The Unexpected Value of Litigation

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Litigation is a sequential process. Litigants learn new information. They adjust their strategies in response to that information. The dominant economic models of litigation, however, assume that litigation is a single stage process, and that adjustments to the mean and variance of a lawsuit’s payoffs are adequate to capture the implications of the learning, adaptation, and uncertainty that characterize a lawsuit. We suggest that this reductionist assumption oversimplifies the litigation process to a degree that no longer accurately describes its reality and that causes single-stage models to generate predictions that diverge dramatically from the behavior of rational litigants who understand litigation’s procedural realities.

To demonstrate this point we present a two-stage model in which risk neutral litigants have no private information and in which the claim’s expected value is held constant throughout the analysis. Information is revealed to the litigants at the beginning of the second stage. The plaintiff then has the option of abandoning the lawsuit contingent on the information that is disclosed. The model thus constitutes an application of real option theory to the litigation process. We demonstrate that the equilibrium settlement value of this lawsuit can diverge dramatically from the same lawsuit’s settlement value when modeled as a single stage process. It follows that the traditional expected value model contains simplifying assumptions that obscure important implications of the learning process that commonly characterizes litigation.

The model also demonstrates that settlement value is a function of the variance of the unknown information, even though the litigants are risk neutral. Variance, in this model, acts as a proxy for the value of the option to react to information. The larger the variance the more valuable the option and the larger the settlement that a rational defendant will pay. The model also demonstrates that settlement values can be a discontinuous function of the information’s variance; that negative expected value lawsuits are credible in a broad range of circumstances; and that changes in the allocation of litigation costs over time can significantly affect settlement values even when total expenditures are held constant. The model also provides a technique for the evaluation of the implications of procedure qua procedure in the litigation process.

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I. Introduction

Litigation is process. A complaint is filed. Discovery ensues. Motions to dismiss and for summary judgment are argued and resolved. A trial date is set. Evidence is admitted. Evidence is excluded. Objections are made, sustained, and overruled. Witnesses testify as expected, or not. Jury instructions are debated. Judgments are entered. Judgments are appealed. Appellate courts affirm, reverse, or remand. Settlements can be reached at any time. And so it goes.

Information is the lifeblood of this process. Litigants battle to learn information, to conceal information, and to spin information so that it might better persuade judges, juries, and opponents to accept their view of the facts and law. Information causes litigants to abandon claims, to settle on terms that would have been inconceivable an instant prior to the information’s disclosure, to re-sequence the order in which they offer or demand information, and to expand or contract investments in developing specific sets of facts or legal theories. Indeed, it is probably no exaggeration to claim that litigation is all about the process of learning information, the cost of learning information, and the optimal response to information.
The dominant economic model of litigation posits a one stage process in which litigants cannot adapt their strategies in response to information. The model assumes that adjustments to the mean and implicitly to the variance of the lawsuit’s outcome are adequate to capture the implications of the learning, adaptation, and uncertainty characteristic of the litigation process. Many extensions of this basic model introduce complexity by assuming that litigants have asymmetric information, heterogeneous expectations, differential attitudes towards risk, or incur differential litigation costs. All of these one-stage models, however, preserve the assumption that the implications of learning, adaptation, and uncertainty are adequately characterized by a litigation process whose outcome is described by its mean and (implicitly) variance.

We suggest that this expected value model generates predictions that diverge dramatically from the behavior of rational litigants who understand the procedural realities of the litigation process. The limitations of the expected value model cannot, however, be resolved by introducing additional forms of asymmetry within it. Put another way, unlike many reductionist assumptions that promote a parsimonious and predictively accurate understanding of economic

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1 See, e.g., STEVEN SHAVELL, FOUNDATIONS OF THE ECONOMIC ANALYSIS OF LAW (2004) chs. 17 – 19 (presenting all discussion and analysis in the form of a one-stage model in which there is no opportunity to adapt strategy in response to the disclosure of new information); RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW (6th ed. 2003) ch. 21 (same); A. MITCHELL POLINSKY, AN INTRODUCTION TO LAW AND ECONOMICS (3d ed. 2003) ch. 16 (same); ROBERT D. COOTER & THOMAS S. ULEN, LAW AND ECONOMICS (4th ed. 2004) ch. 10 (same).

