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In deciding whether to issue a preliminary injunction, courts today focus on three factors: the likelihood that plaintiff will ultimately prevail on the merits; the harm defendant will suffer if the injunction is wrongly issued; and the harm plaintiff will suffer if the injunction is wrongly denied. The idea is to account for the possibility that the court might err in its prediction on the merits. If wrongful denial would be particularly harmful and there is a real chance of wrongful denial, the court is more reluctant to deny. By contrast, if wrongful issuance poses the greater threat, the court is more reluctant to issue. This decision rule has intuitive appeal but overlooks a key point: In most cases, the court will be just as uncertain about its estimates of the harms as it is about its prediction as to the outcome of the case. Thus, the conventional approach begins to unravel. A court cannot minimize the implications of its possibly errant prediction on the merits by blindly relying on its possibly errant estimates of relative harm. The optimal decision rule must account for both types of uncertainty.

I. INTRODUCTION

Consider a lawsuit between two firms over the validity and interpretation of an issued patent. Plaintiff owns the patent and believes that its rival is making, using, or selling the claimed invention without permission. Defendant, meanwhile, either believes the patent to be invalid or believes that the patent, while valid, does not cover the disputed activity. The case will be definitively resolved once the firms fully litigate it or settle; but both firms care a great deal about what will happen in the interim.

To that end, plaintiff will likely ask the court to issue a preliminary injunction barring defendant from engaging in the disputed activity for the duration of the lawsuit. Defendant's actions would otherwise undermine the value of the patent; and while money damages could in theory make up for any such harm after the litigation concludes, plaintiff will argue that those damages would be so difficult for the court to estimate that the resulting remedy would be intolerably random. Better to avoid the possible infringement entirely, or so plaintiff will contend. Defendant will take the opposite position, arguing that a court order barring its use of the invention will substantially interfere with its business. Customers will have to be turned away, advertising campaigns will have to be interrupted, and so on. That is not objectionable if plaintiff eventually prevails on the merits, but if the patent turns out to be invalid, or if defendant's actions turn out not to infringe, those harms will have been wrongly inflicted. Again, money could in theory compensate, but, as with plaintiff's possible injury, defendant's would be speculative. This would require the court to engage in an exercise in estimation that both the court and defendant would very much like to avoid.

Faced with these competing risks of so-called "irreparable" harm, the court will have to decide whether to issue a preliminary injunction. That decision is the focus of this Essay. Most courts approach the problem as follows. If the injunction issues and plaintiff turns out to then lose on the merits, the magnitude of the court's error will be the irreparable harm wrongly imposed on defendant. Conversely, if the injunction does not issue and plaintiff turns out to later win on the merits, the magnitude of the error will be the irreparable harm wrongly imposed on plaintiff. The injunction should therefore issue, courts reason, if the probability of the first error weighted by its magnitude is less than the probability of the second error weighted by its magnitude.[1] Phrased another way, the lower plaintiff's relative irreparable harm, the greater his obligation to show that he will ultimately succeed on the merits.[2]

The stated justification for this conventional approach is that it accounts for and minimizes the costs of court error.[3] Compare the obvious alternative, namely granting the injunction in any case where plaintiff is more likely than not to prevail. That rule would minimize the number of errors—if plaintiff is more likely to win than to lose, in most cases he will win and so the court should issue the injunction—but it would ignore the fact that some errors are more costly than others. The standard approach thus weighs both the probability of a mistake and its magnitude, tipping the scales in favor of an injunction where wrongful denial would be particularly harmful, and tipping against where errant issuance poses the greater threat.[4]

The problem with this balancing approach is that it only works if the court has good information about the relative harms facing the parties. That, however, is unlikely. Preliminary hearings typically take place early in the course of litigation, long before all the evidence has been studied or even made available. Worse, as the patent hypothetical suggests, harms that qualify for preliminary relief are often harms that courts cannot

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[1] As Judge Posner puts it, the injunction should issue "only if the harm to the plaintiff if the injunction is denied, multiplied by the probability that the denial would be an error . . . exceeds the harm to the defendant if the injunction is granted, multiplied by the probability that granting the injunction would be an error." American Hospital Supply Co. v. Hospital Products Ltd., 780 F.2d 589, 593 (7th Cir. 1986). Obviously, this is not meant to encourage courts to engage in mathematical calculations; it is instead meant only to suggest the appropriate relationship between these various factors.

[2] Courts vary in their articulations of this decision rule, but the same basic tradeoff pervades. See, e.g., Charlie's Girls, Inc. v. Revlon, Inc., 483 F.2d 953, 954 (2d Cir. 1973) ("One moving for a preliminary injunction assumes the burden of demonstrating either a combination of probable success and the possibility of irreparable injury or that serious questions are raised and the balance of hardships tips sharply in his favor"); Midcon Corp. v. Freeport-McMoran, Inc., 625 F. Supp. 1475, 1480 (N.D. Il., 1986) ("the magnitude of injury to the plaintiff if the injunction [is] erroneously denied is nearly equal to the injury to the defendants if the injunction [is] erroneously granted" and so "plaintiff must show a better than 50 percent chance of winning the case") (quotations omitted). See generally, Thomas R. Lee, Preliminary Injunctions and the Status Quo, 58 Wash & Lee L. Rev. 109 (2001); Lea Vaughn, A Need for Clarity: Toward a New Standard for Preliminary Injunctions, 68 Ore. L. Rev. 839 (1989). Professor John Leubsdorf was first to make explicit the relationship between the probability of success on the merits and the parties' relative irreparable harms. See John Leubsdorf, The Standard for Preliminary Injunctions, 91 Harv. L. Rev. 525 (1978). Judge Posner formalized the insight in Hospital Supply Co., 780 F.2d at 593.

