2004

A Unified Economic Theory of Noninfringement Opinions

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Until recently, Federal Circuit doctrine on willful infringement provided a strong incentive for potential infringers both to obtain advice of counsel before engaging in infringing activity and to follow that advice. When a defendant was found to have infringed and refuses to disclose whether it sought an opinion of counsel, the court drew "the conclusion that it either obtained no advice of counsel or did so and was advised" that the activity would infringe.[1] In effect, this doctrine imposed an affirmative duty "to seek and obtain competent legal advice from counsel before the initiation of any possible infringing activity."[2] Because a finding of willful infringement could serve as a precursor to imposition of enhanced damages,[3] the contents of an opinion of counsel could become important ingredients in a decision whether to engage in potentially infringing activity. In *Knorr-Bremse Systeme Fuer Nutzfahrzeuge GmbH v. Dana Corp.*,[4] however, the Federal Circuit rejected the old doctrine, finding that no adverse inference could be drawn from a failure to obtain an opinion of counsel or from a refusal to reveal the contents of such an opinion.

The briefs in *Knorr* analyzed in detail a number of issues, including the importance of the attorney-client privilege,[5] the expense of opinions of coun-

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* Associate Professor of Law, George Washington University Law School. The author gratefully acknowledges the financial assistance of the Oracle Corporation, as well as research assistance from Nancy McElwain and Paul Strain. For comments on earlier drafts, I am indebted to participants at the Oracle/GW Symposium on Willful Patent Infringement and at a workshop at Yale Law School. Any remaining errors are the fault of the author, but because others have read and approved of the manuscript, I should not be subject to an enhanced penalty for them.

[1] Kloster Speedsteel AB v. Crucible Inc., 793 F.2d 1565, 1580 (Fed. Cir. 1986).

[2] Underwater Devices, Inc. v. Morrison-Knudsen Co., 717 F.2d 1380, 1389-90 (Fed. Cir. 1983).

[3] 35 U.S.C. § 284 (2000) (permitting up to treble damages).

[4] 383 F.3d 1337 (Fed. Cir. 2004) (en banc); *see also* 344 F.3d 1336 (Fed. Cir. 2003) (order granting en banc review).

[5] *See, e.g.*, Brief of Defendants-Appellants, *Knorr* (Nos. 01-1357, 1376, 02-1221, 1256) (arguing for the importance of guarding the attorney-client privilege); Corrected Brief of the American Bar Association as Amicus Curiae Supporting Neither Party at 3-10, *Knorr* (Nos. 01-1357, 1376, 02-1221, 1256) (arguing that invocation of the attorney-client privilege should not contribute to a finding of willful infringement); Brief for the Association of Patent Law Firms as Amicus Curiae at 4-10, *Knorr* (Nos. 01-1357, 1376, 02-1221, 1256)

sels,[6] whether notice from the patentee should be required for infringement to be considered willful,[7] and the ability of juries to assess the competence of opinion-of-counsel opinions.[8] None, however, offered an economic theory of the functions that enhanced damages may serve in patent law specifically or litigation more generally.[9] This Article seeks to develop such a theory and to explain the role that "noninfringement opinions," i.e. opinions of counsel

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(arguing that adverse inferences should be rare). A related issue is whether placing weight on the opinions of counsel will discourage the honest provision of legal advice. *See* Brief for Amicus Curiae New York Intellectual Property Law Association in Support of Eliminating the Adverse Inference Arising from the Assertion of Attorney-Client Privilege in Defense of Willful Infringement, *Knorr* (Nos. 01-1357, 1376, 02-1221, 1256) (arguing that a requirement will chill provision of honest legal advice). As these citations indicate, the weight of the briefing appears to reflect a belief among members of the patent bar that no adverse inference should be drawn from failure to invoke the attorney-client privilege.

[6] *See, e.g.*, Brief of Amicus Curiae Conejo Valley Bar Association at 5-8, *Knorr* (Nos. 01-1357, 1376, 02-1221, 1256) (arguing that opinions of counsel cost between $5,000 and $50,000 and therefore should not always be required); Brief of Amicus Curiae Public Patent Foundation at 3-4, *Knorr* (Nos. 01-1357, 1376, 02-1221, 1256) (arguing that an opinion-of-counsel requirement will adversely affect small businesses);

[7] *See, e.g.*, Brief of Amicus Curiae Public Knowledge in Support of Defendant-Appellants at 9, *Knorr* (Nos. 01-1357, 1376, 02-1221, 1256).

[8] *See, e.g.*, Brief for Amicus Curiae American Intellectual Property Law Association at 3-4, *Knorr* (Nos. 01-1357, 1376, 02-1221, 1256) (arguing that juries are not competent to assess such opinions, and that trying these issues can be expensive, in part because a separate set of attorneys must be hired from the set that testify).

[9] The most comprehensive analysis to date in the literature of the opinion-of-counsel requirement is Shashank Upadhye, *Understanding Willfulness in Patent Infringement: An Analysis of the "Advice of Counsel" Defense*, 8 Tex. Intell. Prop. L.J. 39 (1999). Upadhye offers an excellent overview of the case law and useful guidelines to practitioners drafting such opinions. *See id.* at 45-63. Upadhye also briefly provides the following three policy justification of enhanced damages for willful infringement:

> First, damages enhancement recognizes that infringement resides on a spectrum ranging from accidental or unknowing, to deliberate, or even reckless. Thus, damages enhancement considers the relative culpability of the infringer and punishes infringers who engage in grossly culpable conduct. Second, enhancement acts as an economic deterrent to the infringer, thus discouraging the infringer from engaging in such behavior again. Finally, enhancement provides some sort of compensation or amelioration to the patentee in an attempt to make the patentee whole again.

Id. at 41-42 (footnotes omitted). The reference to "culpability" in the first of these may implicate a moral theory of patent infringement, which I do not consider further here. The first point, however, also reinforces the second, which corresponds to this Article's discussion of the danger of underdeterrence, because the deterrent effect of enhanced damages can work only where the potential infringer recognizes the possibility of infringement. The third point is puzzling, since the baseline damages awarded by a court should at least already be

that conclude that activity will be noninfringing, could have within the context of such a theory. To accomplish this, I consider the following question: What are the benefits and costs of a regime that generally provides enhanced damages in patent law but provides a safe harbor for potential infringers who have acted only after receiving advice from counsel that their activity likely is noninfringing?[10]

The conclusion, in brief, is that damages multipliers may help deter infringing activity and reduce the incidence of suit. Given the prospect of enhanced damages, potential infringers are less likely to engage in a potentially infringing activity, and damages multipliers thus reduce what otherwise might be a problem of underdeterrence. Although damages multipliers make it more likely that a patentee would sue *given* potentially infringing activity, under plausible assumptions, the effect of such multipliers should generally be to decrease the activity to such an extent that the rate of suit goes down. Damages multipliers, however, will tend to increase suit in cases in which patentees have weak claims, and the application of damages multipliers in such cases threatens to overdeter potentially infringing activity. These cases, however, will tend to be the same cases in which a potential infringer is likely to be able to obtain a noninfringement opinion. The provision of a safe harbor for potential infringers who do obtain such opinions thus enables the legal system to obtain the general benefit of damages multipliers, decreased infringement and decreased litigation, without the costs that these multipliers would impose in cases that are weak for patentees.

Part I elaborates this model by describing three theories of supercompensatory damages. The first theory is that supercompensatory damages encourage consensual negotiation instead of nonconsensual takings. The most common justification for such encouragement, that a potential defendant may have an incentive to take nonconsensually when it values the entitlement for more than the plaintiff, is already reflected in patent law's calculation of baseline damages. There are other reasons, however, to discourage nonconsensual takings, including preventing underdeterrence and reducing the incidence of

compensatory. Perhaps implicit in the point is that the patentee may have had to pay litigation costs, which enhanced damages may cover. *See* 35 U.S.C. § 285 (allowing the award of attorneys' fees against infringers).

[10] This phrasing admittedly inverts the typical legal framing of the inquiry, in which the status quo is a regime of ordinary damages and supercompensatory damages are the exceptional case. Given this legal framing, the Federal Circuit's conclusion is not surprising. As Judge Dyk noted in a partial concurrence, the Supreme Court has suggested that punitive damages are exceptional rather than typical. *See* Knorr-Bremse Systeme Fuer Nutzfahrzeuge GmbH v. Dana Corp., 383 F.3d 1337, 1348 (Fed. Cir. 2004) (en banc) (Dyk, J., concurring-in-part and dissenting-in-part) (citing State Farm Mut. Auto. Ins. Co. v. Campbell, 538 U.S. 408 (2003)). This Article's analysis suggests, however, that a regime in which supercompensatory damages are the norm may have substantial economic benefits.

litigation, the second and third theories discussed. Part II introduces a formal simulation model to illustrate the effects of a regime that combines enhanced damages with a safe harbor for infringers who acted under the favorable advice of counsel. The simulation model incorporates genetic algorithms, which allow the players in a simple patent game (the potential infringer and the patentee) to learn optimal behavior given the rules of the legal regime and the simple goal of wealth maximization. A "baseline simulation" given certain assumption reflects the mechanics of the damages regime. Part III incorporates various alterations to the baseline simulation to test how changes in parties' information may affect the basic conclusions.

I. Three Theories of Supercompensatory Damages

A. Protecting Property Rules

Perhaps the most general theory in the law-and-economics literature on supercompensatory damages is that offered by David Haddock, Fred McChesney, and Menahem Spiegel in a 1990 *California Law Review* article.[11] Haddock et al. suggest that supercompensatory damages, along with other "extraordinary" remedies, help to enforce the distinction between property and liability rules.[12] "An entitlement," they explain, "is protected by a property rule if the law condones surrender only through voluntary exchange. An entitlement has the lesser protection of a liability rule if it can be lost lawfully to anyone willing to pay court-determined compensation."[13] Although property rules are often identified solely with criminal penalties,[14] supercompensatory damages provides a means of creating property-like protection in a context in which the only penalty for wrongful violation of an entitlement is the

[11] *See* David D. Haddock et al., *An Ordinary Economic Rationale for Extraordinary Legal Sanctions*, 78 Cal. L. Rev. 1 (1990).

[12] *Id.* The literature on the choice between property and liability rules dates back to Guido Calabresi & A. Douglas Melamed, *Property Rules, Liability Rules, and Inalienability: One View of the Cathedral*, 85 Harv. L. Rev. 1089 (1972). For more recent works on this choice, see Ian Ayres & J.M. Balkin, *Legal Entitlements as Auctions: Property Rules, Liability Rules, and Beyond*, 106 Yale L.J. 703 (1996), Ian Ayres & Eric Talley, *Distinguishing Between Consensual and Nonconsensual Advantages of Liability Rules*, 105 Yale L.J. 235 (1995) and Louis Kaplow & Steven Shavell, *Property Rules Versus Liability Rules: An Economic Analysis*, 109 Harv. L. Rev. 713 (1996).

[13] Haddock et al., *supra* note 11, at 13.

[14] Haddock et al. offer two explanations for the use of criminal law as an alternative to supercompensatory damages. First, criminal sanctions may be useful where "adequate monetary penalties are infeasible," for example because the defendants would not be able to pay the necessary amount of damages. *Id.* at 48. Second, criminal sanctions may be cheaper and more efficient where it is difficult to measure the plaintiff's loss from an entitlement. *See id.* at 49. *See also id.* at 23–24 (offering a similar justification for injunctive remedies).

payment of money.

Property protection, Haddock et al. suggest, is particularly appropriate in a thin market. Suppose that a potential plaintiff owns a piece of property and values it at a certain amount, and a potential defendant values the property at a higher amount.[15] The ideal legal regime should thus lead to a transfer of the property, but that does not mean that any price will be equally satisfactory from the perspective of social welfare. If the legal system protects the property only with a liability rule, the defendant will take the property and pay the plaintiff's valuation. Property rule protection, by contrast, will force the defendant to pay some higher amount, somewhere between the plaintiff's and defendant's valuations. A drawback to such protection is that strategic bargaining might thwart the transfer.[16] Such protection, however, will provide stronger ex ante incentives for the plaintiff's initial creation or acquisition of the property and thus may well increase social welfare.

This justification for property rule protection would apply easily to the patent context if baseline damages that a patentee received encompassed lost profits but not lost royalties. Suppose Company *X* is considering developing a new and useful process. *X* believes that the profits will allow it to reduce the costs of making *X*'s products, but it also recognizes that the process could help other companies making unrelated products. If those companies could infringe a patent on the process and pay only direct monetary damages for *X*'s lost profits on its products, *X* essentially will expect to receive nothing for its intellectual property, for the infringement has had no effect on the sale of *X*'s products. Property rule protection of any form might improve this patent world by allowing *X* to capture closer to the full amount of the social benefit that its new process creates by negotiating at arms length with other companies that would like to use the process. Incentives to invent will be maximized the greater the amount of social benefit a potential inventor can capture,[17] and so property rule protection provides some social benefit.[18]

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[15] *See id.* at 14–17 (developing this example with more mathematical detail).

[16] *See, e.g.*, Carol M. Rose, *The Shadow of* The Cathedral, 106 Yale L.J. 2175, 2187 n.50 (1997) ("[P]roperty rules . . . [may] exacerbate Type II costs (strategic bargaining), at least in conditions of bilateral monopoly.").

[17] *See, e.g.*, Steven Shavell & Tanguy van Ypersele, *Rewards Versus Intellectual Property Rights*, 44 J.L. & Econ. 525, 534 (2001) (noting that one source of welfare loss from the patent system is "insufficient investment in research" because the patentee cannot capture the full social benefit of the invention).

[18] Of course, property rule protection also imposes some deadweight loss. *See, e.g., id.* If *X* decides to set a fixed price for its process (for example, because it cannot perfectly price discriminate), then some companies that would benefit from the process will choose not to purchase it. *See generally* Robert B. Ekelund, Jr. & Robert D. Tollison, Economics 273–74 (3d ed. 1991) (describing deadweight loss from the exercise of monopoly power).

This is, however, not our patent law. Even in the absence of enhanced damages, patent law already provides for a form of enhancement that reflects the possibility that negotiation might produce returns above lost profits. Under the Patent Act, damages shall be imposed "adequate to compensate for the infringement, but in no event less than a reasonable royalty for the use made of the invention by the infringer."[19] The reasonable royalty is the royalty rate that the patentee and infringer would have agreed to if they had negotiated a license agreement.[20] The baseline damages calculation thus already provides a form of property rule protection. A potential infringer who values the property at an amount greater than the patentee will lose cannot take advantage of this discrepancy.

Haddock et al.'s theory may thus fit too well in the patent context to provide a direct explanation of the immediate issue, imposition of enhanced damages when an infringer fails to obtain an opinion of counsel. The theory, however, might still be useful for two reasons. The first possibility is that there may be some danger that courts will misestimate the amount of the reasonable royalty. As Haddock et al. point out, the danger of misestimation cannot serve as a basis for supercompensatory damages, as long as the danger of a high estimate will cancel out with the danger of a low estimate. Perhaps, however, there is some danger of adverse selection,[21] with the infringers being disproportionately those who expect the courts' formulas for determining damages to be on the low side considering their particular circumstances. Some additional layer of property rule protection may thus be useful. Injunctive relief provides one form of such protection, and enhanced damages, in theory, could provide another.

Is the doctrine of enhanced damages consistent with this theory of protection? The connection appears loose at best. The doctrine may limit enhanced

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The patent system reflects an assessment that these costs are worth the benefits, and this Article will assume without further analysis that this is true, and therefore, that some form of property protection might be useful.

[19] 35 U.S.C. § 284 (2000).