2 Most current models assume that litigants are risk neutral and therefore do not consider variance as an explicit parameter of the model. In these risk neutral litigant models, only information that changes the lawsuit’s mean value has any consequence for the lawsuit’s equilibrium value. However, as we demonstrate below, when a model allows for learning, changes in the variance of outcomes can have dramatic consequences for a lawsuit’s settlement value even when litigants are risk neutral. See infra parts III and IV.

3 Moreover, to the extent that these extensions involve learning, adaptation, and uncertainty, they generally involve one or two-sided asymmetric information. In other words, one or both of the litigants has private information that the other litigant and the court do not. See, e.g., Xinyu Hua & Kathryn E. Spier, Information and Externalities in Sequential Litigation (May 11, 2004) (providing a model of how the optimal liability rule trades off defendants’ incentives to take precautions with plaintiffs’ incentives to create valuable public information through litigation); Kathryn E. Spier, The Use of Most-Favored-Nation Clauses in Settlement of Litigation, 34 RAND J. ECON. 78, 80 (2003) (providing a model of a defendant facing a large group of heterogeneous plaintiffs, each having private information about the (expected) award that she will receive should the case go to trial); Kathryn E. Spier, Tied to the Mast: Most-Favored Nations Clauses in Settlement Contracts, 32 J. LEGAL STUD. 91, 93-94 (2003) (demonstrating that most-favored-nation clauses can mitigate asymmetric information problems and encourage lawsuits to settle earlier).
behavior,⁴ expected value models of litigation oversimplify the litigation process to a degree that no longer accurately describes important realities of the litigation process or of its outcome.

To demonstrate this point we present a model in which identical risk-neutral litigants share common knowledge concerning a lawsuit’s expected value, variance, and both parties’ litigation costs. The parties have no private information. The claim’s expected value is constant throughout the analysis. The dominant one-stage model predicts that changes in the claim’s variance will have no effect on its settlement value because the litigants are, after all, risk-neutral.

We then introduce the assumption that the lawsuit is litigated in two distinct stages and that just one piece of information is disclosed during the litigation. The expected value of this lawsuit is fixed, but its variance is a parameter. To preserve the lawsuit’s constant expected value we constrain parameter values of the variance of the uncertainty that is resolved to have a mean-preserving spread.⁵ The plaintiff can, however, abandon her claim after the parties learn the information revealed by a court’s ruling. If the plaintiff abandons her claim after learning this information then both parties avoid the litigation costs otherwise incurred in the lawsuit’s second stage. The model thus holds constant the lawsuit’s ex-ante expected value but gives the plaintiff two simple options: (1) an option to learn information concerning a lawsuit, and (2) an option to abandon litigation after learning that information.

Although the expected value of this option model of litigation is identical to that of a corresponding expected value model of the same lawsuit modeled as a one-stage process, we demonstrate that the introduction of these simple learning and abandonment options has dramatic

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⁴ MILTON FRIEDMAN, The Methodology of Positive Economics, in ESSAYS IN POSITIVE ECONOMICS 9, 15, 32, 41 (1953) (arguing the irrelevance of realism of hypotheses in economics).

consequences for the lawsuit’s equilibrium settlement value. In particular, these options can cause rational, risk-neutral, and equally (un)informed litigants to settle a lawsuit for an amount that diverges dramatically from the settlement amount predicted by expected value models of litigation. It follows that the traditional expected value model contains simplifying assumptions that obscure important implications of the learning process that commonly characterizes litigation.

The model presented in this paper also generates a series of results that cannot be derived in the context of a one-period expected value model of litigation. For example, the model indicates that a lawsuit’s settlement value can depend on the variance of the information to be disclosed during litigation even if the information’s expected value is constrained to be constant and even if the parties are risk-neutral. The model also demonstrates that settlement values can be a discontinuous function of the variance of the information to be disclosed. A small change in the litigants’ common expectations as to the variance of the uncertainty to be resolved can therefore cause dramatic differences in the price at which the claim will settle. It follows that in a model in which learning and abandonment options exist, variance can be essential to the valuation of the litigation process for reasons that have nothing to do with the litigants’ risk aversion and everything to do with the litigants’ ability to adapt their litigation strategies in response to the disclosure of information. Put another way, a lawsuit’s variance can be important because it reflects the value of the ability to adjust to information, not because of the litigants’ attitudes towards risk.