[3] See, e.g., Roland Mach. v. Dresser Ind., 749 F.2d 380, 388 (7th Cir. 1984) (Posner, J.) ("the task for the district judge in deciding whether to grant or deny a motion for preliminary injunction is to minimize errors").

[4] Note that this *increases* the likelihood of an errant decision; it is nevertheless assumed to be desirable on grounds that it decreases the average magnitude of those now more numerous errors.

reliably estimate no matter what the available evidence. At the preliminary injunction stage, then, the court is uncertain about both the likely outcome on the merits and the harms facing each party. The traditional approach errs in that it accounts for only the first of these two uncertainties. In this Essay, I consider how it might in addition account for the second.

I proceed as follows. In Part II, I continue the above discussion by offering a fuller account of the conventional approach to preliminary relief. In Part III, I explain why uncertainty with respect to the magnitudes of plaintiff's and defendant's harms does not wash out of the analysis. Yes, the court will overestimate in some instances and underestimate in others, but that does not mean that the correct decision rule is the one we would use if there were no uncertainty in the first place. Indeed, as I will explain in some detail, to think that error always washes out is to make a standard mistake, one that infects all algebraic decision rules, from Learned Hand's balancing of the costs of accidents to the familiar cost/benefit analysis employed by administrative agencies. Finally, in Part IV, I consider implications and avenues for further research.

II. THE CONVENTIONAL BALANCE

Preliminary relief is typically unavailable in litigation because most harms can be fully compensated through the use of ex post remedies.[5] There is no need for the court to intervene prematurely in these cases; the court can fully remedy any wrong after a full hearing on the merits. Preliminary relief is therefore available only in cases where there is irreparable harm—that is, injuries of such a nature that the injured party cannot be made whole through an eventual exchange of cash or services. Examples of irreparable harm include harms for which there can be no substitute, for instance the loss of companionship with a child or loved one;[6] harms for which any ex post remedy would be too late to have meaningful effect, as where the harmed party is a business teetering on the edge of bankruptcy;[7] and harms that are difficult for the court to reliably measure, for example harms associated with the unauthorized use of intellectual property.[8]

These categories frequently blur, often leading back to uncertainty as the dominant explanation for preliminary relief.[9] For example, restrictions on speech are typically

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[5] The preliminary injunction is thus typically referred to as an "extraordinary" remedy, shorthand for the notion that damages are the preferred means of court intervention. For the history and a rich discussion, see Douglas Laycock, The Death of the Irreparable Injury Rule, 103 Harv. L. Rev. 687 (1990).

[6] See, e.g., McLaughlin v. Pernsley, 693 F. Supp. 318 (E.D. Pa. 1988) (harm at stake was temporary loss of companionship with foster child). That we cannot compensate for a given harm does not mean that we cannot compare it to other harms. Most people would agree that the loss of a loved one to death is worse than the loss of a long-term friendship to inattention, although clearly neither is a harm for which goods or services can easily compensate.

[7] See, e.g., Young v. Ballis, 762 F. Supp. 823, 827 (S.D. Ind. 1990) (injunction may issue if "necessary to save a plaintiff's business from insolvency"); Roland Mach., 749 F.2d, at 386 (same if plaintiff "may go broke while waiting, or may have to shut down his business but without declaring bankruptcy").

[8] Copyright infringement, for example, is presumed to cause irreparable harm on these grounds in every circuit but the Fifth. See Cadence Design Sys. v. Avant Corp., 125 F.3d 824, 827 n.4 (9th Cir. 1997). Mark Lemley and Eugene Volokh take issue with this presumption in Lemley & Volokh, Freedom of Speech and Injunctions in Intellectual Property Cases, 48 Duke L. J. 147 (1988), mainly on First Amendment grounds.

[9] This is not to say that uncertainty is the only reason courts offer preliminary relief. For example, in some cases, preliminary relief is appropriate because defendant is likely to be judgment proof by the time

characterized as if they are harms for which there can be no substitute.[10] But that is rarely the case. A civil rights activist hoping to stage a peaceful demonstration on a particular Sunday surely would trade away that opportunity if compensated by the funding necessary to sponsor, say, ten demonstrations the following week or, better yet, a mixture of demonstrations, public hearings, and other means through which his message might be heard and thoughtfully evaluated. The real problem with most free speech harms is that the court has no way of reliably estimating this speech-to-speech tradeoff, and so the harm is indeed irreparable, but on grounds of uncertainty rather than incommensurability.[11]

That raises the question of why uncertainty itself is an accepted basis for preliminary relief. After all, an uncertain court is just as likely to overpay as it is to underpay, so it is not immediately obvious that uncertainty makes any particular party better or worse off. The typical response is that an injured party should not be forced to assume this risk,[12] but that at best explains the rule only as it applies to entities that are risk averse. Firms, by contrast, are typically risk neutral, unless managers and executives feel inadequately diversified and thus exercise undue caution when making decisions on behalf of their firms. Intuition might suggest that the real purpose of preliminary relief is to save the court the time and expense needed to measure harm more accurately. That rationale fails, however, in that it only explains why courts might leave harms uncertain; it does nothing to explain why uncertain harms, in turn, justify preliminary relief.