[20] *See, e.g.*, Unisplay, S.A. v. Am. Elec. Sign Co., 69 F.3d 512, 518 (Fed. Cir. 1995). For a list of factors relevant to the determination of the reasonable royalty, see *Georgia-Pacific Corp. v. United States Plywood Corp*, 318 F. Supp. 1116 (S.D.N.Y. 1970), *modified and aff'd*, 446 F.2d 295 (2d Cir. 1971).

[21] In the insurance context, adverse selection is "the process by which low-risk insureds tend to purchase less coverage, and high-risk insureds tend to purchase more coverage than they would if prices were more accurate." Kenneth S. Abraham, Distributing Risk: Insurance, Legal Theory, and Public Policy 15 (1986). That is, because the worst risks are the most likely to buy insurance, the price of insurance rises. Similarly here, the potential infringers who decide to infringe may be those who tend to believe that courts will underestimate their valuations.

damages to cases in which the infringer recognized that there was a reasonable chance that a court would find the activity to be infringing. These cases may tend to be those in which the infringer deliberately avoided the negotiation process. But there are a variety of reasons other than adverse selection for refusing to complete a license negotiation. One reason is that the potential infringer might believe that the patent is invalid or the activity is noninfringing. Willful infringement doctrine seems far more attuned to this possibility than to the possibility of adverse selection. If adverse selection were the motivating concern, then a simple clarification of the reasonable royalties requirement might be sufficient. The level of uncertainty could simply be another factor in the reasonable royalties analysis, with doubts generally resolved in favor of the patentee.

The second approach to applying the Haddock et al. approach to enhanced damages recognizes that even if the baseline damages imposed always exactly mimicked the result of licensing negotiations, there are reasons to encourage potential infringers to negotiate rather than infringe. Haddock et al. justify property rules by explaining that "traders as a group will suffer if individuals can strategically substitute court-ordered compensation for negotiation,"[22] but their analysis details only one reason that negotiated outcomes may be socially preferable, i.e., that negotiated outcomes take into account the valuations of both the plaintiff and the defendant. We have seen that patent law's baseline damages calculation reflects this concern. There is at least one other important reason, however, that negotiation may be preferable to litigation: litigation is expensive.

The expense of litigation is significant in two distinct ways. First, because litigation is expensive, some patentees may decide not to enforce their rights. As a result, some takings (in the Haddock et al. model) or infringements (more specifically in the patent context) may go uncompensated. The possibility of escaping liability altogether may make nonconsensual infringements more attractive to potential infringers. Increased damages can provide a counterbalance, providing some inducement for potential infringers to negotiate rather than risk the judicial process. Second, the expense of litigation is itself a cost that an ideal legal system should take into account. This point is noted most commonly in the tort context, where Guido Calabresi famously noted the importance of minimizing the total cost of accidents, including litigation costs.[23] Certainly there are other important considerations in patent law, such as protecting both patents and noninfringing activity, but reducing transactions costs should be somewhere in the balance. If enhanced damages reduce litigation costs by discouraging infringement, there is then another reason to

[22] Haddock et al., *supra* note 11, at 17.

[23] Guido Calabresi, The Costs of Accidents: A Legal and Economic Analysis 135–40 (1970).

encourage resolution of potential infringement issues with negotiation rather than judicial process.

Haddock et al. claim that their model "can predict a variety of seemingly unrelated extraordinary sanctions that have previously elicited equally various and detailed analyses."[24] The analysis here largely supports that claim, as their model can point to a number of reasons that patent damages should sometimes exceed lost profits. The model, however, is only a starting point, because, aside from the asymmetric valuation rationale that patent law already seems to take into account in calculating baseline damages, the reasons that we might prefer negotiation over litigation are largely exogenous. It is thus worthwhile considering, independent of Haddock et al.'s broad theoretical justification for supercompensatory remedies, the specific problems of underenforcement and litigation costs.

B. Compensating for Underenforcement

Though Haddock et al. do not consider the issue in any detail, the law-and-economics literature does recognize that supercompensatory damages may help optimize deterrence by compensating for underenforcement. This theory has received particular attention in the context of punitive damages, and though not the first to recognize the possibility that punitive damages might compensate for underenforcement,[25] A. Mitchell Polinsky and Steven Shavell offered the most complete explanation of the theory in a 1998 *Harvard Law Review* article.[26]

The theory, which Polinsky and Shavell apply primarily to the tort context,[27] derives from the common claim that potential tortfeasors will have optimal incentives if they bear the full costs of their activity.[28] In a strict liability regime,[29] ensuring that expected damages equals expected harm optimizes two different decisions that a potential tortfeasor must make. Consider first the

[24] Haddock et al., *supra* note 11, at 2.

[25] Among others, Haddock et al. recognize this possibility, although they do not explore it in any detail. *See* Haddock et al., *supra* note 11, at 8–9.

[26] *See* A. Mitchell Polinsky & Steven Shavell, *Punitive Damages: An Economic Analysis*, 111 Harv. L. Rev. 869 (1998).

[27] They also offer a brief explanation of the theory's applicability to breaches of contract. *See id.* at 936–39.

[28] *See, e.g.*, Robert Cooter & Thomas Ulen, Law and Economics 270–81 (2d ed. 1997); William M. Landes & Richard A. Posner, The Economic Structure of Tort Law 66–67 (1987).

[29] A negligence regime adds significant complications, as Polinsky and Shavell note. *See* Polinsky & Shavell, *supra* note 26, at 883–85; *infra* text accompanying notes 37–40.

decision on whether to take a precaution. With expected damages equal to expected harm, "potential injurers will . . . be induced to spend money on precautions if the expenditure is socially worthwhile in the sense that the expenditure reduces the harm by a greater amount."[30] A similar insight applies to a potential tortfeasor's decision on how much of an activity that may produce harm to engage in, given a decision on whether to take a precaution while engaging in that activity. Polinsky and Shavell explain that with expected damages equal to harm, potential tortfeasors "will engage in an activity if and only if the benefit they derive exceeds the additional harm caused by their decision to engage in it."[31]

From the desire that tortfeasors internalize the costs of their decisions follows easily the conclusion that punitive damages should be imposed when a defendant can sometimes escape liability. If victims sometimes do not sue tortfeasors, then expected damages will be less than expected harm in a regime that allows only compensatory damages. "To remedy these problems of underdeterrence," Polinsky and Shavell argue, "damages that are imposed in those instances in which injurers are found liable should be raised sufficiently so that injurers' average damages will equal the harm they cause."[32] For example, if there is only a one-in-four chance that the tortfeasor will be found liable, then multiplying damages by four (so that punitive damages would equal three times compensatory damages) will ensure that expected damages equal expected harm. More generally, cost internalization requires that the damages multiplier be the inverse of the probability of detection.[33]

To assess the extent to which the theory may justify imposition of enhanced damages on patent infringers who did not obtain opinions of counsel, we must consider, first, the extent to which the theory applies generally to the patent context; and second, whether enhancing damages when an infringer fails to obtain an opinion of counsel successfully compensates for underenforcement. The second question will be relevant regardless of the answer to the first. If the underenforcement theory applies to justify across-the-board multipliers, multipliers still might not be appropriate if applied only in situations in which the infringer fails to obtain an opinion of counsel; and if across-the-board multipliers are not justified, multipliers still might be useful in the subset of cases where the infringer fails to obtain an opinion of counsel. I will start with the first question, by considering the extent to which the patent context is similar to the tort context on which Polinsky and Shavell focused.

The analogy to the patent context may appear at first to be straightforward: potential infringers are to patentees as potential tortfeasors are to potential

[30] Polinsky & Shavell, *supra* note 26, at 879.

[31] *Id.* at 882.

[32] *Id.* at 889 (emphasis omitted).

[33] *Id.*

victims. If patentees will not consistently enforce their rights, then potential infringers will recognize that there is only some probability less than one that infringement will be punished. To compensate for that probability, courts can order supercompensatory damages—that is, damages that not only compensate the patentee for lost profits, but also add enough extra so the potential infringers' incentives are aligned with social welfare.

A problem with this analogy is that a decision whether to infringe is meaningfully different from a decision whether to adopt a particular precaution. In the tort context, we must worry about the possibility of overdeterrence as well as the possibility of underdeterrence. If damages are set too high, in a strict liability regime tortfeasors will take excessive precautions. In the patent context, by contrast, we ordinarily do not worry about overdeterring decisions to infringe. If a patent is indeed valid, then social welfare is presumably maximized by preventing entry of the infringing product, at least unless the patentee grants a license. In practice, of course, patent law is an imperfect instrument for identifying the circumstances in which the social benefits of protection, such as encouraging research and development,[34] exceed the social costs, such as higher prices.[35] But a legal determination of infringement represents our system's conclusion that the social costs of the unlicensed infringing activity exceed the social benefits, and so there are no other factors to take account in the balance. In a strict liability tort regime, by contrast and indeed by definition, the legal system might impose damages even where a tortfeasor's decision maximizes social welfare.

A better analogy for the patent system might thus be to a regime of negligence. In a negligence regime, tortfeasors are punished only when the legal system concludes that the tortfeasors failed to take cost-justified precautions.[36] Negligent conduct thus more closely approximates infringing conduct; it is conduct that once identified, the legal system would like to eliminate. Under such a regime, if potential tortfeasors are rational, if courts accurately assess the precautions taken, and if victims always enforce their rights, no torts will ever be committed. The mere threat of imposing compensatory damages will be enough, and there will thus be no need for, or harm from, supercompensatory damages. Unfortunately, we live in a world in which torts are committed and some defendants have acted negligently, so at least one of these assumptions must be wrong.

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[34] I do not mean here to slight other justifications of patent law, such as discouraging wasteful rent dissipation. *See, e.g.*, Mark F. Grady & Jay I. Alexander, *Patent Law and Rent Dissipation*, 78 VA. L. REV. 305 (1992).

[35] *See supra* note 18.

[36] This is, at least, the standard way that the law-and-economics literature models the negligence rule. The approach is often called the Hand rule, after Judge Learned Hand's famous formulation. *See* United States v. Carroll Towing Co., 159 F.2d 169, 173 (2d Cir. 1947).

If the third assumption, that victims always enforce their rights, was the only problematic one, then a regime of punitive damages, with the damages multiplier set to the inverse of the probability of detection, would be the perfect antidote. By ensuring that anyone who fails to take cost-justified precautions will pay for the full costs of the expected harm, even if only some victims sue, we return to the nirvana in which no torts are committed. Because a potential tortfeasor must either pay for the precaution or for the damages resulting from failure to take the precaution, tortfeasors' privately optimal decision will be the same as the socially optimal one.

Similarly, if we can assume that infringers know whether they are committing infringement and that courts are infallible assessors of whether patent infringement has been committed, then a Polinsky-Shavell multipliers regime would be the economically efficient solution, at least placing aside potential complications such as risk aversion and the like. The problem, of course, is with the assumptions of perfect ability by courts and infringers to identify infringing activity. More realistically, there is a broad gray zone of possibly infringing activity, for which some judges or juries would find infringement and some would not. When potential infringers are in this gray zone, they may have an approximate sense of how gray the particular case is, but the infringers may not know precisely where within the zone they lie, and they cannot anticipate whether they will draw a favorable or an unfavorable judge.

The uncertainty about the line between permissible and infringing activity thus appears analogous, at least at first, to uncertainty about the line between negligent and non-negligent activity. As Polinsky and Shavell acknowledge, in reasonably close tort cases, potential tortfeasors will not know for sure whether they are on the safe or hazardous side of the line that a court will eventually set, and again the answer may depend on which court happens to be drawing the line, and even given a particular court, the answer may not be entirely predictable.[37]

From here, however, the analogy between infringement and the standard model of negligence breaks down. As Polinsky and Shavell point out, the discontinuity of the negligence rule may cause some defendants to take excessive precautions to reduce the probability of error.[38] If the negligence rule

[37] *See* Polinsky & Shavell, *supra* note 26, at 884–85. Although Polinsky and Shavell focus here on court error, rather than the possibility of error by potential tortfeasors, the analysis is much the same.

[38] *See id.*; *see also* John E. Calfee & Richard Craswell, *Some Effects of Uncertainty on Compliance with Legal Standards*, 70 Va. L. Rev. 965, 966 (1984). Polinsky and Shavell also acknowledge a second problem, which stems from the observation that the negligence rule fails to optimize the activity-level decision. *See* Polinsky & Shavell, *supra* note 26, at 884–85. Because an actor will face no liability if the actor is non-negligent, the actor will ignore the costs that the activity imposes on victims. The actor thus will engage in more of an activity

produces excessive precautions with full enforcement by tort victims, then optimizing damages requires subcompensatory damages. The combination of this case for subcompensatory damages with the logic of supercompensatory damages in the absence of full enforcement produces an ambiguous policy recommendation. Polinsky and Shavell thus conclude, "[i]n the presence of mistakes, the optimal level of damages under the negligence rule is difficult to ascertain."[39] In the absence of an apparent solution, they adopt the convenient assumption "that optimal damages under the negligence rule equal harm,"[40] but their analysis indicates that this can at best be only a tentative conclusion.

The analogy is imperfect because potential infringers do not simply act more or less cautiously to move their conduct along the gray zone. There may be some cases that fit this paradigm: a potential infringer, to avoid even the possibility of infringement, invents around the patent, far enough around to reduce the probability of a finding of infringement.[41] The investment in inventing around is analogous to a tortfeasor's taking of a precaution, although a welfare analysis of *inventing around* is more complicated.[42] The paradigmatic dilemma for the potential infringer in the patent context, however, involves a situation in which inventing around is not possible. In that case, the potential infringer must decide whether to proceed with the potentially infringing activity or not, rather than whether to invest in pushing the activity from one portion of a continuum to another.

An alternative model of negligence that accords more closely with the

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than would be socially optimal. This problem has no clear analogue in the patent context. Given an assumption that sale of a particular product is noninfringing, increasing sales of that product do not necessarily increase social cost, at least on the standard assumption that lower prices from noninfringing competition generally benefits the public.

[39] *See* Polinsky & Shavell, *supra* note 29, at 886.

[40] *Id.*

[41] The Federal Circuit has argued that one of the virtues of the patent system is that it encourages *inventing around.* State Indus., Inc. v. A.O. Smith Corp., 751 F.2d 1226, 1236 (Fed. Cir. 1985) ("One of the benefits of a patent system is its so-called 'negative incentive' to 'design around' a competitor's products, even when they are patented, thus bringing a steady flow of innovations to the marketplace.").

[42] There are two welfare implications of inventing around. First, inventing around may be socially wasteful, because it involves the expenditure of resources and does not in any way benefit the original patentee. *See, e.g.*, Louis Kaplow, *The Patent-Antitrust Intersection: A Reappraisal*, 97 HARV. L. REV. 1813, 1869 (1984). In this sense, it differs from the taking of a precaution, which benefits the victim. Second, inventing around may produce social welfare gains to the extent that the new invention has some features that differ from the original. If the inventor cannot capture the full gains of the invention, consumers may benefit from the increased product diversity.

patent context is Mark Grady's cost-benefit approach.[43] Grady observes that courts typically do not simply assess a defendant's overall level of precaution in making an assessment of whether the defendant acted negligently. Rather, judges and juries will generally focus on a particular precaution, one that the plaintiff argues would have prevented the relevant accident, and determine whether the defendant's decision not to undertake the particular precaution was cost-justified.[44] Regardless of whether this is a better model of actual court decision-making, it eliminates the tendency of potential tortfeasors in conditions of uncertainty to take excessive precautions.[45] The intuition is that the tortfeasor faces a binary choice, whether to take the precaution or not, and the tortfeasor who fails to take the precaution receives no extra credit for taking other precautions. Given the choice not to take a precaution, then when an injury occurs, the probability that the court erroneously imposes liability cancels out the probability that the court erroneously fails to impose it.