In an extension of this model presented in a separate paper we allow litigants to have a very simple form of differential expectations as to the variance of the information to be disclosed, but again constrain the expected value of the lawsuit to remain constant. We demonstrate that this small difference of opinion as to variance, that does not affect the lawsuit’s expected value, can cause litigation first to be initiated and then to be resolved mid-stream as the parties converge on a common estimate of variance. The settlement value of the lawsuit can again diverge dramatically from values predicted by one-stage expected value models of litigation. See Joseph A. Grundfest & Peter H. Huang, Why Cases Start and Then Settle: A Real Options Perspective (forthcoming 2004).

For a discussion of models that incorporate risk aversion into the analysis of litigation see, e.g., POSNER, supra note 1, at 569 – 570; SHAVELL, supra note 1 at 406 – 407.
The option model of litigation presented in this paper also demonstrates that negative expected value litigation can be credible over a wide range of situations. It further suggests that defendants can appear to act as though they are risk-averse while plaintiffs can appear to act as though they are risk-seeking, even though both are in fact risk-neutral. These appearances are the result of rational, risk-neutral responses to the sequence in which information is revealed and costs are incurred in a two-stage model. Intuitively, the larger the variance of the lawsuit, the more rational it is for the plaintiff to invest only a part of the lawsuit’s total cost to learn if the lawsuit will lead to a very substantial payoff, and the more rational it is for the defendant to accede to paying a larger settlement if the plaintiff has that option. The plaintiff therefore appears to have a preference for cases with higher variance and the defendant appears to be willing to pay more to settle those claims, even though both litigants are risk neutral.

In addition, the option model of litigation suggests that equilibrium settlement values can be quite sensitive to the sequence in which parties must incur litigation costs relative to the time at which information is disclosed. Thus, it makes a difference if the parties have to incur most of their litigation costs before learning takes place or if they can gain a great deal of information before incurring a large percentage of their litigation expenses. Similarly, changes in the parties’ relative bargaining power and in their relative litigation costs can have dramatic, discontinuous, and disproportionate effects on a lawsuit’s equilibrium settlement value.

The model presented in this paper can be viewed as an application of real option theory to the economic analysis of litigation. Indeed, the techniques of real option theory are, we suggest, particularly well suited to the economic analysis of litigation, and our model is a relatively simple application involving an option to acquire information combined with an option to

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8 These findings expand upon a strand of the literature, particularly Lucian A. Bebchuk, *A New Theory Concerning the Credibility and Success of Threats to Sue*, 25 J. LEGAL STUD. 1 (1996), that explores the implications of divisibility in the absence of learning. See also Alon Klement, *Threats to Sue and Cost Divisibility Under Asymmetric Information*, 23 INT’L REV. L. & ECON. 261 (2003) (proving Bebchuk’s conclusions are limited to settings involving relatively little private information). Our findings, however, suggest that the settlement value of negative expected value litigation can diverge dramatically from settlement values generated in the current literature and also demonstrate that Bebchuk’s model is a special case of ours in which there is divisibility but no option to learn or to act upon information.
abandon a project as a function of the information that is learned. This basic approach can be expanded to create real option models of litigation in which there are multiple options to learn sequentially revealed information, as well as multiple forms of strategic response to that information including options to expand or contract investment in the lawsuit, and not merely to abandon it. Legal scholars have recently applied real options analysis to a variety of legal issues other than litigation, but litigation analysis may, we believe, prove to be one of the more fruitful applications of real options analysis.  

Part II of this paper defines our two stage model which contains a learning option and an abandonment option. Part III presents a series of examples that describe the model’s equilibrium settlement values. These examples help develop basic intuition about the model’s operation and also help relate the model’s solutions to prior results that appear in the literature regarding the divisibility of litigation expenditures in the absence of learning and abandonment options. Part IV presents algebraic solutions for the model’s equilibrium values, describes a series of credibility conditions, and presents a set of comparative statics results. Part V discusses the model’s implications and includes a consideration of the prior literature. Part VI describes a series of potential extensions of the model and of its findings. Part VII concludes.

II. The Model

Risk neutral plaintiffs and defendants engage in a lawsuit that is litigated in two distinct stages. At the beginning of Stage 1, the plaintiff spends $C_{p1}$ to initiate the lawsuit while the defendant is forced to spend $C_{d1}$ to defend.  