Perhaps a better response is that injunctions facilitate bargaining by establishing clear property rights.[13] If money damages are the expected remedy, the parties might have different guesses as to how much cash the court will award. Injunctions remove that

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the litigation concludes and thus the only remedy realistically available to the court is to issue a preliminary injunction. In other cases, preliminary relief is appropriate because in its absence there would be a real and irreversible loss of social value, for instance goodwill that would dissipate thanks to a firm's inability to compete during the pendency of litigation. Uncertainty, then, is one of the main justifications, but certainly not the only one.

[10] See, e.g., Bronx Household of Faith v. Board of Ed., 2002 U.S. Dist. LEXIS 11318 (2002), and cases cited therein. See also Elrod v. Burns, 427 U.S. 347, 373 (1976) ("Loss of First Amendment freedoms, for even minimal periods of time, unquestionably constitutes irreparable injury.")

[11] A similar point applies to the threat of bankruptcy. One reason that bankruptcy constitutes an irreparable harm is that bankruptcy is a financial harm that is difficult to estimate reliably. Harms for which there can be no substitute have an inherent element of uncertainty, too. In a dispute over the care of a foster child, for instance, a key feature is that the relative harms and benefits are difficult to predict.

[12] See, e.g., Hospital Supply Co., supra note _, 780 F. 2d. at 597 (Posner, J.). On this theory, the irreparable harm is not the full magnitude of the loss, but the risk premium that the relevant party would require in exchange for voluntarily assuming the risk.

[13] This is an application of Guido Calabresi & A. Douglas Melamed, Property Rules, Liability Rules, and Inalienability: One View of the Cathedral, 85 Harv. L. Rev. 1089 (1972). A vast literature explores these issues. See, e.g., Ward Farnsworth, Do Parties to Nuisance Cases Bargain after Judgment?: A Glimpse inside the Cathedral, 66 U Chi L Rev 373 (1999) (arguing that the litigation process generates such enmity that parties do not bargain around court rulings); Ian Ayres & Eric Talley, Solomonic Bargaining: Dividing a Legal Entitlement to Facilitate Coasean Trade, 104 Yale L.J. 1027 (1995) (arguing that liability rules might be preferable even where transaction costs are low); Louis Kaplow & Steve Shavell, Property Rights and Liability Rules: An Economic Analysis, 109 Harv. L. Rev. 713 (1996) (criticizing the thesis in Ayres & Talley and suggesting refinements).

variable from the negotiation, possibly simplifying any attempts at voluntary settlement.[14] Here, too, however, there are counter arguments. For one, note that an expected damages remedy might decrease uncertainty by replacing the parties' dueling estimates of relative harm with the parties' possibly more consistent guesses as to the *court's* likely estimate of that ratio.[15]

Another response is that injunctions offer an easy way for courts to hide their uncertainty, a result not attainable via traditional money damages. In a case where a preliminary injunction issues and the plaintiff goes on to win on the merits, the court's uncertainty never appears on the public record. There is no need for the court to equivocate as to the appropriate measure of plaintiff's harm because the injunction will have prevented it. There is similarly no need to speak precisely about defendant's harm because, by definition given the outcome of the litigation, there was none. Hiding uncertainty in this fashion might be in a court's and also society's interest. Both benefit from having the judicial system held in high regard, and public confidence would surely be diminished if justice were to appear too obviously random.[16]

Whatever the rationale, courts today frequently recognize uncertain harms as irreparable and thus must frequently decide whether it is better to grant or deny preliminary relief. The easy cases are those where only one side can credibly claim irreparable harm. If plaintiff is the only party at risk, the injunction should issue—perhaps with the added requirement that plaintiff make some minimal showing that his lawsuit is plausible rather than pure nuisance.[17] Similarly, if the irreparable harm lies exclusively with defendant, the injunction should not issue, since plaintiff can be made whole by ex post damages should he ultimately prevail in the litigation. The hard cases are those in which both sides can credibly claim the risk of irreparable harm.

As outlined in the Introduction, courts in this situation typically approach the problem by considering both the likelihood that plaintiff will succeed on the merits and the relative irreparable harm threatening the two parties. Focus first on the likelihood that plaintiff will succeed. A court could adopt the simple rule that an injunction will issue whenever plaintiff is more likely than not to win on the merits. For instance, if the court thinks plaintiff has an 80% chance of prevailing—perhaps the law and evidence thus far

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[14] Preliminary hearings—whether or not they lead to injunctions—surely do promote settlement by increasing the information available to the parties. For instance, the parties learn more about how the judge is approaching the case, and they also have a chance to size up competing counsel. All that, however, is not so much an argument for preliminary relief as it is an argument for having informative hearings early in the course of litigation.

[15] These competing hypotheses could be tested empirically, for example by comparing (with appropriate controls) the rates of settlement after the issuance of an injunction with the rates of settlement after the denial of an injunction.