Similarly, because a court will determine either that there is infringement or there is not, the possibility of error by courts or infringers roughly cancels out. In the middle of the gray zone, a potential infringer will recognize that there is some probability, 0.5 if courts on average make accurate determinations, of liability being imposed. There should thus be no systematic tendency towards excessive caution or excessive risk-taking in a world of full enforcement. When the infringer believes that the potentially infringing activity is in a portion of the gray zone that courts would find to be infringing 45 percent of the time, the potential infringer (disregarding again complications like risk aversion) will conclude that there is roughly a 45 percent chance of liability. The infringer will recognize the possibilities that in fact the activity lies in a portion of the gray zone that would result in courts assessing liability 35 percent of the time, and some probability that the infringer really is in a portion of the gray zone that would result in courts assessing liability 55 percent of the time. Assuming, however, reasonably ordinary probability distributions, the self-recognition of the possibility of mistake should not cause the infringer's estimate of the probability of liability to deviate much from a world in which the infringer was sure of where in the gray zone the conduct would fall.[46]

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[43] *See* Mark F. Grady, *A New Positive Economic Theory of Negligence*, 92 Yale L.J. 799 (1983).

[44] *Id.* at 824–29.

[45] *Id.* at 817–21.

[46] This will be less true on the ends of the probability distribution. Suppose that a potential infringer believes that a product is at a portion of the gray zone that would result in a finding of infringement 99 percent of the time. The infringer, however, recognizes that she is as susceptible to error as anyone else in making calculations. If the universe of potential infringement actions is uniformly distributed across the gray zone, then the infringer will

If this model captures the dynamics of the infringement calculus, and if patentees always sue when potential infringers decide to engage in the relevant conduct, then potential infringers will have optimal incentives, provided two additional assumptions are met.

First, assume that from a social standpoint, a decision to conduct an activity that in fact is on the infringement side of the gray zone (that is, that courts are more likely than not to conclude is infringement) is equally as bad as a decision to refrain from an activity that is on the noninfringement side. Under this assumption, the social costs of infringement in a particular case (for example, lower research and development if the infringement is successful, plus the costs of the patent litigation system itself if it is not) are on average equal to the social costs of noninfringing conduct that the patent system deters in a particular case (for example, higher prices for consumers).

Second, assume that from the private standpoint of the potential infringer, the cost of a bad decision to engage in the possibly infringing conduct is equal to that of a bad decision not to engage in such conduct. A potential infringer faces at least two possible bad outcomes: (1) the potential infringer engages in the activity, when doing so causes the infringer to lose money (because the infringer is sued and loses, or because the cost of vindication exceeds the profits from the activity); or (2) the possibility of suit deters the potential infringer from engaging in the conduct, when in fact the infringer would not have been sued or would have won and still made money. The assumption here is that these two costs are equal.

Given these assumptions, the potential infringer will infringe if, and only if, the infringer believes that it is more likely than not that a court would conclude that infringement had not occurred, and this decision will be socially optimal. To be sure, if the infringer had *better* information, knowing exactly where in the gray zone its activity would lie, social welfare would rise, but the infringer at least is acting as a benevolent social planner would act, given the infringer's best guess about where in the gray zone the activity is. This is the best a patent litigation system can accomplish in optimizing a potential infringer's decision, and it can serve as a useful baseline for considering a world in which some of the assumptions are not met.

If we accept these assumptions then, the patent case, though structurally different, produces a recommendation similar to the one Polinsky and Shavell reached for a strict liability regime in tort. If infringers pay full damages, their conduct will be optimized, so if patentees will enforce their rights only some of the time, enhanced damages are appropriate, with the enhanced damages multiplier equal to the inverse of the probability of detection. Such a conclusion

recognize that it is more likely that the real location is lower rather than higher, simply because most of the probability distribution is lower than 99 percent. This consideration is incorporated into the model of Part II. *See infra* note 71.

would then invite critical second-order questions, such as whether courts are capable of estimating the probability of detection and applying the rule.[47]

Before we can consider such questions, we must determine whether the above two assumptions are valid, at least as first approximations. The first assumption seems more controversial from a political standpoint, but the second seems more troublesome from an analytical perspective. If the patent system has set the right threshold for patentability and liability, then at least the marginal benefits of increased protection should be equal to the marginal costs. Although this is no guarantee that a false positive is as bad socially as a false negative, there is no inherent reason to assume that false positives are more costly than false negatives. I do not mean here to demean inquiries into whether the patent system is too favorable or too harsh toward patentees, but rather to suggest that an assumption of a roughly optimized patent system, albeit one that may err in individual cases, is a useful starting point for the analysis.[48] If the system as a whole is fundamentally misconceived, either immunizing or chilling too much activity by potential infringers, then this fact alone may determine the wisdom of adjusting policy with respect to enhanced damages.

The second assumption is analytically more troublesome, because there is no inherent reason that the two bad outcomes for a potential infringer should be equally bad. When a defendant is found liable for patent infringement, the infringer will be liable at least for lost profits.[49] This damages payment is likely to be greater than the profits the infringer made if the infringer's entry caused some price competition, or if the infringer's unit production costs are higher than the patentee's. How great a loss the infringer will suffer as a result of paying damages relative to never having engaged in the conduct at all is a far more difficult question, depending on variables like supply elasticities that may vary considerably from one case to another. On top of this loss come the infringer's trial costs. How these compare with the infringer's profits, which are the opportunity cost of not entering the market, is an empirical question. Maybe the opportunity cost of not entering is greater than the costs associated with entry, for example, because a trial is relatively inexpensive. In this case, even if patentees always sue, infringers will be underdeterred. Perhaps the opportunity cost of not entering is relatively low, for example, because other potential producers will follow the potential infringer's initial entry, and this rent-seeking may lower profits close to the level of a normal return.

[47] For an argument that juries do not and cannot incorporate this type of consideration, see W. Kip Viscusi, *Punitive Damages: How Jurors Fail to Promote Efficiency*, 39 Harv. J. on Legis. 139 (2002).

[48] I will relax this assumption later. *See infra* Part III.D.

[49] *See supra* notes 19–20 and accompanying text.

In this case, infringers may be overdeterred from entry.

The case for across-the-board damages multipliers in patent cases is thus questionable. Damages might already be too high in patent cases, even taking into account underenforcement of rights, in which case damages multipliers would only aggravate the overdeterrence of noninfringing entry. We could borrow Polinsky and Shavell's conclusion that in the absence of empirical evidence to the contrary, we ought to assume that full damages are the right amount of compensation even under a negligence rule,[50] and therefore that damages multipliers are appropriate in a world of underenforcement. But the opposite assumption also seems attractive: that the patent system may reflect a series of ad hoc compromises, and the infringement decision may be roughly optimized given existing damages levels. Adding multipliers to compensate for a problem that may already have produced other responses may make matters worse, even if those responses are not well tailored to the problem. Perhaps the most that can be said is that to produce an answer with any confidence, we would need to know much more than we do about the relevant parameters that infringers face.

That does not, however, necessarily mean that we can say nothing about the appropriateness of a damages multiplier that is imposed only in a situation in which the infringer fails to obtain an opinion of counsel indicating that the conduct is likely noninfringing. These cases are only a subset of the universe of cases in which an infringer is considering potentially infringing conduct. If we assume that damages multipliers for failing to obtain a noninfringement opinion will lead potential infringers at least to seek to obtain opinions of counsel, then the cases in which the damages multipliers might be applied will not be representative of the broader universe of cases. They will be cases in which lawyers refused to grant a favorable opinion and the potential infringers decided to engage in the activity anyway.

There are at least two reasons that potential infringers might decide to engage in the activity despite not having received a noninfringement opinion in a regime in which damages multipliers will be applied should such infringers lose at trial. First, the infringer might believe that the patentee is relatively unlikely to sue. Ordinarily, a patentee might not sue because the patentee has little chance of winning, but this explanation seems that it would rarely apply, considering that at least the counsel from whom an opinion was sought agreed with the patentee. Patent law will rarely present problems of detection, so these are likely to be cases for which the cost of trial is high relative to the amount at stake. This rationale presents a strong argument for application of damages multipliers contingent on failure to receive an opinion of counsel. Because the cases in which damages multipliers apply will be those in which

[50] *See supra* notes 39–40 and accompanying text.

the infringer believes that the patentee probably will not sue despite having a fairly strong case, they will be cases in which underdeterrence is particularly likely. The damages multipliers both increase the probability of suit and punish infringers whose calculation that suit is unlikely turns out to be mistaken.

The second reason that an infringer might engage in potentially infringing activity despite not obtaining a noninfringement opinion is that the infringer might believe that the third party is simply wrong. The cases in which a lawyer concludes that the activity will be infringing and a potential infringer concludes that the activity will not be infringing will be those that are closest to the line, in the middle of the gray zone. Of cases in which a potential infringer does engage in the relevant activity, these will also be the cases in which it is most likely that a patentee will sue. Thus, the Polinsky-Shavell argument for damages multipliers seems inapplicable. If a patentee will sue with high probability in such a case, underenforcement is not an issue.

We are thus left with two empirical questions about the use of damages multipliers, and the applicability of both should be unsurprising. First, how great is the danger, in a system without damages multipliers, that potential infringers will refrain from engaging in potentially infringing activities because they will receive only a portion of the social benefit from suit? When that danger is high, entry into potentially infringing activities may already be overdeterred, and damages multipliers of any kind will merely exacerbate matters.

Second, how often will a patentee in a system without damages multipliers be deterred from suing by the high cost of suit? If patentees often will not sue, then the case for damages multipliers as a general matter will be strong. Moreover, a tendency of patentees not to sue particularly strengthens the case for damages multipliers that apply only when an infringer fails to obtain an opinion of counsel. As the above analysis indicates, the cases in which the damages multipliers apply will be largely of the two types described above, cases in which underenforcement is particularly likely and cases that are particularly close. The more cases that fall into the former category, the stronger the case for the damages multipliers.

C. Discouraging Trial

The analysis in the previous section considers the extent to which damages multipliers optimize a potential infringer's initial decision whether to infringe. That analysis is limited for two reasons, and the reasons point in opposite policy directions. First, a potential infringer's decision is not the final word, at least in cases in which the potential infringer is sued. When a court concludes that a patent is valid and infringed, it restores lost profits and thus much of the incentive to invent. So an initial decision to engage in arguably infringing activity may not be a problem at all, but just a prelude to a resolution by a court, which may be in the best position to reach an acceptable conclusion.

Second, the cost of trial itself might be relevant. Above, I considered that anticipation of the cost of trial might affect patentees' decisions and thus prospectively potential infringers', but I did not count the cost of trial itself as a welfare cost. If trial itself is seen as a transactions cost, then by discouraging infringement, multipliers may advance social welfare.

The level of litigation thus matters not only because a greater volume of litigation responds to concern about underdeterrence, but also because litigation matters in and of itself. The two views above focus on the litigation process, rather than on litigation's effects on incentives to engage in infringement, with the first view depicting litigation as a social good and the second view depicting litigation as a social bad. The first view, however, seems normatively unattractive, at least in the patent context. Perhaps litigation is a social good independent of its effects in a litigation context in which a primary goal is to achieve outcomes that are perceived as fair.[51] For example, in the Social Security context, we may be concerned not only with optimizing the government's initial decision whether to grant benefits, but also to correct initial mistakes. In the patent system, by contrast, what we care about most is not justice for inventors, but whether the system on average provides optimal incentives to engage in inventive and commercial activity.

This argument does not deny that errors in patent litigation matter. Systematic errors in patent adjudication may cause inefficient primary conduct, and even noisy decisions may increase uncertainty, thus discouraging invention. The point, though, is that if litigation can optimize the initial invention decision and the decision whether to infringe with fewer, rather than with more cases, society benefits. To be sure, it is possible that a world in which all cases were costlessly tried would produce more consistent outcomes and a more reliable environment for decision-making than a world in which only some cases are tried and other decisions are made in the shadow of trial. The costs of trials, however, are significant and serve as a disincentive to engage in inventive and commercial activity. The challenge, then, is to design a litigation system in which only a relatively small number of cases are tried, but the shadow a trial casts helps to optimize private decisions across-the-board.

Even once we agree that a legal system with fewer trials should be a goal, it may not be immediately obvious that damages multipliers would be an answer. Such multipliers have two effects that point in opposite directions. They make arguably infringing behavior less likely in a particular case, and thus, trial less likely, but they also could make a suit more likely should arguably infringing behavior occur because a plaintiff will be more likely to sue if damages are greater. The first effect, however, is generally much larger in

[51] *See, e.g.*, E. Allan Lind & Tom R. Tyler, The Social Psychology of Procedural Justice (1988); John Thibaut & Laurens Walker, Procedural Justice: A Psychological Analysis (1975).

magnitude than the second. The reason is that the first effect eliminates the relatively egregious cases of potential infringement, so the cases that previously would have been the strongest for the patentee no longer exist. As a result, the proportion of cases of arguably infringing activity that result in suit does not change much when damage multipliers increase, and so the overall level of litigation ordinarily will decline.

Table 1 illustrates the point with a simple model in which there is no asymmetry of information.[52] Suppose that across a universe of 101 cases, infringement would profit the potential infringer $100 and cost the patentee $100. Assume further that the probability that the infringer would win in these cases is uniformly distributed from 0 to 1. Table 1 illustrates the effect of changing multipliers on the number of instances of infringement and the number of resulting lawsuits. With relatively low trial costs of $10 per side and a damages multiplier of 1 (i.e., no damages enhanced), the defendant will engage in the potentially infringing activity in 91 of the 101 cases (all those for which the probability that the patentee wins is 0.90 or less), and the plaintiff will sue in 80 of these cases.[53] With multipliers of 2 and 3, the defendant engages in the potentially infringing activity less often, but the total number of cases that the plaintiff brings declines. Relatively high trial costs produce a similar result. A simple conclusion is that across-the-board damages multipliers tend to reduce the frequency of suit, and the effect is stronger with relatively low trial costs than with relatively high costs.

Table 1. *Effect of multipliers on the level of litigation*

	Low trial costs ($10 per side)			High trial costs ($50 per side)		
	1	2	3	1	2	3
Potential infringement occurs	91	48	33	67	40	29
Patentee sues	80	42	29	16	14	12

Table 1 does not mean that there are no individual cases in which a lawsuit is more likely with higher damages multipliers. Indeed, a lawsuit will be more likely for relatively frivolous cases, that is those the patentee is relatively unlikely to win. Table 2 is illustrative. This table is identical to Table 1, except the population of cases reflects a uniform distribution of the probability that the patentee will win from 0 to just 0.2. Because these are weak cases for the

[52] A spreadsheet illustrating these results is available from the author. The spreadsheet reveals that these conclusions are robust across a fairly wide range of trial costs and multipliers.

[53] This reflects the assumption that the plaintiff will not sue when the benefits of suit exactly equal the costs.

patentee, there is no effect with these parameters on the frequency with which the potentially infringing activity occurs. It occurs in every case, and indeed that is presumably a good result from a social perspective, given that most courts would conclude that the activity is noninfringing. Higher multipliers, however, may induce greater frequency of suit. In the low trial costs case, the frequency of suit rises from 50 to 84 with multipliers, and in the high trial costs case, the frequency of suit rises from 0 to 17.