Additional information regarding the outcome of the

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9 See, e.g., Avinash K. Dixit & Robert S. Pindyck, Investment Under Uncertainty, 6-25 (1994); Ienios Trigeorgis, Real Options 1-4, 9-20, 121-50 (1996); Special Issue 38 Q. Rev. Econ. & Fin. (1998) (providing a collection of articles applying real options analysis to managerial issues).


11 The defendant is forced to incur this expenditure because if she fails to do so she will incur a default judgment the consequences of which are more severe than spending Stage 1 litigation costs.
litigation is revealed to both parties at the beginning of Stage 2. After that information is revealed the plaintiff has the option either to abandon the litigation, thereby avoiding litigation costs of $C_{p2}$, or to continue through Stage 2 in order to collect the judgment. If the plaintiff decides to continue through Stage 2 she incurs costs of $C_{p2}$ and the defendant is forced spend $C_{d2}$ in defense. The court announces its verdict at the end of Stage 2. The parties can settle the lawsuit at any point without incurring additional costs.

The litigants share homogeneous expectations over the expected value of the judgment, $\mu$, which the plaintiff would win from the defendant if the lawsuit is pursued to judgment. The uncertainty regarding the information revealed at the beginning of Stage 2 is described by a binary random variable $X$ that assumes the value $A$ with probability $p$ or $B$ with probability $(1-p)$, such that $pA + (1-p)B = \mu$. The information revealed at the beginning of Stage 2 is thus constrained to have an expected value of $\mu$, and the two possible outcomes of the uncertainty, $A$ and $B$, are the support for a distribution that belongs to a family of distributions that are mean preserving spreads of each other.

If we assume for ease of exposition and without loss of generality, as we do in Section III of this paper, that the value of $p$ is fixed, then the variance of this distribution is uniquely defined by the value $A$ or $B$. It also follows that if $pA$ increases for any reason then $(1-p)B$ must simultaneously decline in order to preserve the relationship $pA + (1-p)B = \mu$, which is the sine qua non of a distribution with a mean preserving spread. Because the litigants have homogeneous expectations as to the variance of the underlying process, they also agree as to the values $A$ and $B$.

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12 We recognize that a plaintiff’s ability voluntarily to dismiss an action at no cost may depend on the stage of the lawsuit and on a variety of additional factors. We make this assumption solely to simplify the analysis. See generally, Michael E. Solimine & Amy E. Lippert, Deregulating Voluntary Dismissals, 36 U. MICH. J.L. REFORM 367, 376-78, 406-18 (2003).

13 Again, if the defendant fails to incur this expense she will incur a default judgment the consequences of which are more severe than spending stage 2 litigation costs.

14 Thus, the conditions that the defendant finds it rational to continue to litigate in Stages 1 and 2, as described in supra notes 11 and 13 are equivalent to assuming that $\min (A, B) > C_{d1}$ and $\min (A, B) > C_{d2}$.

15 For a discussion of mean preserving spreads in the economics and finance literature, see the references cited above in supra note 5.

16 For a proof of this proposition see infra p. 44.
The relative bargaining power of the litigants is described by $a$. For ease of exposition and without loss of generality we initially assume that the litigants’ bargaining power is fixed and equal, so that $a = 0.5$, but we later relax that assumption.

The litigants share common knowledge about litigation costs, $\mu$, $p$, $A$ (or equivalently, $B$), $a$, and about the fact that each is risk neutral and rational, in the sense of behaving so as to maximize expected wealth.

This model can be viewed as describing a relatively simple lawsuit in which risk neutral litigants confront only one uncertain variable. That variable can, for example, describe third party witness testimony that is equally unknown to plaintiff and to defendant. Although the content of that third party testimony might be unknown, the parties concur as to the implications of that testimony for the expected value and variance of the ultimate judgment to be awarded. Alternatively, the uncertainty can describe a court’s choice between two potential interpretations of a statute to be applied to a set of stipulated facts. The litigants share the same expectations as to the likelihood that the court will select one interpretation of the law over the other, and as to the implications of each choice for the ultimate judgment to be awarded.

