, the rival does disclose, and hence the expected value of the patent is reduced. The second term is the payoff if the firm completes stage one, chooses not to disclose, and ends up leading the race. In this case, the firm has not induced its rival to exit and so the firm faces competition from its rival at stage two. The third term once more represents the costs incurred at stage two.

Comparing the expected payoff from disclosure with the expected payoff from a failure to disclose, we see that disclosure is optimal so long as the following condition holds:

(7) $v + p_o\beta x > p_a x$.

Like equation (2) in the prior model, equation (7) here gives us the most insight into the leader's incentives with respect to strategic disclosure. The left-hand side of the equation represents the leader's payoff if it chooses to disclose and that disclosure drives the laggard from the race: the leader earns profits from the subset market (v) plus has some chance (p_o) of earning the partially preempted patent (βx). The right-hand side represents its payoff if it foregoes disclosure and simply continues in the race: it has some chance (p_a) of earning the full patent (x). Naturally, the condition tells us that the leader will choose disclosure when its payoff from disclosure is larger than the payoff it expects to earn without disclosure.

To complete the proof, we need to show that it is optimal for each firm to invest at stage one. This is true if the expected cost of investing at stage one is less than the expected benefit from investing at stage one, or so long as:

(8) $p_1 p_1(p_s\beta x + v) - c_{2i}) + p_1(1 - p_1)(p_o\beta x + v) - c_{2i}) +$
        $(1 - p_1)(p_1)(v) + (1 - p_1)(1 - p_1)(p_f x - c_{2i}) > c_{1i}$
        .

Once again, this is a somewhat inelegant but simple equation. The four terms capture four states of the world. The first term represents the payoff if both firms

complete stage one. In this state of the world, both firms complete the stage, disclose, and then attempt to win the race by investing at stage two. The second term represents the payoff to a firm when it is the only firm to complete stage one. In this state of the world, the successful firm discloses, this induces the rival firm to exit, and then the leading firm invests at stage two. The third term represents the opposite case, namely that the rival completes the first stage, discloses, and drives this firm from the race. The only payoff here are the returns from the subset market. The fourth and final term represents the payoff if neither firm completes stage one successfully. In this case, neither firm discloses and subsequently each attempts to win the patent by investing at stage two. If the sum of these four terms is greater than the investment cost at stage one, then it is optimal for each firm to invest at stage one.

Given equations (4)-(8), no firm can deviate from its equilibrium strategy and increase its payoff consistent with its beliefs and the equilibrium strategy of its rival. Thus, if the parameters of the model are such that these equations are satisfied, then the strategies outlined in proposition 2 constitute a perfect Bayesian equilibrium.

C. Policy Implications and Private Bargaining

As it was with the laggard strategy, from a policy perspective strategic disclosure by leaders is appealing mainly because these disclosures place information in the public domain earlier than the patent system otherwise would. There are two interrelated points here: the public becomes aware of the information earlier than it would through the normal publication of patent applications, and the public can use the information more efficiently since any information disclosed is not subject to patent protection. Moreover, strategic disclosure does not take the place of patent application disclosures in this setting; quite the opposite, in settings where a leader discloses, any early revelations will later be followed by fuller disclosures since leaders who strategically publish typically still intend to actually file patent applications on some related technology.[75]

All this again only suggests that strategic disclosure *might* be attractive from a societal point of view—although the case in favor of strategic disclosure by

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[75] On the other hand, if there were no strategic disclosure, trailing firms would more often remain in the patent race, and in some cases they would either push the leader to achieve the invention more quickly or themselves leapfrog the leader and achieve the invention. Each of these options would lead to earlier patenting and, hence, earlier disclosure. Thus, while strategic disclosures will indeed be followed in most cases by patent applications, those applications will likely come later in time than they would have had there not been strategic disclosure.

leaders does seem stronger than the one for strategic disclosure by laggards. This is true because, to whatever extent leader disclosures help laggards more realistically estimate their chances of winning a given patent race, the disclosures make possible more efficient research decisions. That benefits laggards (who avoid wasting their research dollars) and also makes for a better use of societal resources. The strategy does change payoffs for both leaders and laggards, however, for example increasing the expected payoff for leaders (who now have some ability to drive out laggards), increasing the expected payoff to laggards to the extent that they avoid wasteful research investments, and decreasing the expected payoff to laggards to whatever extent they leave the race only because the patent's value was diminished through disclosure. Again, we cannot adequately evaluate the merits of these sorts of incentive shifts without first developing a fuller model of how the patent system works, something that goes far beyond the scope of this project.