[16] An interesting related question is to ask why plaintiffs so often request preliminary relief and why defendants so often oppose it. If parties are risk neutral and if damages are not biased up or down, preliminary relief ex ante and damage remedies ex post should be perfect substitutes. Yet parties clearly prefer preliminary relief in many cases, which suggests that perhaps injunctive relief does facilitate settlement, or perhaps that parties believe courts systematically understate or overstate damages. For a discussion of other possible explanations for why parties request preliminary relief, see Jean Lanjouw & Josh Lerner, Tilting the Table? The Use of Preliminary Injunctions, 44 J. Law & Econ. 573, 576-78 (2001).

[17] See Cooper v. Bombela, 34 F. Supp. 2d 693, 698 (1999) (Shadur, J.) (requiring "better than negligible" chance of ultimate success as prerequisite to standard preliminary injunction inquiry), citing Boucher v. School Bd. of the Sch. Dist. of Greenfield, 134 F.3d 821, 824 (7th Cir. 1998).

look favorable, but there is still some chance that the defendant will uncover a particular bit of damaging evidence during discovery—this rule would have the court issue an injunction. The logic is that this is the best guess the court has about the ultimate outcome on the merits.

It is likely a pretty good guess, too. Preliminary injunction hearings are real hearings, and while they are necessarily incomplete, they do offer the court a genuine opportunity to preview the main arguments and examine important evidence. The hearings expose other predictive information as well, for instance the relative quality of the lawyering and the state of the evidentiary record. Moreover, the result of the preliminary hearing often changes the positions of the parties in ways that make the court's predicted outcome more likely. This is at times a psychological effect, as where the judge is subconsciously influenced by his earlier decision when he later makes rulings, announces jury instructions, and so on;[18] and it is at times just an unavoidable ramification of preliminary relief, for example where an injunction temporarily entrusts a minor to the custody of one of two feuding foster families, the unintended consequence being that the minor then strengthens his or her attachment with that family, thereby changing the case on the merits.[19]

Despite all this, courts today do not focus exclusively on their predictions with respect to the merits. Instead, courts also factor in the relative harms threatening the parties. The intuition here is that not all mistakes are equally troubling, and so a court should be willing to increase the likelihood of error if, in so doing, it can decrease the expected gravity.[20] Consider a specific example. Suppose defendant's irreparable harm is estimated to be twice the magnitude of plaintiff's—so, say, plaintiff faces losses of 100 whereas defendant faces loses of 200.[21] If plaintiff is 60% likely to win on the merits, should the court issue the injunction?

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[18] Similarly, a plaintiff who wins at the preliminary injunction stage might more aggressively pursue the litigation, and a defendant who defeats a motion for preliminary relief might more aggressively defend. Cf. Jolls, Sunstein & Thaler, A Behavioral Approach to Law and Economics, 50 Stan. L. Rev. 1471, 1516-18 (1998) (same point applied to prosecutors).

There are strategies for minimizing these sorts of psychological biases. For instance, the judge's psychological bias could be rendered irrelevant by scheduling litigation such that one judge decides preliminary matters but then a second judge, unaware of the result in the earlier hearing, actually hears the case. The cost of this approach would be the obvious lost economy of scale. In the alternative, the importance of the judge's bias could be minimized by abandoning the modern decision rule and instead granting injunctions in any case where the plaintiff is more likely than not to prevail at trial. That rule maximizes the accuracy of the judge's initial decision, thus minimizing the number of cases where his psychological bias weighs in the wrong direction.

[19] This is a real concern in family law; see supra note _.

[20] Courts focus solely on wrongful losses, but it is hard to understand why that is the right emphasis. After all, if the point is to minimize deviations from the desired state of the world, errant gains are just as troubling as errant losses. Where an injunction wrongly issues, then, there are two errors to count: the harm wrongfully imposed on defendant, and the gain wrongfully bequeathed to plaintiff. Courts count only one of those two errors, and that seems to raise yet another problem for the conventional approach. For further discussion, see Douglas Lichtman & John Pfaff, Rethinking the Standard for Preliminary Relief (working paper, 2002).

[21] These measurements are not necessarily in dollars. For instance, in a dispute over the legality of a pet tiger, the court might determine that the fear felt by neighbors in the absence of a restraining injunction would be twice as significant as the lost companionship felt by the pet owner in the event of a restraining injunction.

The conventional answer is that it should not. If the injunction issues, there will still be a 40% chance that defendant will win. If that happens, the court will have wrongly imposed a harm of 200. Multiplying the probability by the gravity, the expected harm from issuing the injunction is therefore 80. By contrast, if the injunction is denied, there is a 60% chance that plaintiff will win. In that case, the harm wrongfully imposed will be 100, meaning that the expected harm from denying the injunction is 60. Because 80 is greater than 60, on these numbers the court should deny the injunction, even though that means that the court will be wrong in 60% of the cases. The likelihood of error goes up, but the expected cost of error goes down.[22]

III. WHY UNCERTAINTY MATTERS

The analysis presented thus far mirrors the conventional analysis of preliminary relief in that it focuses on the possibility that the court might err with respect to its prediction on the merits but ignores the possibility that the court might also err with respect to its estimate of the parties' relative harms. As I pointed out in the Introduction, this is a significant oversight. Uncertainty with respect to these magnitudes is one of the main reasons why courts offer preliminary relief in the first place. Besides, at the preliminary hearing stage, everything is uncertain since there is almost always more evidence yet to come. My purpose in this Part is therefore to consider whether the standard analysis changes once uncertainty with respect to plaintiff's and defendant's harms is acknowledged.