Table 2. Effect of multipliers on the level of litigation (weak cases for patentee only)

	Low trial costs ($10 per side)			High trial costs ($50 per side)		
	1	2	3	1	2	3
Potential infringement occurs	101	101	101	101	101	101
Patentee sues	50	75	84	0	0	17

Thus, while across-the-board damages multipliers tend to reduce the level of litigation overall, they tend to increase the level of litigation where potential infringers have strong cases. As a result, with relatively high damages multipliers, a relatively large portion of the number of cases in which suit is brought will be cases in which potential infringers have strong cases. For example, in Table 1, with low trial costs and damages multiplier of 3, a lawsuit occurs in 29 cases. Of those 29 cases, 17 are cases in which the probability that the plaintiff would win is less than or equal to 0.2. The assumption of a uniform probability distribution in Table 1, moreover, may be unrealistic; it seems plausible that the number of potential cases in which patentees could concoct weak claims could dwarf the number of cases that are genuinely close. Thus, to the extent that the goal is to reduce the level of litigation, the legal system ideally should impose damages multipliers except in the cases where the probability that the patentee wins is relatively low. The problem is that these ex ante probabilities are not apparent ex post. A court that issues a judgment in favor of a plaintiff is unlikely to conclude that the plaintiff had a weak case.[54]

[54] There are some contexts in which judges do sometimes assess the ex ante probability that a plaintiff will win, such as in the context of awarding attorney's fees after a class action settlement or judgment. *See, e.g.*, Lindy Bros. Builders v. Am. Radiator & Standard Sanitary Corp., 487 F.2d 161, 167–68 (3d Cir. 1973) (describing how to multiply attorney's fees based on the initial probability of success). *But see* Burlington v. Dague, 505 U.S. 557, 565–66 (1992) (refusing to allow such multipliers in a civil rights case, lest they encourage lawyers to undertake frivolous litigation). In many such cases, the assessment of a low ex ante probability is not in tension with the resolution of the case, as the award in effect may reward counsel

There are a variety of strategies that might be used to evade this problem. One might be for courts to develop some form of two-way penalty regime. With this approach, a plaintiff's victory leads to imposition of a damages multiplier, but a plaintiff's defeat requires the plaintiff to make some payment, either to the defendant or to the court. The plaintiff's penalty might be set equal to the defendant's trial costs, though there is no immediately apparent reason that this should be the optimal number. This approach will discourage a patentee from bringing relatively frivolous suits, without having a substantial effect on more serious suits. The literature on fee-shifting is vast, and it encompasses concerns that are beyond my scope here.[55] F. Scott Kieff has offered several persuasive points in favor of the imposition of fee-shifting in patent cases,[56] and he observes that the Federal Circuit has shown willingness to impose fee-shifting against patentees by imposing sanctions under Rule 11 of the Federal Rules of Civil Procedure.[57]

Though such measures may help, the hook for them is independent of the doctrine imposing enhanced damages on infringers. That doctrine, however, can reflect other strategies that may reduce the tendency of damages multipliers to increase frivolous litigation. First, the requirement that infringement be willful before enhanced damages are imposed may help. It may be the case that when a patentee has a weak case, but nonetheless prevails in litigation, the court is relatively unlikely to find that the infringement was willful. Courts generally refuse to impose enhanced damages when the infringer has a substantial defense to infringement. Even when a court is unusual in finding for a patentee, it will usually not be so anomalous that it finds the infringer did not even have a substantial defense. Interestingly, the point here is not that this doctrine is useful because it separates cases in which an infringer mounts a frivolous infringement defense from those in which an infringer mounts an unsuccessful but meritorious defense. Rather, the counterintuitive point is that the doctrine may help separate the cases in which the *patentee* has a weak case but wins from those cases in which the patentee has a stronger case. The theory developed so far suggests that if the goal is to reduce litigation, damages multipliers may be appropriate in all cases that the patentee wins,

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for uncovering surprising information. There may be some analogues to this in the patent context, for example when discovery reveals unexpected prior art invalidating a patent. There are many patent cases, however, in which ambiguity is legal, not factual.

[55] Omer Alper and I will consider optimal fee-shifting rules in a separate project, tentatively entitled *Litigation Bonding.*

[56] F. Scott Kieff, *The Case for Registering Patents and the Law and Economics of Present Patent-Obtaining Rules*, 45 B.C. L. Rev. 55, 118–22 (1993).

[57] *See id.* at 119-20 (citing Judin v. United States, 110 F.3d 780, 783–85 (Fed. Cir. 1997)). The Federal Circuit can impose attorney's fees on infringers under 35 U.S.C. § 285 (2000).

except those that initially seemed weakest.

Second, a limitation of damages multipliers to only cases in which an infringer fails to obtain an opinion of counsel indicating that infringement is willful can serve a similar function. In a case that is initially weak for the patentee, an infringer presumably will be able to obtain an opinion of counsel indicating that the activity likely is not infringing. Even if the patentee is lucky and happens to draw a favorable court, the opinion of counsel would prevent the court from enhancing damages. Once again, the key for reducing litigation is that damages multipliers not be available in the cases in which the patentee initially has only a small chance of prevailing. This suggests, again counter-intuitively, that the opinion-of-counsel requirement could enhance social welfare more if an opinion of counsel is relatively hard to obtain in close cases.[58]

The analysis so far, however, suffers from a serious limitation, the exact opposite of the analysis in the previous section. Reducing litigation costs is only half the picture, and optimizing the incentives of potential infringers is the other half. On the end of the probability spectrum where patentee claims are weak, the concerns generally seem aligned. These are cases in which we do not want the plaintiffs to sue because we do want the potential infringers to engage in the activity most courts would conclude is not infringing. The opinion-of-counsel safe harbor will limit the tendency of damages multipliers to make suit more attractive for plaintiffs. On the other side of the probability spectrum, the interests also seem at least roughly aligned. What we are worried about here is frivolous infringement, and imposing damages multipliers here will deter such infringement, and thus, also greatly reduce the incidence of trial. Thus, at least as a first theoretical approximation, it appears that a regime of damages multipliers, with a safe harbor for cases in which the infringer obtains an opinion of counsel, leads to good results on both ends of the probability spectrum: a deterrent to infringement (and thus lawsuits) where the infringer does not have a strong case, without providing an inducement to a lawsuit (and thus a deterrent to engaging in the activity) where the infringer does have a strong case.

In the rough middle of the probability spectrum, it may appear still more difficult to assess the optimality of a regime of enhanced damages in the absence of an opinion of counsel. For cases in this area, there may be a large number of errors — cases in which a particular court's conclusion about infringement is wrong, at least in the sense that most courts would disagree with the assessment.[59] These are also likely to be the cases in which outcomes are most sensitive to model specification. For example, whether it is relatively easy or

[58] I demonstrate this formally *infra* Section III.C.

[59] For a defense of a definition of presumption legal correctness that similarly looks to what a majority of courts would decide, see Michael Abramowicz, *En Banc Revisited*, 100

difficult to obtain an opinion of counsel may have little effect on the ends of the probability spectrum, but will have a significant effect in the middle. Similarly, if courts are as a general matter slightly systematically biased in favor of patentees or in favor of infringers, that bias is most likely to affect the marginal cases.

The analysis, however, ultimately might be easier for the middle of the probability spectrum as these cases will be those for which concerns about reducing litigation costs loom large relative to concerns about reaching the "correct" answer. In the middle of the probability spectrum, courts will reach the correct answer only just over half the time, so the benefit of litigation in arriving at the correct answer is reduced. Moreover, a patentee's or potential infringer's own assessment of where the case lies will be wrong close to half the time, so to the extent the legal system succeeds in leading patentees and infringers to act based on whether they believe the activity really is infringing, the social gains will be slight. The social costs of trial will be roughly the same for close cases, or perhaps even worse, since these cases may be less likely to be settled.[60] Applying damages multipliers for such cases thus seems likely to advance social welfare, even if the multipliers mean that some individuals who would not have been infringing do not engage in the noninfringing activity. A rule of thumb thus is that at the ends of the probability spectrum it is particularly important for the legal system to induce the parties to behave optimally, and in the middle of the probability spectrum for the legal system to keep cases out of court. This again reinforces that providing the safe harbor only in cases in which there is a strong argument that the activity is not infringing might be better than a regime in which opinions of counsel can be obtained more easily.

II. A Simulation Model of Infringement and Trial

The analysis so far has been sufficient to identify an intuition that enhanced damages where an infringer fails to obtain an opinion of counsel might advance social welfare, and a more tentative intuition that social welfare might be increased more if the opinions of counsel are relatively difficult to obtain. This part introduces a simulation model that will allow more formal testing

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Colum. L. Rev. 1600, 1602 (2000). This definition seems particularly appropriate given the assumption above that courts are not systematically biased in favor of patentees or infringers, so in any given suit the majority is more likely to be right than wrong. I relax that assumption below. *See infra* Part III.D.

[60] These are also the cases in which suits are least likely to be settled. Cases are more likely to settle when the parties are mutually optimistic about the expected outcome, and mutual optimism seems most likely to have a significant effect near the middle of the probability spectrum. *See* Michael Abramowicz, *A Compromise Approach to Compromise Verdicts*, 89 Cal. L. Rev. 231, 294 (2000).

of these intuitions. Because all formal models abstract from reality, results will always depend somewhat on the structural features of the model, as well as values of model parameters. It would be hazardous to use a formal model, for example, to determine an optimal damages multiplier, at least in the absence of a robust model and empirical studies allowing the setting of model parameters with confidence. Judges and other decision-makers, however, do need to make decisions in the face of great uncertainty about the effects of those decisions. Formal models at least make it possible to roughly identify the effects of different institutional rules on private parties' incentives, and to assess the extent to which those effects are robust to or contingent on parameters about which there might be uncertainty.

Rather than use a formal mathematical model, this paper relies on a computer simulation employing genetic algorithms. Part II.A explains the basis for this choice and describes the model in more detail. Part II.B offers a comparison, under a particular set of parameters, of a patent system without damages multipliers with a patent system with damages multipliers that are applied when an infringer fails to obtain an opinion of counsel. Part III will then offer numerous variations on the initial setup to show how different features of the universe of patent cases or of the legal regime might affect the results.

A. The Model

The primary advantage of a mathematical model over computer simulation models is that mathematical models allow for precise identification of assumptions and for certainty that, assuming the mathematics is correct, the conclusions follow from those assumptions. A limitation of mathematical models is that the demands of mathematical tractability may force unrealistic assumptions and prevent formal consideration of how altering both the model's realistic and unrealistic assumptions might change the paper's conclusions. In this particular project, an important question is to what extent various conclusions hold, assuming changes in parameters, such as the accuracy with which patentees, infringers, and lawyers assess cases. The setting involves a game between the patentee and the potential infringer, with the potential infringer deciding how to act based in part on an assessment of how likely the patentee is to sue, and the patentee deciding whether to sue based in part on a Bayesian calculation about the potential infringer's information. It would be difficult to develop a satisfactory game theoretic account of the interaction without severe simplifications. This project thus uses a simulation model, and the usual caveats about such models apply. Because it is difficult to generalize beyond the particular set of simulation parameters, I will seek to assess robustness by showing how altering various simulation parameters may affect the model's results.

Perhaps one reason that simulation models have not been more widely

used in economics, and particularly in the law-and-economics literature on litigation, is that if a simulation involves interactions among multiple actors, there must be some specification of how these actors should behave. But often that is one of the primary questions, and once we know how the parties would behave, welfare calculations become trivial. In this project, for example, if we simply made assumptions about when potential infringers will infringe and when patentees will sue, it would be very easy to make generalizations about the effects of policy variables such as the imposition of damages multipliers. But those generalizations' accuracy would depend on the accuracy of the assumptions. A model of the patent process or of the litigation process in which the behaviors of the actors are defined exogenously will often not be interesting. Because mathematical models are the typical method for endogenizing behavior of the actors, simulations might seem to have relatively limited scope.

The challenge is to develop a simulation in which the players' goals (e.g., maximization of wealth) are specified, along with other parameters, but the simulation endogenously determines the players' behavior. To accomplish this, the players' behavior must be learned over repeated plays of the game. Though there are a variety of artificial intelligence techniques that might allow learning in the context of a relatively simple litigation game (simple compared, say, to chess), one approach is to use a genetic algorithm to evolve the behavior of the players. The next section describes genetic algorithms in general and the particular implementation of genetic algorithms that this project uses.

1. Genetic Algorithm Implementation

Perhaps the most famous implementation of genetic algorithms in the social science literature stems from Robert Axelrod's famous, if controversial,[61] study of cooperative behavior.[62] Axelrod invited submissions of different strategies for a computer simulation of an iterated prisoner's dilemma game.[63] The computer pitted these strategies against one another in a round-robin tournament. Axelrod found that a very simple strategy — "tit-for-tat" — proved to be the most effective.[64] Though Axelrod's initial analysis involved a tournament selecting among predetermined strategies, later work by Axelrod and others

[61] For a criticism of Axelrod's work, see Ken Binmore, Book Review, *at* http://jasss.soc.surrey.ac.uk/1/1/review1.html (reviewing Robert Axelrod, The Complexity of Cooperation: Agent-Based Models of Competition and Collaboration (1997)) (last visited Aug. 14, 2004).

[62] Robert Axelrod, *Effective Choice in the Prisoner's Dilemma*, 24 J. Conflict Resol. 3 (1980).

[63] *See generally* Douglas G. Baird et al., Game Theory and the Law 31–35 (1994) (providing an introduction to the prisoner's dilemma).

[64] Under this strategy, a player would cooperate in the first round, and in each subsequent round would cooperate only if the opponent did so in the previous round.

employs initial random strategies and an evolutionary process to refine the strategies over a number of generations.[65]

The prisoner's dilemma is a relatively simple game, and the computational demands of genetic algorithms may help explain why genetic algorithms have not been used more extensively in social science.[66] Genetic algorithms are, however, finding increasing application in economics,[67] perhaps as a result of increasing computer processor speed. As this project demonstrates, genetic algorithms can be used to evolve fairly refined strategies for litigants, at least in relatively simple contexts in which the players make a series of binary choices. Genetic algorithms also make it straightforward to determine how parties' behavior will change given changes in the rules or parameters of the game.

The literature on genetic algorithms is vast,[68] but genetic algorithms generally work roughly as follows: a population of genomes is randomly generated. The fitness of each genome is then evaluated. Some genomes are then eliminated from the population, with more fit genomes less likely to be eliminated. The population shortfall may be made up through *crossover*, in which two genomes are combined to produce another genome. In addition, some genomes are randomly selected for *mutation*, with some change being made to the genome to produce another genome. The fitness levels of the new genomes are evaluated, and this process repeats across a number of generations. Eventually, the population members may converge to a particular solution to the relevant problem.

In the context of a game based on the litigation system, a genome must encode the strategy for each of the players. To evaluate the fitness of the genome, the game is played. Where there is some randomness to the game (for example, because of information uncertainty in a litigation game), the game must be played large numbers of times to generate reliable indications of the fitness of the particular genomes. Where the genetic algorithm is being used to evolve the behavior of more than one player in a game, the behaviors may be *coevolved*. With co-evolution, the initially optimal strategy for one player (say, the plaintiff) may no longer prove optimal once the strategy of another player (say, the defendant) improves over time. A genetic algorithm, however,

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[65] *See, e.g.*, Robert M. Axelrod, *The Evolution of Strategies in the Iterated Prisoner's Dilemma*, *in* Genetic Algorithms and Simulated Annealing 32–41 (Lawrence Davis ed., 1987).

[66] For a bibliography of social science use of genetic algorithms, see The Evolutionary Models in Social Science (EMSS) Web Bibliography, *at* http://www.soc.surrey.ac.uk/~scs1ec/emssbib.html (last visited Aug. 14, 2004).

[67] For an introduction, see Thomas Riechmann, Learning in Economics: Analysis and Application of Genetic Algorithms (2001).

[68] For overviews, see Melanie Mitchell, An Introduction to Genetic Algorithms (1997) and William B. Langdon & Riccardo Poli, Foundations of Genetic Programming (2002).

may converge to a Nash equilibrium in which neither player's strategy can be improved upon given the strategy of the other player.