As for the concern that inventors might use private negotiations to displace public disclosures, in this setting private alternatives are at times quite plausible and at other times rather unlikely. Private alternatives seem plausible to whatever extent leaders disclose in order to signal their relative positions vis-a-vis laggards. Suppose, for example, that a public demonstration of some new technology was going to serve as a credible signal of a leader's position. Instead of going public, the leader should (and could quite easily) arrange to give that demonstration to its rivals on the side. The demonstration's value as a signal would be identical, but, by doing it privately instead of publicly, the leader would minimize the chance that the disclosure would come back to partially preempt its ultimate patent application.[76] The only reason, in fact, for a leader to choose a public signal as opposed to a private one would be if the leader was unsure of the identities of its rivals and so had to use at least some measure of public disclosure as a way of identifying the relevant parties.

By contrast, to whatever extent leaders disclose information as a way of eroding patent value and thereby undermining a rival's incentive to race, private negotiations seem difficult at best. The difficulty comes in specifying by contract exactly what the laggard is supposed to do. Were a leader in this setting to publish, laggard behavior is straightforward: the publication would change the expected value of the patent, and the laggard's incentive to continue in the race would be correspondingly diminished. The laggard might drop out, compete less

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[76] One interesting wrinkle: if a laggard in this case refused to sign a confidentiality agreement, the leader's arguably private disclosure might be deemed "public" for the purposes of sections 102(b) and 103, defeating the leader's purpose in choosing a "private" as opposed to a public disclosure. *See supra* note 68. Here again, then, the leader might be forced to engage in some negotiation.

vigorously, and so on. To simulate that result by contract, however, the firms would have to agree on exactly what the laggard can and cannot do, all the while negotiating in a context where the technology at issue is still under development and thus poorly defined. Monitoring compliance with such a contract would also likely prove both difficult and expensive, and that—taken together with the difficulties inherent in drafting the contract; standard negotiating impediments like private information, bilateral monopoly, and free-rider problems; and the legal constraints discussed in Section III.C.—might in the end cause race leaders to opt for public disclosure even though private negotiations could in theory make both laggards and leaders better off.[77]

V. CONCLUSION

Strategic disclosure is not entirely a reaction to law. When a firm discloses research information, that disclosure has three effects: it gives rivals some information about how close the disclosing firm is to accomplishing the invention; it assists rivals by giving them possibly valuable information about the invention; and it affects the expected value of any patent that might eventually cover the invention, whether applied for by the disclosing party or a rival. Law—specifically the prior art rules—has significant influence over only the last of these effects, and thus the incentive to disclose information is in part, but only in part, determined by legal rules.

That said, modest changes to the prior art inquiry could surely encourage or discourage strategic disclosure in various settings, and so one direction for further research would be to explore possible changes to the prior art system that might encourage beneficial forms of strategic disclosure. For example, if we believe that strategic disclosure by leaders is desirable whereas strategic disclosure by laggards is not, prior art rules could be adjusted such that the ultimate patentee's pre-patenting disclosures have less of an effect on its ability to patent than they do on a rival's ability to patent. That is, prior art rules could be adjusted so as to make it less costly for ultimate patentees to disclose while leaving intact the effect those disclosures have on other firms.

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[77] Again, as was explained *supra* note 61, leaders might not prefer private negotiations even in cases where they are easy to accomplish. True, if there is no chance of additional entry in a given race, private negotiations are a no-brainer: they salvage patent value and generate a surplus that all the parties can share. In instances where new firms can still enter the patent race, however, the leader has to account for the fact that, by increasing the race payoffs, he might inadvertently encourage entry—bringing in new firms that, much to his chagrin, could end up either competing with him in earnest, or researching just enough such that they, too, can demand bribes.

Further research also should include empirical research on the question of whether firms do, under current legal rules, or would, under a modified prior art regime, engage in strategic disclosure. Research firms obviously disclose information all the time, but whether any of these disclosures are made with an eye toward their effects on patentability is unclear. For example, firms might allow employees to participate in trade shows or publish articles in industry periodicals not because of patent system strategy but, instead, as a way of generating favorable publicity for the firm or as a form of in-kind employee compensation since giving talks and writing articles both enhance employee resumes. Rebecca Eisenberg has found some evidence that firms trailing in the race to map the human genome have engaged in strategic disclosure in the hopes of thwarting rivals' patent applications;[78] but, before the analysis presented here can be fruitfully applied, more work of this sort clearly should be pursued.

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[78] Eisenberg, *supra* note 12; Rebecca Eisenberg, *Genomics in the Public Domain: Strategy and Policy*, 1 NATURE REVIEW 70 (2000). Further empirical work might build on some of the existing studies of private sector disclosures, for example Diana Hicks, *Published Papers, Tacit Competencies, and Corporate Management of the Public/Private Character of Knowledge*, 4 IND. & CORP. CHANGE 401 (1995). Another approach might be to pursue a case study, for example considering the *IBM Technical Disclosure Bulletin*, a series of technical disclosures published directly by IBM from 1958 until 1998 and, ever since, published by an outside firm under IBM's auspices. *See* http://www.ibm.com/ibm/licensing/ibm_tdb <visited October 1, 2000>.