The answer turns out to depend on what it means to say that a court is uncertain. Under one interpretation, uncertainty means that the court speaks in terms of probabilities, but that those probabilities are known with confidence. That is, given the evidence, the court knows for sure that there is, say, a 40% chance that plaintiff's harm is 250 and a 60% chance that plaintiff's harm is 225. This is an uncertain result in the sense that the court does not know whether the harm is 250 versus 225, but it is certain in the sense that the court knows for sure the specific probabilities associated with each possible outcome. In cases where this is what uncertainty means, the standard approach to preliminary relief works as traditionally stated. The probabilities known to the court represent the best information available, and the optimal decision rule should use that information in exactly the same way it would use a value known with precision.

There is another interpretation of uncertainty, however, and where it applies uncertainty cannot be ignored. Under this interpretation, an uncertain value is a value that

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[22] We can generalize this tradeoff using some simple notation first suggested by Judge Posner in Hospital Supply Co., 780 F. 2d. at 593. If we use P to represent the probability that plaintiff will win on the merits, H_p to represent plaintiff's irreparable harm, and H_d to represent defendant's irreparable harm, a court should issue an injunction whenever

$$P \times H_p > (1 - P) \times H_d$$

or, less formally, whenever the expected harm from denial outweighs the expected harm from issuance. We can solve the Posner equation for P^*, the critical probability above which injunctions should issue. That cut-off is simply

$$P^* = H_d / (H_d + H_p).$$

As expected, the lower plaintiff's relative irreparable harm, the more likely it must be that plaintiff will succeed on the merits. Conversely, the higher plaintiff's relative irreparable harm, the less likely it must be that plaintiff will succeed on the merits.

different courts would estimate differently even given the same evidence, or, equivalently, a value that a single court would estimate differently given the same evidence on different occasions. This is exactly what happens when, for example, a group of people try to guess the number of pennies in a jar. Each looks at the same evidence and yet each offers up a different estimate. If the guesses are unbiased, they might converge toward the right answer; but any specific guess can be too high or too low. As applied to the court example given above, this might mean that four out of every ten courts would think plaintiff's harm was 250, while the remaining six would think that plaintiff's harm was 225. Or it might mean something more complicated—for instance, that half the courts would think there is a 45% chance that plaintiff's harm is 250 and a 55% chance that plaintiff's harm is 225, while the other half would think that the percentages were 35% and 65%, respectively. The insight, again, is that on this interpretation of uncertainty, courts might on average converge to the same estimate as before, but any court in isolation can overstate or understate the harm.

To see the implications of this type of uncertainty, consider a simple example drawn from everyday life. Suppose that you value an evening at the theater anywhere from $0 to $300, with your exact enjoyment varying with such factors as your ability to identify with the main characters and your sense of the theater's acoustics. For simplicity, let us assume that your valuations are distributed uniformly, meaning that if you were to choose a play at random, you would be just as likely to enjoy it at the $300 level as you would at $210, $145, $0, or any value in between. Suppose, however, that on this particular night you are not choosing a play at random but have instead asked a friend for advice. Your friend has only partially internalized your taste for theater, so his advice is helpful but imperfect. Indeed, to keep things simple, assume that when he predicts your enjoyment for a given play, his guess is guaranteed to be within plus or minus 50% of your actual enjoyment, uniformly distributed on that range. So, for a play that you would actually enjoy at $20, your friend is equally likely to guess anywhere from $10 to $30, and for a play you would enjoy at $100, your friend might guess anywhere from $50 to $150. On this particular evening, your friend reports that he just saw a new production of Ibsen's *The Wild Duck* and he thinks you would enjoy this play at value $45. Tickets are $50. The question you face is whether to go to the theater.

This example makes use of the second interpretation of uncertainty given above: On average your friend predicts accurately, but any particular prediction is equally likely to overstate or understate your valuation. The rest of the problem maps to the legal issue at hand. Your expectations about the theater are similar to the court's expectations about the magnitudes typically associated with various irreparable harms. Your friend's imperfect advice corresponds to the court's imperfect interpretation of the evidence. Lastly, your decision about whether to go to the theater matches the court's decision about whether to issue the injunction. Both you and the court are looking to define the optimal decision rule by which to make your decisions, and in both instances the question is whether uncertainty affects the optimal decision rule.

If your friend were perfectly accurate in his predictions, the optimal decision rule would have you purchase a ticket only in instances where his prediction is greater than the price of the ticket. That is, you would purchase a ticket any time your friend predicted your value to be greater than $50. The surprise here is that, given uncertainty, this is no

longer the correct rule. Indeed, in this example, the correct decision rule has you purchasing a ticket whenever your friend predicts a value of $41 or more.

The mathematics are presented in the Appendix, but what drives this result is the fact that the variance associated with your friend's guess changes with your real valuation. That is, when your real valuation is $40, your friend's guess is within plus or minus $20, but when your real valuation is $50, your friend's range increases to plus or minus $25. This is perfectly natural. For instance, if you were right now to attempt to guess the number of M&M candies contained in the average single-serving bag and also the number of individuals living in the state of Indiana, your guesses might both be within 30% of their respective right answers, but your error range for the number of candies would be plus/minus 10, while your range for Indiana would be over two hundred thousand times larger.[23] In short, in most situations involving estimation, variance increases with the underlying actual value.[24]

Because variance is not constant, some of your friend's guesses contain more information than others. Suppose, for example, that your friend predicts a value of $30 for the play. Hearing that, you would know that your actual valuation is somewhere between $20 and $60.[25] The friend's prediction thus narrows the range down to 40 different values. By contrast, if your friend predicts a value of $39, your real value can be anywhere from $26 to $78, a range of 52 different values.[26] The latter guess, then, contains less information about your true value than does the former. This difference in the information contained in the various guesses ruins the symmetry that would otherwise have caused error to drop out of the problem. Your friend is indeed equally likely to guess too high and too low, but those probabilities do not offset because high guesses and low guesses carry different amounts of implicit information.