However, in order to present the court with the opportunity to resolve this uncertainty, each party must first incur Stage 1 litigation costs. These costs can be viewed as discovery expenses if the uncertainty is fact driven, or as legal research and briefing costs if the uncertainty presents a pure question of law. After that uncertainty is resolved, the plaintiff has the option to continue to pursue the case in order to collect a judgment that both parties, viewing the litigation as of its inception, agree will be granted in an amount with an expected value of $\mu$. However, in order to cause payment of that judgment the plaintiff must spend an additional $C_p^2$ either for additional briefing on questions of law or for further factual development of the record. If the plaintiff decides to continue with the lawsuit then the defendant is forced to incur costs of $C_d^2$. Alternatively, if the plaintiff views the information revealed in Stage 2 as being sufficiently unfavorable, the plaintiff can abandon the lawsuit at no cost.\textsuperscript{17}

\textsuperscript{17} See Solimine & Lippert, supra note 12.
The model can alternatively be described as containing a compound real option\textsuperscript{18} that combines a learning option and an abandonment option.\textsuperscript{19} The learning option is exercised when the plaintiff, at the beginning of the lawsuit, decides to invest the premium of $C_{p1}$ in order to learn the information that is disclosed at the beginning of Stage 2. The abandonment option arises after that information is revealed when the plaintiff has the choice to drop the lawsuit at no cost or to continue the litigation by investing a further $C_{p2}$.

III. Intuition and Examples

Although the articulation of the model is relatively simple, its analysis can be complex because each litigant’s optimal strategy depends on the content of the information disclosed at the beginning of Stage 2. As is the case in all models with full information and homogeneous expectations, the parties will settle the action at the outset rather than incur any of the expenses involved in litigating the dispute. This result is, in essence, the litigation equivalent of the “no-trade” result in financial markets.\textsuperscript{20} To help develop intuition about the equilibrium process that leads to a unique settlement value, and to establish a foundation for the model’s algebraic solution, we begin our analysis with a series of examples that underscore the importance of learning in the presence of an abandonment option even when the expected value of the lawsuit is constrained to remain fixed at a commonly agreed-upon sum.

\textsuperscript{18} Compound options provide the “possibility of stopping midstream…[where] each stage completed (or dollar invested) gives the firm an option to complete the next stage (or invest the next dollar).” DIXIT & PINDYCK, \textit{supra} note 9, at 320.

\textsuperscript{19} For a description of various forms of real options, including abandonment options and staged investment options that provide parties with the opportunity to invest specifically in order to gain additional information, see, e.g., TRIGEORGIS, \textit{supra} note 9, at 2-3 and and Han T.J. SMIT & LENOS TRIGEORGIS, \textit{STRATEGIC INVESTMENT: REAL OPTIONS AND GAMES} 108-09 tbl.3.1 (2004).

\textsuperscript{20} See, e.g., Robert J. Aumann, \textit{Agreeing to Disagree}, 4 \textit{ANNALS OF STATISTICS} 1236 (1976); JEAN FUDENBERG & DREW TIROLE, \textit{GAME THEORY} 548 (1991) (“The first and best-known result obtained with the formal definition of common knowledge is Aumann’s proof that rational players cannot “agree to disagree” about the probability of a given event. The intuition for this result is that if an opponent’s beliefs are different from his own, he should revise his beliefs to take the opponent’s information into account.”) In a separate paper we demonstrate how the existence of heterogeneous expectations over the variance of information to be disclosed during the litigation process, even if the parties agree as to the expected value of the lawsuit, can be sufficient to cause the initiation of a lawsuit that later settles once the parties learn information sufficient to reduce or eliminate their differences of opinion as to the variance of the underlying distribution, even though expected values remain constant throughout. See Grundfest & Huang, \textit{supra} note 6.
These examples illustrate circumstances under which the commonly agreed upon variance of the information to be disclosed at the beginning of Stage 2 causes the parties rationally to settle lawsuits for amounts that can differ dramatically from the lawsuit’s expected value, as well as from other, more sophisticated settlement values that have recently appeared in the literature. These examples also demonstrate the existence of discontinuities in settlement values, i.e., conditions under which small changes in the variance of the uncertainty litigants face can cause lawsuits suddenly to gain or lose credibility even though the expected value of the litigation remains constant. These examples underscore the extent to which information about a lawsuit’s expected value may be insufficient to determine its settlement value in the face of learning and litigation expenses.