The genetic algorithm used in this project is derived from a genetic algorithm library created by Matthew Hall for the C++ programming language.[69] For this project, the genomes corresponding to a particular actor consist of coefficients for a linear decision-making model like the following: $Decision = (\alpha_0 + \alpha_1\beta_1 + \alpha_2\beta_2 + \ldots + \alpha_n\beta_n) > 0$.

The genetic algorithm optimizes the α coefficients, and the β variables represent information available to the decisionmaker in any particular iteration of the game. The α coefficients are initially set to random values, and where the right hand side evaluates to TRUE (because the sum of the terms is greater than zero), the player makes an affirmative decision. In each generation of the game, each player receives a score that depends on the performance of the genetic algorithm across a large number of iterations.

The genomes that perform well are more likely to survive into the next generation, and the selection algorithm employs *elitism*, which means that the best genome in every generation always survives. A danger of elitism is that a genetic algorithm might converge too quickly to a particular solution that represents a local but not a global optimum. To limit this danger, the algorithm uses a variant on the idea of *overlapping populations*. Specifically, the algorithm re-randomized the entire population of genomes approximately each 100 generations, and then it merged the best genomes to emerge from these separate evolutions after 80 percent of the total number of generations. For this project, each run of the genetic algorithm involved a total of 5050 generations, with 1000 iterations in the first 5000 generations, 5000 iterations in the next 49 generations, and 250,000 iterations in the final generation to minimize the danger that the selection of random numbers in each iteration of the game significantly affects the optimal strategy.

Each iteration requires that the game be played with the same random settings for each member of the population, and populations of 50 genomes were used. In evolving the genome for a particular actor in a patent litigation game, the competition for each genome of the other actors is the best genome in the preceding evaluation of the opponents' genomes. Thus, in generation 2, a population of potential infringer genomes plays the litigation game against the patentee genome that had the highest score in generation 1, and then later in that same generation, the population of patentee genomes plays the game against the potential infringer genome that achieved the highest score.

This implementation of co-evolution raises two concerns: first, if there are multiple sets of equilibrium strategies, the genetic algorithm may converge randomly to one set of strategies. The outcome on one run of the genetic

[69] *See* GAlib: Matthew's Genetic Algorithms Library, *at* http://lancet.mit.edu/ga/ (last visited Aug. 14, 2004).

algorithm might then, by chance, be different from the outcome on a different run. This danger seems small, however, in the context of a simple litigation game, and repeated runs did not reveal multiple equilibria. Second, the behavior that evolves will be the optimal behavior against sophisticated players, rather than against naïve players.[70] Potential infringers in the patent litigation game will thus conclude that patentees will never sue when it would be irrational for the patentees to sue. They thus might infringe in such a situation for a very small benefit, even though they would not do so in a world in which a relatively small number of irrational patentees would sue. This aspect of the simulation, of course, is a limitation common in game theoretic rational expectations models.

2. The Infringer-Patentee Game

The game that the infringer and patentee play in the simulation begins with invocation of a random number generator to choose various simulation variables for the particular iteration of the game. The values that would be selected for the baseline version of the simulation are as follows (with variations on this setup described in Part II.C):

- A *probability of infringement* from a uniform distribution from 0 to 1. This represents the probability that a court would find the patent to be valid and infringed by the potential infringer's activity. This simple game thus makes no distinction between the validity and infringement decisions. The random number generator also determines whether the court would eventually find infringement, though the players have no access to this information.
- An *estimate of the probability* for each of three parties: the patentee, the infringer, and the third-party counsel. The probability is determined by taking the actual probability and adding some noise factor.[71] In the

[70] This may be of greater significance in games that involve long sequences of moves by the different players, such as the iterated prisoner's dilemma. *See, e.g.*, P.J. Darwen & X. Yao, On Evolving Robust Strategies for Iterated Prisoner's Dilemma (Nov. 16, 1993) (unpublished manuscript, on file with author) (demonstrating that genetic algorithms may cause useful behavior responses to naïve players to atrophy).

[71] The noise factor was added as follows: Let p_0 represent the initial probability estimate and n the noise factor. Let p_1 equal the sum of p_0 and a stochastic variable from a normal distribution with a standard deviation of n. There would be two related problems with using p_1 as the revised probability estimate. First, this procedure may produce values that are lower than 0 or higher than 1. Second, the rational actor would make an adjustment to p_1 to map the distribution of possible p_1 values onto the corresponding p_0 values. For example, if $p_1 = 0.99$, it is more likely that p_0 is a lower number than a higher number, because there is a wider range of lower numbers that with the addition of an error term can produce 0.99 than there are higher numbers. The function that performs the biased calculation accomplishes this

baseline version of the simulation, the level of noise was sufficient so that all three parties had relatively good information. More specifically, the noise levels resulted in an average error for each party of 6.8 percentage points.[72]

- A *damages multiplier*. In most simulations, this was randomly selected from 1 (no damages multiplier) to 4 (a high multiplier). The purpose of randomly selecting the damages multiplier during evolution is to ensure that the players' behavior evolves to take the multiplier into account in their decision-making. The genetic algorithm can then subsequently be run with any particular damages multiplier within the range.

In this simulation, the third party is always consulted.[73] When the third party's estimate in the baseline simulation results in a conclusion that there is greater than a 0.50 probability that the patent is valid and infringed, the third party refuses to issue an opinion of counsel providing the defendant a safe harbor; when it is less than or equal to 0.50, the third party issues such an opinion. The potential infringer must then make a decision whether to perform the potentially infringing activity, and, if the potential infringer decides to do so, the patentee must make a decision whether to sue. The variables available to the potential infringer include whether the third party has issued a letter, the damages multiplier, and the infringer's own initial estimate of the probability that the activity is infringing.[74] In cases in which the potential infringer decides to engage in the activity, the patentee considers the damages multiplier and the patentee's own estimate of the probability that the activity is infringing.[75]

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inverse calculation automatically. Note that as n approaches infinity, the function's output will converge to 0.5.

[72] These resulted from noise factor $n = 0.10$.

[73] A more elaborate model would endogenize the potential infringer's decision whether to consult a third party. I did not incorporate such a decision into this model because the effects seem likely to be straightforward. The cheaper such a consultation, and the greater the penalty for not seeking a third-party opinion, the greater the chance that an infringer will consult with a third party. The infringer also presumably would be more likely to seek an opinion in close cases than in cases in which the third party is confident about whether the activity is infringing.

[74] The linear model also included variables that reflected combinations of these. In particular, for each of these variables, an additional term was included in the model representing the product of the variable and (1) the variable indicating whether an opinion letter issued; (2) the damages multiplier; (3) the square of the damages multiplier; and (4) the infringer's initial probability estimate. For example, one of the terms of the linear model would include the cube of the damages multiplier, since the square would be multiplied by itself.

[75] The linear model for the patentee similarly multiplies these variables by (1) the damages multiplier, (2) the square of the damages multiplier, and (3) the patentee's initial probability estimate.

The scores that potential infringers and patentees receive for a generation are the average of their scores in each iteration. In each iteration, the scores depend on the decisions the parties make and the outcome in court, if the case goes to trial. In the baseline simulation, the patentee faces a loss of 100 if the potential infringer conducts the activity and the patentee does not sue or loses, and the potential infringer faces a loss of 100 if the potential infringer does not conduct the activity or eventually loses in court. At the same time, the parties face costs from trial itself. In the baseline simulation, each party's cost is fixed at 20. Note that the model does not incorporate settlement, so the cost of trial is always the same once the patentee makes the initial decision to sue.

B. Baseline Results

Let us now consider the results of a simulation using the default settings for parameters described above. First, Table 3 uses the evolved genomes to play the litigation game 10,000 times with a damages multiplier of 1; that is, without imposing any enhanced damages in cases in which the infringer fails to obtain an opinion of counsel. Each row represents a different subset of the iterations of the game, with the first column indicating the proportion of cases in that category. Thus, the "activity occurs" row represents the 69.8% of cases in which the infringer decides to engage in the activity; the "patentee sues" row represents the 52.5% of cases in which the patentee decides to sue (leaving 17.3% of cases in which the potential infringer's decision to engage in the activity is unchallenged); the "no op. letter" row represents the 50.2% of cases in which the third party refuses to grant an opinion letter; the "opinion letter" row represents the 49.8% of cases in which an opinion letter is issued; the "not infringing" row represents the 49.8% of cases in which a majority of courts would not find infringement; and the "would be infringing" row represents the 50.2% of cases in which a majority of courts would find infringement. (The deviations in the last four rows from exactly 50% of the cases occur as a result of chance.) The columns represent the proportions of those groups of cases in which: 1) the activity would be found by most courts to be infringing; 2) no opinion letter issues; 3) the potentially infringing activity occurs; 4) the patentee sues; 5) the patentee wins; 6) the multiplier (here, inconsequential, because the multiplier is 1) is imposed; and 7) the outcome of the game is a false negative (activity occurs and is not stopped by the courts even though most courts would find it infringing) or a false positive (activity does not occur even though most courts would not find it infringing).

Table 3. Baseline simulation (no damages multipliers)

	% of cases	Would be infringing	No op. letter	Activity occurs	Patentee sues	Patentee wins	Multiplier imposed	False negatives	False positives
All cases	1.000	0.502	0.502	0.698	0.525	0.231	0.120	0.076	0.107
Activity occurs	0.698	0.288	0.286	1.000	0.752	0.330	0.172	0.109	0.152
Patentee sues	0.525	0.383	0.379	1.000	1.000	0.439	0.229	0.145	0.202
No op. letter	0.502	0.922	1.000	0.398	0.397	0.239	0.239	0.116	0.035
Opinion letter	0.498	0.080	0.000	1.000	0.654	0.222	0.000	0.036	0.179
Not infringing	0.498	0.000	0.078	0.999	0.652	0.213	0.035	0.000	0.214
Would be infringing	0.502	1.000	0.921	0.400	0.400	0.248	0.205	0.152	0.000

Consistent with the analysis in Part I, Table 3 suggests that in the absence of enhanced damages, both infringement and suit will occur too often. Note that the potential infringer decides to engage in the activity 69.8% of the time, even though most courts would find the activity infringing half the time. The potential infringer engages in the activity 99.9% of the time when most courts would find the activity not infringing, and 40.0% of the time when the courts would find the activity infringing. Note also that while the potential infringer is aggressive, the patentee is as well, suing 75.2% of the time that the activity occurs, even though most courts would find the activity infringing only 28.8% of the time. As a result, the patentee wins only 43.9% of lawsuits. Overall, the patentee ends up suing in 52.5% of cases.

The challenge for the legal system is to lower the frequency of suit and improve the incentives of potential infringers and patentees, or at least not affect them too adversely. In this iteration of the game, false negatives occur 7.6% of the time, and false positives 10.7% of the time. Enhanced damages should decrease false negatives (by deterring infringers) and increase false positives (by incentivizing suit when infringement does occur). The theory developed in Part I.C suggests that a safe harbor in cases in which the potential infringer receives an opinion of counsel authorizing the activity should mute the second effect, by limiting the increase in patentees' incentive to sue when their cases are weakest.

Figure 1 tests this theory by reporting results from the same simulation, but varying the multiplier. For each multiplier level from 1 to 4 (in increments of 0.1), the best genomes played the game 10,000 times, and the figure shows how changing the multiplier affected the rate of suit, false positives, and false negatives. Because there is some randomness even across 10,000 iterations of the game, the lines are not entirely smooth, but trends unmistakably emerge. As predicted, increasing damages multipliers reduced the rate of suit, an effect that levels off past a certain level. The figure shows an increase in false positives, but only a modest one, along with a marked decrease in false negatives. The

baseline simulation thus suggests that damages multipliers may enhance social welfare, with benefits leveling off past a damages multiplier of about 2.

Figure 1. Effect of enhanced damages on false negatives, false positives, and lawsuits

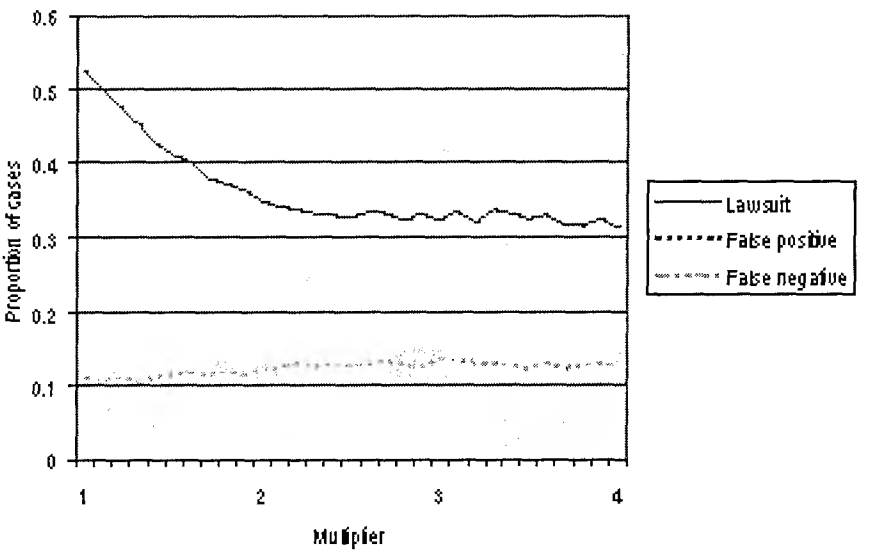


Figure 2. Effect of enhanced damages on potential infringement, suit, and outcomes

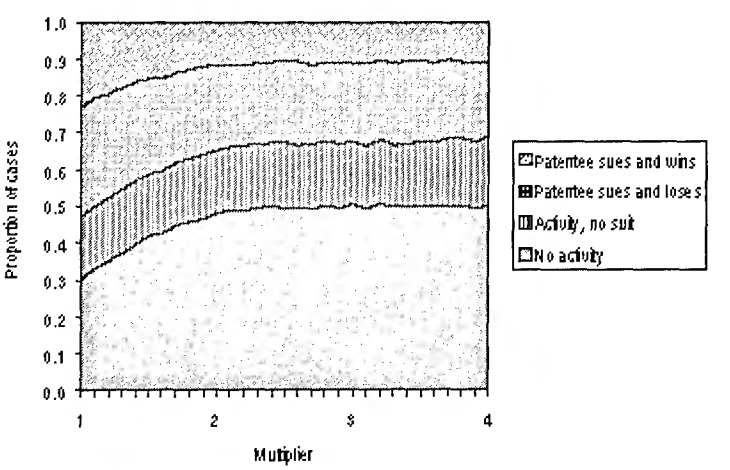


Figure 2, meanwhile, provides a graphical demonstration of how this damages multipliers regime manages to reduce suit without adversely affecting incentives. The figure shows that the increase in the multiplier level from 1 to 2 produces a steady increase in cases in which the potential infringer decides not to engage in the potentially infringing activity. There are small negative effects on the number of cases in which the activity occurs but the patentee does not sue and in which the patentee sues and loses. Most of the increase

in cases in which the potential infringer decides not to infringe comes largely at the expense of cases in which the patentee would sue and win. The damages multiplier regime thus succeeds in deterring potential infringers from engaging in activity for which there is a high probability that they would be successfully sued.