Note that the same basic dynamic applies even if for some reason variance decreases with increases in the underlying value. For instance, suppose that, instead of purchasing theater tickets on the advice of a friend, you are thinking of purchasing an expensive painting on the advice of a collector. We had assumed that the friend's estimates would be within plus or minus 50% of the actual value, no matter what that value. But this assumption probably does not work well for an art collector. Instead, an art collector's advice is probably more accurate for high-value works than it is for low-value ones because high-value works are of interest to a larger number of buyers, and those competing bids surely help the collector to more accurately estimate value. A $20 work thus might be valued anywhere from $0 to $40, while an $80 work might be more accurately predicted to be in the $75 to $85 range.[27] The optimal decision rule still shifts

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[23] There are approximately thirty candies in each bag, and approximately 6 million people currently living in Indiana.

[24] In some instances, variance decreases in response to increases in the underlying value. For examples, see infra note _ and accompanying text.

[25] Because the friend is guaranteed to guess within plus/minus 50% of the real value, a real value of $20 is the smallest real value for which a prediction of $30 is possible. Similarly, a real value of $60 is the highest real value for which a guess of $30 is possible.

[26] A real value of $26 is the lowest value that can still lead to a guess of $39. A real value of $78 is the highest value.

[27] We can capture this in the model by assuming that a work of value x will be reported with error of plus or minus $400/x$. Note that this sort of assumption might apply to litigation. After all, litigants spend more money—and hence courts likely have better information—when high value harms are at stake.

under this assumption, but in the opposite direction. Whereas last time you should have purchased the $50 theater ticket any time your friend predicted its value to be $41 or more, this time you should purchase a $50 painting only if the collector predicts its value at $56 or more.[28]

One might object to the above analysis by arguing that, knowing all this, the art dealer and the friend will adjust their predictions. The friend, for instance, will not tell you his guess of $45, but will instead run through all this math in his head and report to you a different figure that already takes uncertainty into account. That is possible, but unlikely. After all, if you the reader cannot tell by inspection what that new figure should be—the correct answer is that a guess of $45 should be interpreted to be a predicted value of approximately $55—the assumption that the friend knows what adjustment to make probably credits him with too much economic sophistication.[29] Let alone courts. That said, this sort of question has generated a lively debate in other settings. For instance, economists are split over whether auction participants still fall victim to the winner's curse, or whether instead modern bidders adjust for it ex ante by optimally lowering their bids.[30] Without empirical evidence, there is no way to answer these sorts of questions. Either way, however, in this instance the core insight remains: Uncertainty matters, and maybe the decision-maker but more likely the decision rule must account for it.

The implications of all this are significant not just for the decision regarding preliminary relief but, more broadly, for decision rules throughout the law. For instance, state and federal agencies frequently evaluate programs and policies under the rubric of cost/benefit analysis. The correct decision rule is assumed to be that programs should be rejected in cases where costs exceed benefits. But what happens if the above model of uncertainty applies? Uncertainty is pervasive in agency decision-making. When the Environmental Protection Agency considers ordering the removal of pesticides from a river bottom, for instance, the costs might be known with some accuracy but the agency's estimate of the benefits is surely a stab in the dark. Adjustments to the nation's air quality standards likely put both costs and benefits into play. Worse, as Cass Sunstein reminds us,[31] even seemingly precise data are in actuality uncertain given how difficult it is to achieve consensus on the correct reading of empirical evidence.[32]

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[28] As one might expect, if variance is constant—plus or minus some constant k no matter what the real value being estimated—symmetry is restored and the decision rule is again unaffected by uncertainty.

[29] It is possible that, even without understanding the phenomenon, the friend will learn over time to adjust his guess appropriately. After all, if he adjusts even once by mistake, his prediction in that instance will be more accurate, and that success will encourage him to adjust again in the future. This is true even though he might not understand why the adjustment helped in the first place. This kind of story seems particularly plausible as applied to the art dealer, since art dealers receive precise feedback as to the quality of their predictions in the form of how much the market is willing to pay for their services. It seems less likely as applied to courts, however, since a judge will rarely see precise feedback as to the quality of his damage estimates.

[30] See Richard H. Thaler, The Winner's Curse, 2 J. Econ. Persp. 191 (1988) (surveying the empirical and theoretical literature).

[31] Cass R. Sunstein, The Arithmetic of Arsenic, 90 Geo. L.J. (forthcoming 2002).

[32] Uncertainty is a topic of serious interest in the cost/benefit literature. For a variety of views, see Lewis A. Kornhauser, On Justifying Cost-Benefit Analysis, 29 J. Leg. Stud. 1037, 1043 (2000); Matthew D. Adler & Eric A. Posner, Rethinking Cost-Benefit Analysis, 109 Yale L.J. 165, 216-38 (1999); Bernard Goldstein, Risk Management Will Not Be Improved by Mandating Numerical Uncertainty Analysis for Risk Assessment, 63 U. Cin. L. Rev. 1599 (1995).