Taken as a whole, these examples also suggest that estimates of settlement values that currently appear in the literature depend on a series of unstated but strong and unrealistic assumptions as to the parties’ inability to adapt litigation strategies in response to the revelation of new information. These estimates are also contingent on a set of strong, unstated, and possibly unrealistic assumptions as to the statistical processes that generate the uncertainty confronting litigants. Indeed, as we later suggest, these unstated assumptions are so strong and unrealistic that they are not innocuously reductive, as are many other assumptions in economics. Instead, these assumptions may call into question the predictive accuracy of the current literature relating to the economics of litigation.

We begin our series of illustrations by distinguishing between positive expected value (“PEV”) lawsuits and negative expected value (“NEV”) lawsuits. A PEV lawsuit has the characteristic that \( C_{p1} + C_{p2} < \mu \). The expected value of that lawsuit to the plaintiff is thus \( EV = \mu - C_{p1} - C_{p2} > 0 \). Because we initially assume that the parties have equal bargaining power if the plaintiff’s minimum demand to settle a lawsuit is lower than the defendant’s maximum offer to resolve the same dispute, then the parties will split the difference and share the bargaining surplus equally by resolving the dispute for an amount at the midpoint between the plaintiff’s minimum demand and the defendant’s maximum offer.

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21 See, e.g., Bechuk, supra note 8.

22 See FREIDMAN, supra note 4.
In NEV litigation, $C_{p1} + C_{p2} > \mu$. Traditional expected value analysis suggests that these cases will never be instituted because they are not credible: it costs the plaintiff more to pursue the lawsuit than she expects to recover and, because the defendant is aware of that fact, the defendant will offer nothing to settle. Several authors have, however, suggested that NEV litigation can indeed arise because of imperfect information,\footnote{Lucian Ayre Bebchuk, Suing Solely to Extract a Settlement Offer, 17 J. LEGAL STUD. 437 (1988) and Avery Katz, The Effects of Frivolous Lawsuits on the Settlement of Litigation, 10 INT’L REV. L. & ÉCON. 3 (1990).} asymmetries in the timing of litigation costs between the plaintiff and the defendant,\footnote{David Rosenberg & Steven Shavell, A Model in Which Suits are Brought for their Nuisance Value, 5 INT’L REV. L. & ÉCON. 3 (1985).} the plaintiff’s ability to commit to pay her attorney in advance part of the cost of litigation,\footnote{David C. Croson & Robert H. Mnookin, Scaling the Stonewall: Retaining Lawyers to Bolster Credibility, 1 HARV. NEGOTIATION L. REV. 165 (1996).} or a lawyer’s reputation for pursuing NEV litigation.\footnote{Amy Farmer & Paul Pecornio, A Reputation for Being A Nuisance: Frivolous Lawsuits and Fee Shifting in A Repeated Play Game, 18 INT’L REV. L. & ÉCON. 147 (1998).} In an important recent contribution Lucian Bebchuk demonstrates that there exist conditions under which equally informed identical litigants will settle NEV lawsuits for positive amounts simply because the lawsuit can be pursued in stages that allow the plaintiff to subdivide her litigation expenses.\footnote{Bebchuk, supra note 8.} The settlement values generated in Bebchuk’s analysis describe a lawsuit’s “divisibility value,” i.e., the amount that the defendant will rationally pay because the plaintiff has the ability to subdivide her expenditures over time. The model does not contemplate the possibility that the plaintiff’s decision to continue the litigation might be animated by the fact that the plaintiff learns new information in the course of pursuing the action.

Bebchuk’s model is, as we later demonstrate, a special case of the more general model presented in this article.\footnote{In particular, when the information revealed at the beginning of Stage 2 has no value to the litigants because it does not change their behavior, our model and Bebchuk’s generate identical settlement values. See infra Proposition 8.} In particular, the pure divisibility values derived by Bebchuk are identical to the settlement values derived in our model if one assumes that the information disclosed to litigants is worthless in the sense that the information does not cause any litigant to
change her optimal strategy (i.e., the information is worthless because neither party could profit from learning the information and would therefore pay nothing for it in advance).