Table 4. Baseline simulation (damages multiplier of 2.0)

	% of cases	Would be infringing	No op. letter	Activity occurs	Patentee sues	Patentee wins	Multiplier imposed	False negatives	False positives
All cases	1.000	0.492	0.497	0.520	0.348	0.116	0.007	0.017	0.120
Activity occurs	0.520	0.079	0.033	1.000	0.670	0.223	0.014	0.032	0.177
Patentee sues	0.348	0.117	0.050	1.000	1.000	0.333	0.020	0.048	0.264
No op. letter	0.497	0.917	1.000	0.035	0.035	0.014	0.014	0.005	0.068
Opinion letter	0.503	0.072	0.000	1.000	0.658	0.217	0.000	0.028	0.172
Not infringing	0.508	0.000	0.082	0.944	0.605	0.181	0.010	0.000	0.237
Would be infringing	0.492	1.000	0.926	0.083	0.083	0.049	0.004	0.034	0.000

Finally, Table 4 elaborates the changed incentives from damages multipliers in more detail by reporting in detail the results of running the simulation with a damages multiplier of 2.0. The "all cases" row reflects the central conclusions of Figure 2: 1) conduct of potentially infringing activity falls (from 69.8% in Table 3 to 52.0% here); 2) the lawsuit rate falls (from 52.5% of all cases to 34.8%); 3) the cases in which the patentee wins falls (from 23.1% of all cases to 11.6%); and 4) false negatives fall dramatically (from 7.6% to 1.7%) with only a slight increase in false positives (from 10.7% to 12.0%). Meanwhile, in cases in which potentially infringing activity occurs, the rate of suit drops from 75.2% to 67.0%, a reflection of the fact that in such cases, there is a precipitous drop in the percentage of cases in which a majority of courts would find the activity to be infringing (from 28.8% to 7.9%). Finally, the results show that the simulation effects are almost entirely due to cases in which no opinion letter is issued. This is exactly as expected, because no damages multipliers are applied where an opinion of counsel is obtained. The statistics for cases in which an opinion letter is issued approximately track those in Table 3. But where no opinion letter is issued, there are dramatic differences, most notably, a decline in the proportion of these cases in which the potential infringer engages in the activity anyway, from 39.8% to 3.5%. This dramatic increase helps explain why the effect of damages multipliers levels off quickly in this simulation for numbers higher than 2.0; there are simply very few cases in which the additional deterrent may still be relevant.

III. Variations and Extensions

To assess the robustness of the model, this Part offers various modifications to the model. Part III.A considers the possibility that the parties may have asymmetric stakes from litigation or asymmetric costs of litigation, and it also considers the effect of changes in both parties' costs on the level of litigation. Part III.B assesses the model given assumptions of weaker information than is reflected in the baseline simulation. Part III.C examines how the ease of obtaining a noninfringement opinion may affect the effectiveness of an enhanced damages regime. Finally, Part III.D considers the effect of an enhanced damages regime *if* the patent system is biased toward patentees or toward infringers. Interestingly, a regime in which the patent system is biased toward infringers but damages multipliers are imposed appears to be effective in reducing litigation without producing substantial adverse effects on parties' incentives.

A. Asymmetric Stakes and Costs

As a formal matter in patent law, the parties face the same stakes: the damages that the defendant must pay are equal to the damages that the plaintiff receives. As a practical matter, however, the parties may face very different consequences from litigation. Probably the most common potential asymmetry is that the patentee will have far more at stake than the infringer. If the patentee either decides not to sue an infringer or loses in court, other infringers are likely to follow, causing the patentee losses beyond the damages that the patentee would seek to prove in a case. In such a situation, the result is that the patentee will have a very strong incentive to sue infringers, even in cases that it might not win. It might seem that damages multipliers might increase the effect, but if a patentee's incentives to sue are already sufficiently strong, the addition of damages multipliers may provide little if any extra incentive to sue. At the same time, damages multipliers may reduce suit by deterring potentially infringing activity.

Figure 3 illustrates such a case. In this simulation, the patentee is assumed to bear a large supplemental loss of 200 should infringement occur. The effect is that the patentee has a very strong incentive to sue, even when it has only a small probability of winning. Indeed, in this simulation, the patentee sued whenever the potentially infringing activity took place. The result of imposing damages multipliers is a rapid deterrence of potentially infringing activity in cases in which the potential infringer is unable to obtain the benefit of the safe harbor. Indeed, beyond damages multipliers of about 1.5, the potential infringer will never engage in the activity without such a letter. Damages multipliers bring a slight increase in false positives, but not as sharp as the decrease in false negatives. Once patentees will sue all who engage in potentially infringing activity, the damages multiplier regime may advance

Figure 3. Effect of enhanced damages where infringment causes the patentee additional losses

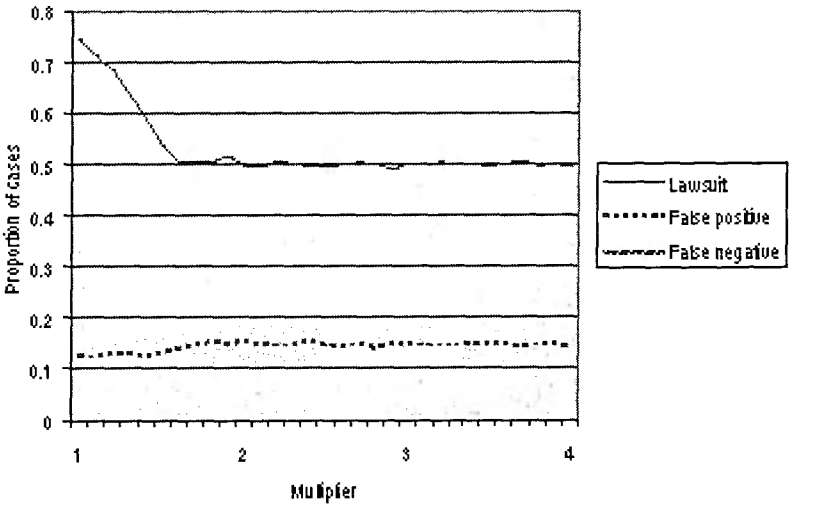
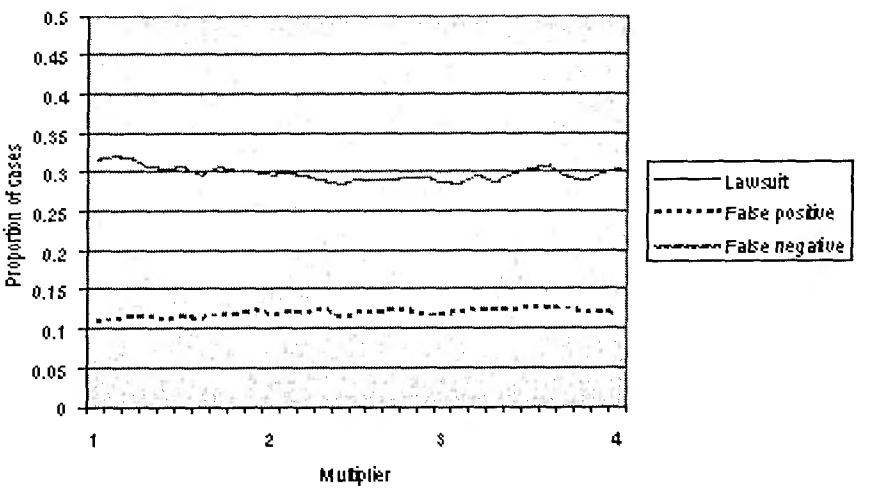


Figure 4. Effect of enhanced damages where infringer has higher trial costs



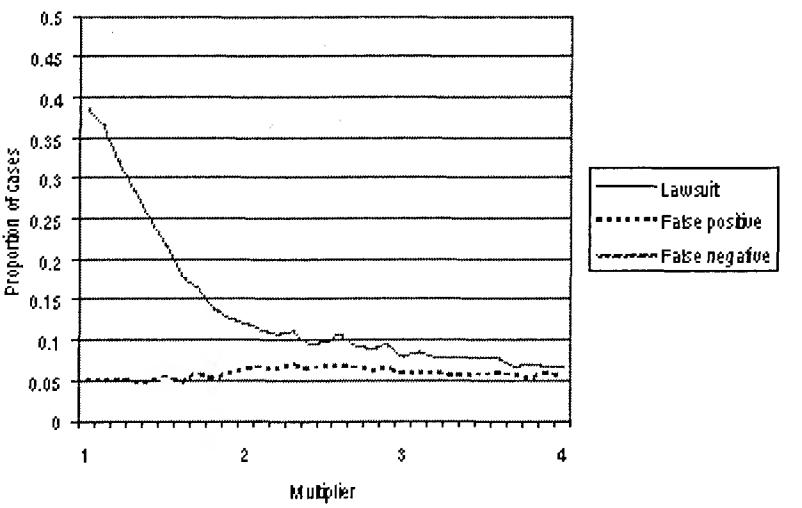
social welfare by deterring potentially infringing activity in cases that the patentees have a strong chance of winning.

An additional possible type of asymmetry is that the parties may bear different litigation costs. For example, the infringer may have a higher cost in a patent case centering around validity issues, both because the patentee may have previously conducted a thorough examination of the prior art and because much of the relevant information may be in the possession of the patentee. Figure 4 illustrates this possibility, by making the exaggerated assumption that the infringer's trial cost is twice the level in the simulation. The consequences for social welfare are mild, as the false negative rate is low

and the false positive rate only slightly higher than in the baseline simulation. Damages multipliers, however, no longer appear to deter suit. Even in the absence of damages multipliers, the high cost of suit leads the potential infringer to risk suit only in cases in which it has a very strong suit, in which case damages multipliers will have no effect because the potential infringer will have received clearance from an opinion of counsel. The damages multiplier regime does no harm in this simulation, but it does not help either.

Figure 5 illustrates the case in which a patentee has higher trial costs, by doubling the patentee's trial costs from the baseline simulation. The model appears to be robust to this specification. Indeed, damages multipliers seem particularly effective here. This is not surprising. When it is particularly expensive for a patentee to enforce its rights, it will be particularly useful to compensate for the resulting underenforcement through use of damages multipliers.

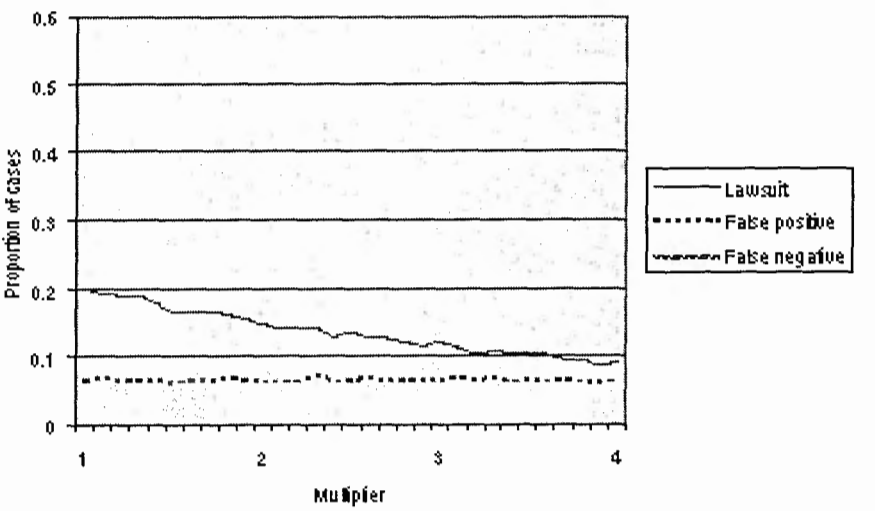
Figure 5. Effect of enhanced damages where patentee has higher trial costs



An additional important robustness check is to consider whether the relationship between the total cost of litigation and the stakes affects the effectiveness of damages multipliers. Figure 6 provides such a check by considering the possibility of expensive litigation, with costs for both parties twice as high as in the baseline simulation. The most immediately relevant observation is that damages multipliers continue to lower the rate of litigation. What is more striking, though, is that the increase in the cost of litigation in this simulation appears to increase welfare across the board. It should not be surprising that even in the absence of damages multipliers, the level of litigation is considerably lower than before. What may be surprising, however, is that litigation occurs less than half as often, so doubling trial costs actually reduces the total private cost of trials. Moreover, rates of false positives and false negatives, which are relatively unaffected by the damages multipliers,

are generally lower than in the baseline simulation. In effect, the high cost of litigation results in the parties behaving well to avoid litigation. Whether these outcomes are a robust alternative to litigation contexts and specification of parameters requires further study beyond the scope of this Article. The mere existence of such a possibility, however, strengthens the intuition that it may be possible for the legal system to be sparing in its use of trials, yet still be effective.

Figure 6. Effect of enhanced damages where both parties have higher trial costs



B. Strength of Information

1. Very Weakly Informed Third Parties

This section tests the results if the third parties who provide or refuse to provide opinions of counsel have very weak information, and thus, are less accurate in determining where a particular activity lies within a gray zone. The result of such inaccuracy is that the third party will make more errors, issuing more opinions in cases in which a majority of courts indeed would find the activity to be infringing, and refusing to issue opinions in more cases in which a majority would not find the activity to be infringing. To show the effect of weakening the third-party information, I have selected an exaggerated level, leading to an average absolute error in the estimate of the probability of an infringement finding of 19.7 percentage points. Note that with no information at all, one would estimate a probability of 0.50 and have an average absolute error of 25 percentage points, so the third party's performance is relatively woeful.

The strength of the third-party information may affect not only cases in which there will be a damages multiplier, but also those in which there is no

multiplier (i.e., the multiplier is set to 1). The third-party issuance or refusal of an opinion of counsel has two distinct effects. First, the third party's decision affects the legal environment that the potential infringer and the patentee face. This effect, however, is eliminated when there is no damage multiplier. Second, the third party's decision provides some information to the infringer. This is, of course, one of the primary justifications for encouraging potential infringers to obtain advice of counsel; an independent examination of the legal issues may affect the potential infringer's assessment of a court's likely response to the potential activity. To disentangle how weaker third-party information independently may alter these effects, we must consider the case in which there is no damages multiplier in addition to the case in which there is a damages multiplier.

Table 5. Very weak third party information (no damages multiplier)

	% of cases	Would be infringing	No op. letter	Activity occurs	Patentee sues	Patentee wins	Multiplier imposed	False negatives	False positives
All cases	1.000	0.495	0.498	0.630	0.440	0.195	0.034	0.051	0.122
Activity occurs	0.630	0.247	0.202	1.000	0.700	0.310	0.054	0.080	0.143
Patentee sues	0.440	0.353	0.213	1.000	1.000	0.443	0.077	0.115	0.205
No op. letter	0.498	0.709	1.000	0.256	0.188	0.069	0.069	0.013	0.116
Opinion letter	0.502	0.282	0.000	1.000	0.691	0.321	0.000	0.088	0.127
Not infringing	0.505	0.000	0.287	0.938	0.564	0.178	0.052	0.000	0.240
Would be infringing	0.495	1.000	0.714	0.315	0.315	0.213	0.016	0.102	0.000

The most obvious differences between Table 3 and Table 5 are the expected differences. In cases in which an opinion letter is issued, the activity nonetheless would be infringing 28.2% of the time, in comparison with just 8.0% of the time in the earlier simulation. Similarly, in cases in which most judges would find the activity noninfringing, the third-party counsel nonetheless refuses an opinion letter 28.7% of the time, in contrast to 7.8% in the earlier simulation. These differences produce other more subtle differences in the results. First, the potential infringer is somewhat less aggressive, engaging in the activity in 63.0% of cases, in contrast to 69.8% of cases.[76] Second,

[76] There are two competing effects. On one hand, when the third-party information is better, the infringer's information derivatively is better, making the plaintiff less willing to second guess the infringer, and making the defendant more willing to engage in the arguably infringing activity. On the other hand, when the third-party information is better, a finding that the activity would be infringing becomes more reliable, and the infringer in that case should be less likely to engage in the activity in those cases. These simulations suggest that at least under certain conditions, the first effect dominates the second, and producing the surprising conclusion that providing a party with better information can lead to more suit.

the overall rate of lawsuits drops slightly, from 52.5% to 44.0%. Third, and most importantly for our purposes, the reduced aggressiveness by the potential infringer reduces the number of false negatives (from 7.6% to 5.1%) and slightly increases the number of false positives (from 10.7% to 12.2%). Though neither of these effects was large, both occurred also in other runs of the same simulation, and the combined effect is to produce an imbalance between the number of false negatives and false positives, with more than twice as many of the latter.