Similarly, in tort law, Judge Learned Hand famously proposed that an injurer should escape liability only where the marginal cost of any remaining precaution is greater than the expected reduction in the probability of harm multiplied by the expected loss.[33] That certainly works if all of those quantities are known with certainty. But, again, what happens when we acknowledge that different courts likely read the same evidence differently? And how does that result interact with other forms of uncertainty—for example the court's uncertainty about the level of care actually taken by a given defendant,[34] or the defendant's uncertainty about the level of care required?[35]

The list of possible examples here is long. Every algebraic decision rule must be rethought in light of uncertainty. This is not to say that these rules should be discarded. Quite the opposite, with very little information we were nevertheless able to account for uncertainty in the theater example, and we can similarly account for uncertainty in other settings, too. The point is that uncertainty cannot be ignored. Decision rules that are optimal when all values are known precisely are not necessarily optimal in the face of uncertainty. This means changes need to be made to cost/benefit analysis, the Hand formula, and, as I discuss below, the standard by which courts evaluate motions for preliminary relief.

IV. RETHINKING THE STANDARD

The conventional approach to preliminary injunctions focuses on one type of uncertainty, namely uncertainty as to the proper outcome on the merits. Courts account for this uncertainty by considering both the likelihood that plaintiff will win on the merits and the relative harms to which plaintiff and defendant are exposed. My point thus far has been that this balance introduces a second type of uncertainty into the analysis— uncertainty with respect to the magnitudes of those harms—and that the decision rule must be re-optimized to account for it.

Admittedly, doing that is a tricky business. One part of my on-going work on this topic is to try to understand how different types of uncertainty can be integrated into the

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[33] This is technically a version of Hand's formula based on marginal effects instead of absolute ones, an adjustment to Hand's original articulation that is now routinely made. See, e.g., Robert Cooter & Thomas Ulen, Law & Economics 313-16 (3d ed., 2000). For Hand's original statement, see United States v. Carroll Towing Co., 159 F.2d 169 (2d Cir. 1947).

[34] See Jason Johnston, Bayesian Fact-Finding and Efficiency: Toward an Economic Theory of Liability under Uncertainty, 61 S. Cal. L. Rev. 137 (1987) (pointing out that this type of uncertainty leads courts to sometimes find liability even in cases where adequate precaution was taken, thereby giving rational injurers an incentive to minimize this risk by taking excessive care); A. Mitchell Polinsky & Steven Shavell, Legal Error, Litigation, and the Incentive to Obey the Law, 5 J. Law, Econ. & Org. 99 (1989) (studying how this uncertainty affects the incentive to bring lawsuits).

[35] See Calfee & Craswell, Some Effects of Uncertainty on Compliance with Legal Standards, 70 Va. L. Rev. 965 (1984) (arguing that the effect varies depending on assumptions about the type of uncertainty generated by the legal system, the penalty structure associated with violations of the legal rule, and so on); Craswell & Calfee, Deterrence and Uncertain Legal Standards, 2 J. Law, Econ. & Org. 279 (1986) (expanded mathematical treatment). See also Mark Grady, A New Positive Economic Theory of Negligence, 92 Yale L. J. 799, 809 (1983) (assuming that "injurers make small errors" in estimating the required level of precaution, and examining the implications of this error when combined with other sorts of information limitations).

conventional balancing approach.[36] If it turns out to be clear that the legal standard should be (say) higher than that currently employed, courts can be encouraged to shift their decision processes accordingly. Similarly, if it turns out that uncertainty means that the modern rule overreacts to perceived differences in the harms facing defendant and plaintiff, courts can be encouraged to put less weight on those harms and correspondingly more weight on the court's prediction as to the outcome on the merits. The results do not have to be mathematically precise; even the current standard is more of a verbal intuition than a mathematical calculation.

That is not the end of the analysis, however, as there are three additional wrinkles that also have implications for uncertainty. First, under the Federal Rules of Civil Procedure, a judge will not issue a preliminary injunction unless plaintiff is willing to post a bond, set by the court, equal to the court's estimate of the harm facing defendant.[37] The purpose of this bond is to ensure that there are funds available to compensate defendant in the event that the injunction turns out to have been wrongly issued.[38] But the bond also has implications for court error. For instance, suppose that in a given case the judge overestimates all irreparable harms by 30%. The standard decision rule would still lead this judge to resolve the question of preliminary relief correctly since those overestimates cancel out.[39] The overstated bond, however, might cause plaintiff to decline even a correctly offered injunction, since plaintiff will not necessarily be willing to take on the (overstated) financial exposure. The requirement that plaintiff post a bond, then, changes both the likelihood of an errant result and its expected magnitude.

Second, in cases where the court denies plaintiff's motion for preliminary relief, defendant is still liable for any legally cognizable harm imposed on plaintiff during the pendency of the litigation. The fact that there is no injunction does not mean that, say, a firm sued for patent infringement can infringe with impunity from the time the case is filed until it is resolved. Instead, any ultimate damage award will account for harms imposed both before and during the lawsuit. The court's uncertain estimate of plaintiff's irreparable harm thus has implications beyond just the decision of whether to grant preliminary relief. For instance, too high an estimate of plaintiff's possible harm not only makes the injunction more likely but also more strongly discourages defendant from causing those harms in the absence of an injunction. Like plaintiff's bond, then, defendant's possibility of ultimate liability must be accounted for in the analysis of court error.