The disproportion results in part from the order in which decisions are made. When the infringer decides not to engage in an activity, that decision will never be corrected. The patentee's information may suggest in some cases that the potential infringer has made a bad decision, but the patentee has no incentive to correct the potential infringer. On the other hand, when the potential infringer decides to engage in an activity, the patentee may well sue, sometimes when most courts would approve of the infringer's activity and always (at least in this simulation) when most courts would disapprove. In a backwards world in which the patentee first had to indicate whether it will sue and the potential infringer then faced a decision if the patentee announced that it would sue, presumably the effects would be reversed. But that is not the world we live in, even given declaratory judgment, which is generally available only when patentees have threatened suit.[77] In the baseline simulation, the third party's information led the potential infringer to engage in the activity more often, but with the weakening of the third party's information, a disproportion between false negatives and false positives exists.

Once the baseline in a no-enhanced damages regime includes more false positives than false negatives, the danger increases that adding enhanced damages will make things worse. Figure 7 bears this out. The general trends are the same as in Figure 1, but the slopes differ greatly. False negatives do decline, but there are fewer to start with, and they do not decline by much. False positives, meanwhile, increase at a much more rapid rate, as the damages multipliers increasingly apply to potential infringers who fail to receive an opinion of counsel as a result of an error on the third party's part. Finally, increased damages multipliers still reduce the incidence of suit, but not by nearly as much. This is largely a result of the reverse error by third parties, providing opinion letters to those who should not receive them. Many potential infringers who do receive the benefit of the opinion-of-counsel safe harbor will decide to engage in the activity, prompting many lawsuits and reducing the litigation-deterrent benefits of damages multipliers.

[77] *See, e.g.*, Arrowhead Indus. Water, Inc. v. Ecolochem, Inc., 846 F.2d 731, 734–35 (Fed. Cir. 1988) (discussing the conduct on the patent holder's part necessary to make a declaratory judgment suit justiciable).

Figure 7. Effect of enhanced damages where third-party information is very weak

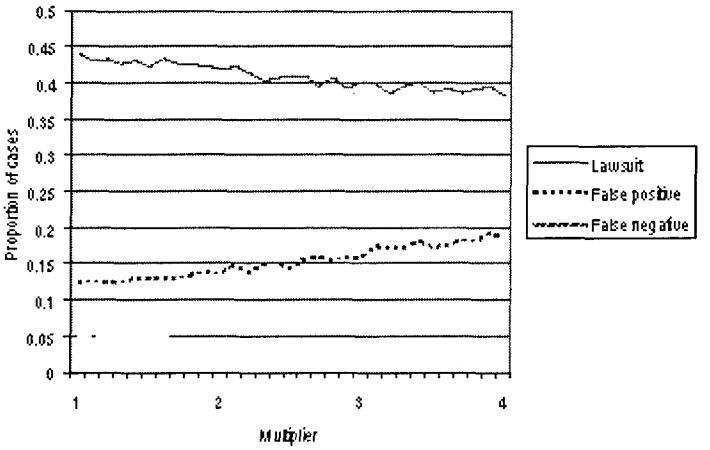


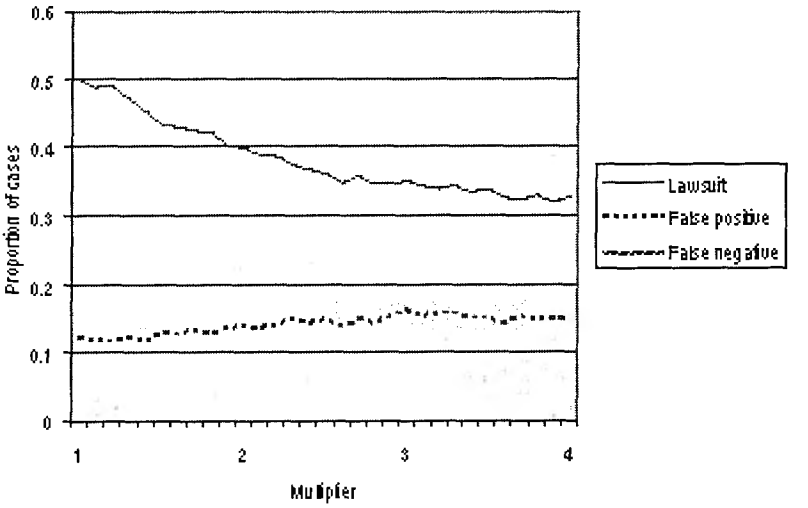
Figure 7, of course, does not mean that enhanced damages with a safe harbor for those with opinions of counsel are entirely a failure when third-party information is weak. The rate of suit and false negatives do decline, and up to a multiplier of about 2.5, the decrease in suit is marked, if not dramatic; the increase in false positives, meanwhile, seems most dramatic beyond this level. The ultimate question is how the social costs of trial and of false negatives balance with the increase in false positives. Too much weight should not be placed on fine slope gradations in the graph, in any event, as these results will differ in small ways from one run of the simulation to another even without any changes in parameters. The safest conclusion from this simulation is that the case for damages multipliers weakens when third parties are poor predictors of judicial decisions.

2. Weak Information for All Parties

The previous simulation assumed that the third-party information was very weak, but that the infringer and patentee had the same relatively good ability to make predictions about court actions as in the baseline simulation. Let us now suppose that all three parties have somewhat weaker information than in the baseline simulation (though stronger than the third parties' in the previous simulation). By doubling the noise factor parameter, the average absolute error of each party in estimating the probability that a court will find infringement rises from 6.8 percentage points to 12.6 percentage points. Once again, though this does not sound like a high level of error, it is a significant degree. In a case in which the actual probability is 50%, the average estimate might be at 37.4% or 62.6%, and about half of cases will be worse than this average.

Figure 8 shows the results. The data points corresponding to no damages multiplier suggest that the situation might be similar to the case in which the third party has very weak information, as false positives about double false negatives. The slopes, however, seem to present a much stronger case for the

Figure 8. Effect of enhanced damages where all parties have somewhat weak information



damages multiplier regime. The rise in false positives is a bit steeper than the decline in false negatives, for reasons much the same as before. The decline in the incidence of suit, however, is much greater, indeed quite similar to the decrease illustrated in the baseline simulation of Figure 1. With respect to the goal of reducing suit, there is a great difference between a third party whose information is weak and one whose information is very weak. With very weak information, a third party will with some frequency make the wrong decision on the far ends of the probability spectrum, in particular by refusing to provide an opinion letter to a potential infringer who should receive one, thus leaving the potential infringer exposed to frivolous suits by patentees enticed by the enhanced damages award.

C. Ease of Obtaining Opinions of Counsel

The previous section considered the possibility that the third party counsel's estimates of the probability of an infringement finding might be noisy, but it did not consider the possibility that the third party might be biased. Yet there are reasons that a counsel might well be biased. On one hand, a counsel might be biased in favor of a potential infringer. If obtaining an opinion of counsel provides a safe harbor, then clients will want to obtain the opinion. Privately, they might also appreciate an honest signal about the chance that a court would find infringement, but a potential infringer that does not receive the answer that it wants to hear plausibly might seek out a different law firm the next time. On the other hand, a law firm is more likely to face malpractice liability if it issues an opinion of counsel indicating that an activity will not be infringing. There is, of course, no inherent reason that these effects should cancel out. My own intuition is that the first effect is likely to be greater than

the second, so it should be relatively easy to take advantage of the safe harbor benefit, but I will consider both possibilities.

First, I will assume that it is relatively easy to obtain an opinion of counsel, by changing the simulation so that the third party issues an opinion of counsel indicating that the activity is likely not infringing whenever the third party estimates that fewer than 75% of courts would find infringement. One interesting effect of this change in assumptions is that the opinion of counsel becomes far *more* influential in the decision-making of the potential infringer than in the absence of that letter. Consider Table 6, for which there are no damages multipliers. The potential infringer virtually always infringes when the opinion of counsel is issued and never infringes in the absence of an opinion of counsel, even though the opinion of counsel will have no legal effect in a regime without multipliers. In the baseline simulation, the potential infringer always engaged in the activity when cleared by the opinion letter, but still engaged in the activity in the absence of an opinion letter 39.8% of the time. The fact that an opinion letter is so easy to obtain means that the third party's decision provides much more information to the infringer. When no letter issues, that *must* mean something, and the infringer is much more inclined to trust the ordinary lenient lawyer's advice.

Table 6. Easy to obtain letters of counsel with good information (no damages multipliers)

	% of cases	Would be infringing	No op. letter	Activity occurs	Patentee sues	Patentee wins	Multiplier imposed	False negatives	False positives
All cases	1.000	0.496	0.252	0.733	0.560	0.257	0.000	0.083	0.110
Activity occurs	0.733	0.313	0.000	1.000	0.764	0.350	0.000	0.113	0.150
Patentee sues	0.560	0.410	0.000	1.000	1.000	0.459	0.000	0.148	0.197
No op. letter	0.252	0.999	1.000	0.000	0.000	0.000	0.000	0.000	0.001
Opinion letter	0.748	0.326	0.000	0.981	0.749	0.344	0.000	0.111	0.147
Not infringing	0.504	0.000	0.000	1.000	0.656	0.218	0.000	0.000	0.219
Would be infringing	0.496	1.000	0.508	0.463	0.463	0.296	0.000	0.167	0.000

This result provides a lesson about the benefits of inducing potential infringers to obtain opinions of counsel: opinions of counsel may provide considerable information to potential infringers, and infringers may be influenced by such letters even in the absence of any direct legal consequence flowing from the letters. The counter-intuition is that infringers may be more likely to follow the advice of letters when a noninfringement opinion is relatively easy to obtain. Because potential infringers generally will have an incentive to infringe in close cases, at least under the assumptions of the present simulation, a refusal by a lenient counsel to issue an opinion may help the potential infringer identify precisely those cases in which it does not want to infringe. Of course, the

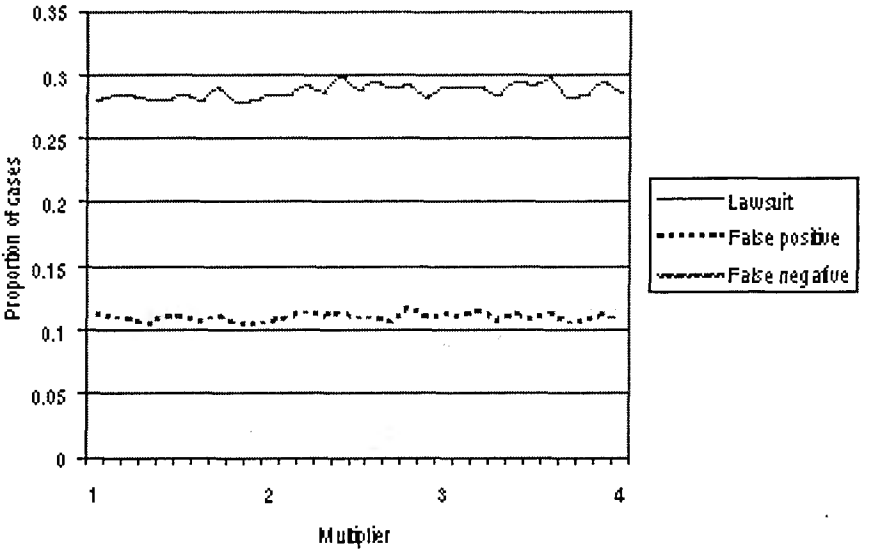
model in this paper is stylized in assuming that the information the potential infringer obtains from an opinion of counsel is binary. More realistically, a potential infringer may be able to obtain a sense of the lawyer's probability estimate regardless of how easy an opinion of counsel is to obtain. If that is so, the requirement of a second opinion, if not too expensive, might be quite useful whether an opinion of counsel is easy or hard to obtain, at least if the infringer and the counsel have relatively good information about where in the probability spectrum the activity lies.

If the informational effect of an opinion of counsel is so strong that it will induce the potential infringer always to follow the advice of the counsel, then multipliers will have little effect. To obtain a richer understanding of the possible interplay between the ease with which an opinion of counsel is obtained and the imposition of enhanced damages, it is worth considering what happens if information is weaker but opinions of counsel are still relatively easy to obtain. I thus ran the simulation again using the weak information assumptions of Section III.A.2. Interestingly, the potential infringer continued to rely heavily on the third party opinion, never producing in the absence of a favorable letter and producing given a favorable letter 96.2% of the time in the absence of damages multipliers. As expected, damages multipliers therefore had little effect at all,[78] as Figure 9 illustrates.

The effects of enhanced damages when opinion letters are difficult to obtain are quite different. Figure 10 illustrates a simulation in which opinions of counsel are hard to obtain, with opinions given only when the third party estimates that fewer than 25% of courts would find the activity to be infringing. This assumption isolates those cases in which potential infringers will have the strongest cases, precisely those cases in which there otherwise would be the greatest danger that damages multipliers might increase the rate of suit.

[78] In a separate simulation not reported in full here, the potential infringer and patentee had strong information, and the third party had very weak information. Damages multipliers continued not to have much of an effect. Because the potential infringer more often did not engage in the activity after having received a letter (about 17.6% of these cases with no damages multipliers), the rate of suit was higher, but damages multipliers have no effect in such cases. The potential infringer continued to be very hesitant to infringe in the absence of a letter. Note that there were very few cases like this because the third party's weak information, which effectively causes the third party to regress its noisy probability estimates to the mean, meant that there were very few cases in which the third party would conclude that there was over a 75% chance of infringement. *See supra* note 71. I also ran a separate simulation in which it was not quite as easy to obtain an opinion of counsel, setting a 60% chance of infringement as the threshold. The results were comparable in this simulation as well, but damages multipliers did result in a slight decrease in the rate of lawsuits due to the increased number of cases in which no letter was issued.

Figure 9. Effect of multipliers given easy-to-obtain opinion letters and relatively weak information



Under the same relatively weak informational assumption of Figure 9,[79] this regime does result in dramatic decreases in the rate of lawsuits, as predicted in Part I.[80] Because patentees would be encouraged to sue when potential infringers do not have favorable opinions of counsel, potential infringers are hesitant to infringe; meanwhile, patentees will rarely sue when potential infringers do have favorable opinions of counsel because the potential infringers will probably win and there are no enhanced damages anyway. The drawback to this world is that there is a significant increase in false positives, cases in which most courts would not find infringement but the potential infringer was still unable to obtain an opinion of counsel.

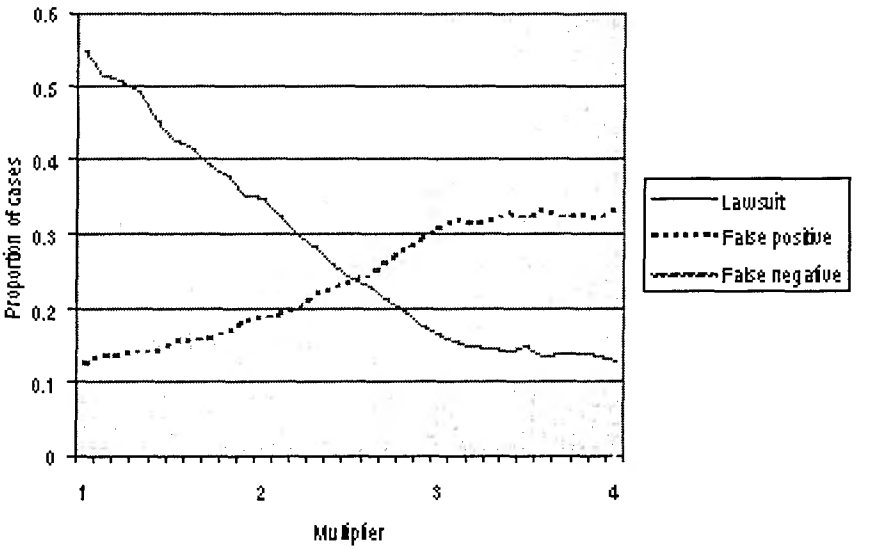
D. Systemic Bias

So far, I have assumed that though the courts face uncertainty, they have no particular bias toward patentees or infringers. This section will change that assumption. Suppose, for example, that courts are biased against patentees and toward infringers. By this, I do not mean that judges have any personal bias, but that the intellectual property system as a whole provides too little protection for patent holders. More specifically, I assume that at the portion of the probability spectrum where 50% of courts previously would find

[79] A separate simulation, not reported here, shows qualitatively similar results with the stronger information assumption. In that simulation, the overall rate of suit was slightly lower than the rate here across all damages multipliers, but the rate of decrease in the rate of suit was similar. The effects on false positives and false negatives were also comparable.

[80] *See supra* text accompanying note 58.

Figure 10. Effect of multipliers given hard-to-obtain opinion letters and relatively weak information



infringement, now only 25% of courts will find infringement. The probability spectrum is then adjusted accordingly, but leaving 0% and 100% as the endpoints. So, for example, where previously 25% of courts would have found infringement, now only 12.5% of courts will do so.[81] As before, I assume that cases above 50% in the original probability spectrum represent those in which the "correct answer" is to find infringement so the courts' bias introduces considerable error, with potential infringers benefiting. I also assume here that third parties asked to give opinions of counsel adjust their probability estimates to the new probability spectrum as well.[82]

Figure 11 depicts the results. If the patent system provides too little protection for intellectual property, damages multipliers are a useful way of evening the playing field. Without damages multipliers, the systemic bias against patentees and toward infringers means that there will be a high rate of false negatives (now the middle line at the left of the graph). Recognizing

[81] Given a uniform initial probability distribution, this results in the court finding infringement in approximately 40% of cases.

[82] This results in opinion letters being issued 66.7% of the time, a slightly higher percentage of cases than in which the court would in fact find infringement (60%). This slight discrepancy occurs because the high end of the original probability spectrum is much denser than the low end (with probability of an infringement finding rising rapidly from 25% to 100%). A different way to see that there should be a discrepancy is to imagine transforming the probability spectrum so that there was never less than a 25% chance of an infringement finding. This would not affect the third party, who cares only whether there is greater than or less than a 50% chance of an infringement finding.

the courts' favorability to them, more potential infringers will infringe when they should not. The rate of false positives, by contrast, is low. The imposition of damages multipliers leads to a decrease in false negatives, leveling off after approximately a 1.5 damages multiplier is imposed, and a modest rise in false positives. With the multipliers deterring the entry of potential infringers, patentees have less need to sue.

Figure 11. Effect of multipliers given systemic bias in favor of infringers

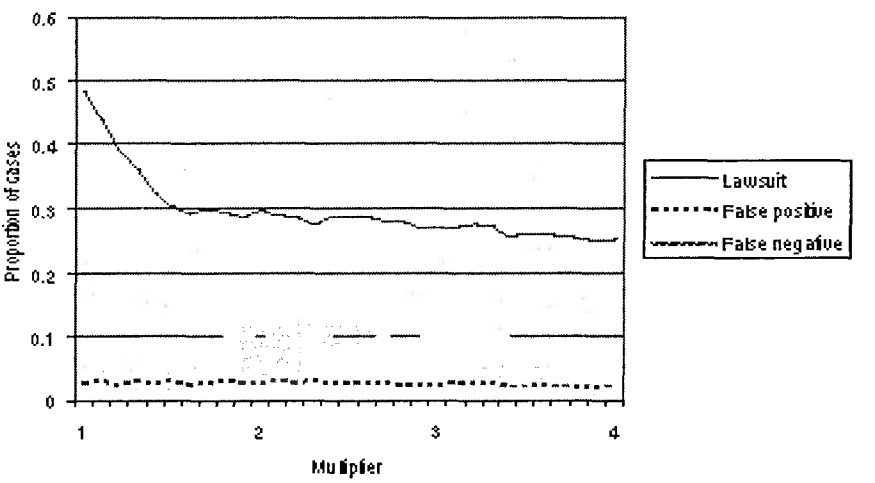
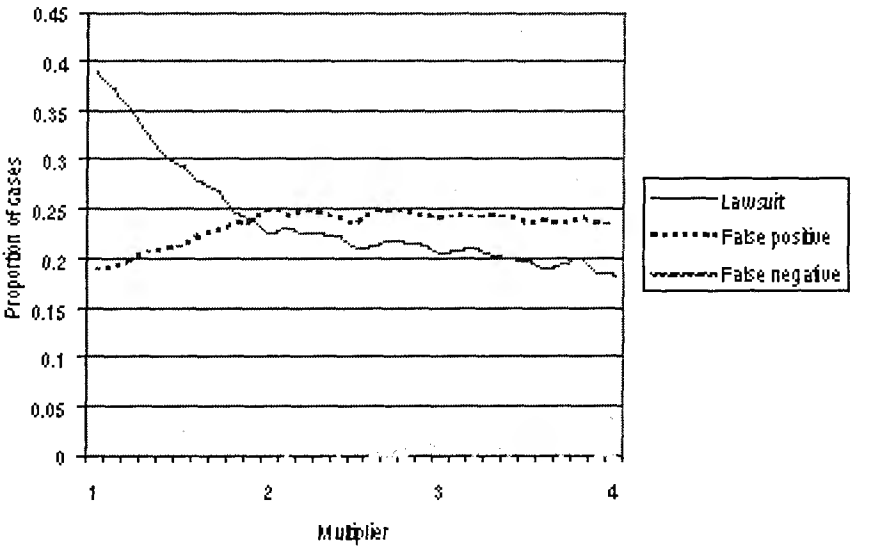


Figure 12 shows unsurprisingly that the damages multipliers regime seems less attractive where there is systemic bias in favor of patentees. The assumption for this simulation was that for cases in the middle of the gray zone, the courts would find infringement 75% of the time, with appropriate changes to the rest of the probability distribution. Given the systemic bias in favor of patentees, there is a high rate of false positives and a very low rate of false negatives. The enhanced damages regime does reduce the rate of false negatives but that number is so low that the social benefits from that reduction seem likely to be small. Up to a multiplier of about 2.0, by contrast, multipliers lead to a marked increase in false positives, as the prospect of enhanced damages discourages even more potential infringers from suing unless they are among the lucky few who have obtained opinions of counsel. The system is not, however, unambiguously a failure. The enhanced damages do lead to a marked decrease in the rate of suit, as the deterring of potential infringers gives patentees fewer cases in which to sue. Depending on the relative social costs of suit, a regime of enhanced damages thus might increase social welfare even where the system is systemically biased in favor of patentees.

If the litigation system as a whole is biased toward one side or the other, then it is plausible that the effects of opinions of counsel becoming easier or harder to obtain might change as well. In Section III.B, we saw that the enhanced damages regime was generally less effective when opinions of counsel were

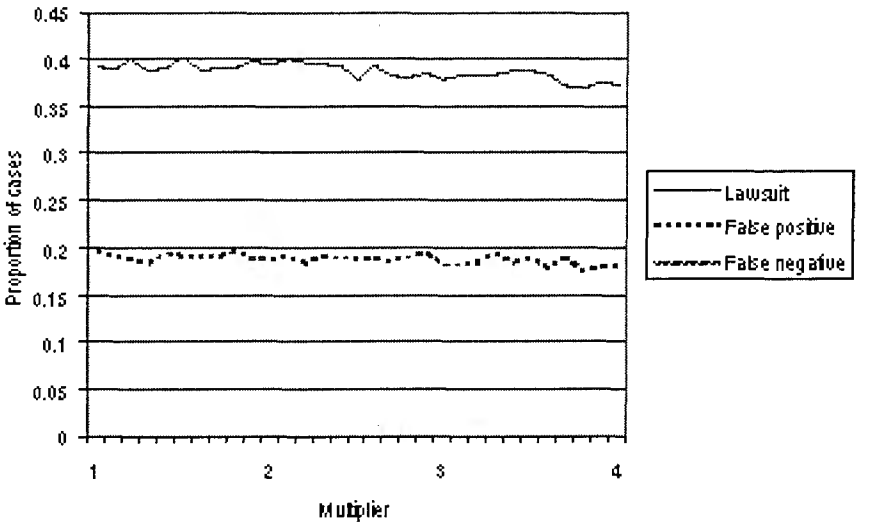
Figure 12. Effect of multipliers given systemic bias in favor of patentees



relatively easy to obtain, and more effective when opinions of counsel were relatively hard to obtain. It might seem that the ease of obtaining an opinion of counsel would hinge largely on the extent to which it offsets systemic bias. So, for example, if the system is biased toward patentees, it might seem that making opinions of counsel easier to obtain would advance social welfare. As Figure 13 shows, however, that does not appear to be the case. In the simulation represented there, third parties will give an opinion of counsel whenever the chance that courts will find infringement is less than 0.75, taking into account court bias. Although the increase in false positive results shown in Figure 12 is avoided, making a welfare comparison contingent, Figure 13 confirms the effect shown in Figure 9, that damages multipliers will cease to have a meaningful effect when opinions of counsel are relatively easy to obtain. A separate simulation, not illustrated here, shows that much the same is true with respect to damages multipliers where opinions of counsel are relatively easy to obtain and there is systemic bias toward infringers.

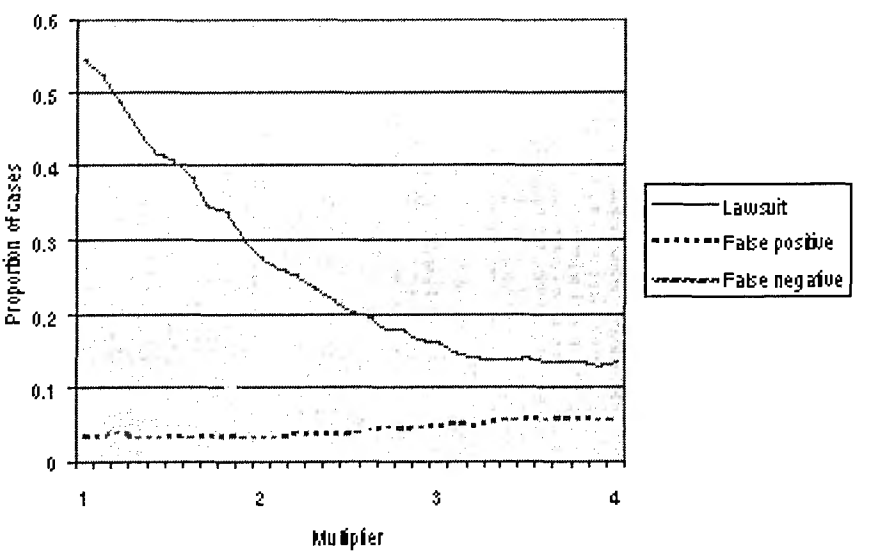
The reverse is true when opinions of counsel are relatively hard to obtain; damages multipliers regimes become more effective. Figure 14 illustrates the more dramatic finding, showing the effect of damages multipliers where there is systemic bias in favor of infringers and opinions of counsel are relatively hard to obtain, meaning that third parties will grant opinions only when there is less than a 25% chance of an infringement finding. Though there is an increase in false positives with enhanced damages multipliers, the overall level of false positives is quite low as a result of the systemic bias in favor of infringers. Meanwhile, damages multipliers have dramatic effects on the rate of suit and false negatives, with both effects leveling off only after treble damages. This combination appears to promote the highest social welfare

Figure 13. Effect of multipliers given systemic bias in favor of patentees, where opinions of counsel are relatively easy to obtain



of any we have seen. When it is hard for patentees to show infringement and when it is also hard for a potential infringer to obtain a safe harbor and damages are high, a relatively small number of suits can do an excellent job of optimizing the parties' incentives. Bias can benefit social welfare, at least when the biases in decision-making by courts and third parties happen to point in useful directions.

Figure 14. Effect of multipliers given systemic bias in favor of infringers, where opinions of counsel are relatively hard to obtain



IV. Conclusion

The conclusions of this Article's model must be tentative for several reasons. Most notably, although the genetic algorithm allows more flexibility to assess the effects of altering parameters than a formal mathematical model likely would, it still contains some significant simplifications. Perhaps most importantly, once a suit is launched, the model offers only a simplistic depiction of the litigation process. There is no opportunity for the gradual accumulation of evidence or for settlement, and trial costs are fixed, rather than dependent on the evidence or on the parties' stakes. If litigation unfolded more slowly, the processes of discovery and negotiation might help improve the parties' information and thus reduce errors. In a world in which plaintiffs can cheaply bring suit and then determine whether to exercise the option of continuing the litigation,[83] suit becomes far less risky for patentees, and damages multipliers might be less necessary to combat underenforcement. Moreover, if the slow unfolding of the litigation process in effect gives patentees an informational advantage, many potential infringers might be so cautious that the addition of a safe harbor from a noninfringement opinion might make less difference than the model suggests.

Even within the framework of the model, policy recommendations depend on the relative social costs of trial, false positives, and false negatives. At least three generalizations, however, are possible. First, if underdeterrence of potential infringers is a problem, imposition of damages multipliers will help reduce underdeterrence and the rate of suit, at least in cases in which the patentee has a relatively strong claim. Second, the provision of a safe harbor for potential infringers who have had clearance of counsel may mitigate the tendency of damages multipliers to increase litigation in cases in which patentees have relatively weak cases. Third, the safe harbor may have more dramatic effects on social welfare if opinions of counsel are somewhat difficult to obtain, so that the receipt of an opinion of counsel provides a reasonably reliable indication not merely that the case is close, but that the patentee in fact has a strong case. To the extent that courts can change the incentives of parties providing opinions of counsel, for example by expanding malpractice liability in cases in which third parties have given poor advice, the receipt of an opinion of counsel that an activity is not infringing will become more meaningful.

Given this last caveat, it is not at all clear that *Knorr* will produce inefficient policy. In a world in which opinions of counsel are relatively easy to obtain but expensive, we may be better off with a legal regime that provides

[83] *See, e.g.*, Peter H. Huang, *A New Options Theory for Risk Multipliers of Attorney's Fees in Federal Civil Rights Litigation*, 73 N.Y.U. L. Rev. 1943 (1998) (explaining the importance of the plaintiff's option to continue or end the litigation).

no special incentive to seek or follow legal advice. Moreover, the *Knorr* court did not eliminate the willful infringement doctrine, and even if imposition of enhanced damages is rare, the prospect of such damages may still have a modest dampening effect on infringing activity and also decrease the incidence of suit. This Article's analysis, however, suggests that this is only a second-best solution. Retaining the adverse inverse and providing more vigorous judicial policing of opinions of counsel, for example through expanded malpractice liability for erroneous opinions, might have better advanced the goals of the patent and litigation systems. That neither the Federal Circuit nor any of the amici in the *Knorr* case even considered the economic issues reflects that the nexus between patent policy and the economics of litigation remains poorly understood, even though the structure of the litigation process potentially can have significant ramifications for welfare.