Third and finally, just as plaintiff can in certain cases pay a bond and in that way trigger an injunction, defendant can in certain cases violate an issued injunction and then pay a fine. That is, while preliminary injunctions are typically phrased as if they are mandatory commands by the court enforced through the threat of incarceration, in practice the penalty for violating an injunction is sometimes just a hefty cash fine.[40] In

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[36] See Douglas Lichtman & John Pfaff, The Implications of Legal Uncertainty (working paper, 2002).

[37] Fed. R. Civ. P. 65(c).

[38] For discussion, see Erin Morton, Security for Interlocutory Injunctions Under Rule 65(c): Exceptions to the Rule Gone Awry, 46 Hastings L.J. 1863, 1866 (1995).

[39] This is easy to see in the second Posner formula, supra note _: multiplying each term in the fraction by 130% would leave the ratio unchanged.

[40] For discussion, see DOUGLAS LAYCOCK, MODERN AMERICAN REMEDIES: CASES AND MATERIALS 775-812 (3d. ed. 2002).

those instances, the fine is yet another factor that must be accounted for in the analysis of uncertainty because it is a safety valve for court error. For example, in a case where the court has significantly underestimated defendant's harm and thus wrongly issued an injunction, defendant can respond by violating the injunction and incurring the financial penalty. If that penalty is wisely set, this could be the equivalent of efficient breach, and, as such, it might decrease the importance of court error.

V. CONCLUSION

It is common to assume that, if courts are equally likely to overestimate or underestimate a given value, uncertainty can be safely ignored. The main contribution of this Essay is to challenge that assumption by showing that, under one intuitive interpretation of uncertainty, even unbiased error does not drop out of the analysis. I have applied this insight in particular to the standard by which courts evaluate motions for preliminary relief. As I have noted, however, this same point has implications throughout the law, applying in any instance where decision-makers today take their best guess at some value and use that guess as part of an algebraic inequality. That roughly describes several important decision rules, including the Hand formula and cost/benefit analysis.

Open issues obviously abound. As applied to preliminary relief, I have pointed out that plaintiff's obligation to post a bond, defendant's possible liability for actions taken in the absence of an injunction, and defendant's option of violating an issued injunction all affect the likelihood and magnitude of court error under various decision rules. More broadly, there is the empirical question of how courts actually address uncertainty in various instances, a question that will help to distinguish settings where this model applies from settings where it is inapt. This Essay, then, is best understood as the start of a broader research agenda on uncertainty. Comments are welcome.

APPENDIX

The theater example can be solved using Bayes' Rule which states that the probability that two events will both occur is equal to the probability of the first event occurring given that the second occurs, multiplied by the probability of the second occurring.[41] More formally,

(1) $P[A, B] = P[A \mid B]P[B] = P[B \mid A]P[A]$.

In our example, we would like to know the probability that the performance will be worth x given that the friend predicts y. Bayes' Rule tells us

(2) $P[x, y] = P[x \mid y]P[y] = P[y \mid x]P[x]$

or, rearranging,

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[41] SHELDON ROSS, A FIRST COURSE IN PROBABILITY 62-72 (3d. ed., 1988).

(3) $P[x \mid y] = \dfrac{P[y \mid x]P[x]}{P[y]}$.

    To find the decision point above which tickets should be purchased, we have to account for the possibility of every real value for x on [0, 300] as well as the net gain or loss associated with that value. The net gain or loss is simply the value minus the ticket price.

    Define the critical recommendation, y^*, to be the cutoff above which the expected payoff from ticket purchase is zero or greater. We know that

(4) $\displaystyle\int_0^{300} P[x \mid y^*](x - 50)dx = 0$

which we can rewrite using Bayes' Rule as

(5) $\displaystyle\int_0^{300} \dfrac{P[y^* \mid x]P[x](x - 50)}{P[y^*]} \, dx = 0$.

    Given our definition of uncertainty, $P[y^*|x]$ equals (1/x) for all x in $[(2/3)y^*, 2y^*]$, but zero elsewhere. Of course, $2y^*$ cannot exceed the upper bound, which in this case is 300. $P[x]$ is a constant thanks to the uniform distribution. $P[y^*]$, by contrast, equals

(6) $\displaystyle\int_0^{300} P[y^* \mid x]P[x]dx$.

    Solving, we find that under these assumptions the left-hand side of (5) is increasing in y^* over the relevant ranges and thus equation (5) is satisfied only when y^* equals approximately 41. Note that this answer is not particularly sensitive to the boundary conditions. For instance, raising the upper bound from 300 to 1000 does not change the solution, nor does lowering the bound from 300 to 100.

    The same basic mathematics can be used to solve the art dealer problem. Under that error assumption, $P[y^*|x]$ equals (x/800) for all x in $[(y + \mathrm{sqrt}(y\mathbin{\char94}2 - 1600))/2, (y + \mathrm{sqrt}(y\mathbin{\char94}2 + 1600))/2]$ but zero elsewhere, again subject to the constraints that the maximum value for x is 300 and the minimum value for x is 0. In that case, y^* solves to approximately 56.

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