The equilibrium settlement mechanism described by Bebchuk does, however, describe a portion of the equilibrium settlement mechanism that governs our model. Therefore, to help fix our results within the context of the existing literature, we begin with a recapitulation of Bebchuk’s model which addresses the credibility and settlement value of NEV litigation. We then demonstrate how the introduction of a learning option and abandonment option, while holding fixed all the stated parameters of Bebchuk’s model, can cause equilibrium settlement values in NEV litigation to diverge dramatically from the lawsuit’s expected value as well as from the pure divisibility values presented by Bebchuk. We then extend these results to illustrate how the presence of learning and abandonment options in PEV litigation can again cause settlement values to diverge dramatically from traditional expected values, as well as from pure divisibility values, simply because of changes in the variance of the value of the information to be revealed, even though the expected value of the litigation remains constant.

The lesson of these examples is simple. Learning and information are important to the economic analysis of litigation. Even when the expected values of judgments and litigation costs are held constant, and when the parties are risk neutral and share common knowledge about relevant parameters, a lawsuit’s settlement value can fluctuate dramatically with changes in the known variance of unknown information, and with changes in the sequence in which litigation costs are incurred and information is revealed. Put another way, the dominant modes of economic analysis of litigation may abstract away from pragmatically significant factors that warrant careful consideration if one is to understand the true dynamics of litigation and settlement.

A. NEV Litigation With Divisibility

To recapitulate Bebchuk’s example, consider a lawsuit in which “the expected judgment (the probability of the plaintiff prevailing, times the magnitude of the judgment that she will get if she prevails) is 100. If the parties proceed all the way to judgment, each party will incur litigation costs of 140.”\(^{29}\) The expected value of this litigation is – 40. Standard, single-stage

\(^{29}\) Bebchuk, supra note 8.
expected value analysis suggests that the plaintiff will not file this action and that, if filed, the
defendant will pay nothing to be rid of the complaint because it does not present a credible
threat. Simply put, “if the defendant refuses to settle, the plaintiff would choose to drop this case
and get zero rather than litigate the case and suffer an expected loss. Anticipating this, the
defendant would refuse to settle for any positive amount. The lawsuit has no credibility, and
thus cannot succeed.”

Bebchuk’s innovation is to divide this lawsuit into two stages. During each stage each
party must spend 70, for a total of 140. The plaintiff, however, can abandon the lawsuit at the
end of the first stage after having spent 70 without any obligation to spend the remaining 70
required to pursue the lawsuit’s second stage. Bebchuk then demonstrates how the process of
backward induction leads a rational defendant to settle this litigation for 100, even though the
lawsuit has a single-stage expected value of – 40.

The difference between the standard single-stage model and a pure divisibility model is
illustrated in Figure 1. In the standard single-stage expected value model, as described in Panel
(a), the plaintiff pre-commits to the expenditure of 140 in pursuit of 100. Because the strategy
has a negative value of – 40, it is not credible. In a pure divisibility model, as illustrated in Panel
(b), the plaintiff can subdivide her litigation expenses into two sequential expenditures of 70
each, and can abandon the litigation in midcourse after the expenditure of only 70. Because of
backward induction, simple divisibility has a dramatic effect on the plaintiff’s willingness to file
the lawsuit and on the defendant’s willingness to settle.

Backward induction “is the standard method used by economists for analyzing strategic
interactions in which parties make decisions over several time periods.” Backward induction is
based on the observation that a party’s action at any stage of a process depends only on
expectations regarding the future evolution of the process viewed as of that stage. Actions do
not depend on the prior history of the process because that history can only reflect sunk costs. If

30 Id.
31 Id at 6 and n.7, citing FUDENBERG & TIROLE, supra note 20, at 96-99 and DAVID M. KREPS, A COURSE IN
MICROECONOMIC THEORY 399-402 (1990). There are numerous experimental findings questioning the realism of
backward induction as an equilibrium process to indicate that we are aware of those critiques. See, e.g., THEODORE
A process is divided into $t$ discrete stages, a party’s behavior at period $t-1$ should depend only on the party’s expectations regarding the future outcome $t$, measured as of $t-1$. It does not depend on prior actions taken at dates $t-2$, $t-3$, etc. Similarly, behavior at period $t-2$ depends only on expectations of outcomes at $t-1$, which are in turn optimized in expectation of the outcome at $t$.

Thus, the backward induction approach suggests that the analysis should start by examining what parties will decide in the final stage.... Knowing what parties will do in the last stage, we can determine their decisions for any set of circumstances in which they may find themselves in the stage before last. We can continue to proceed backwards in this way, identifying the decision that will be reached in each stage based on the understanding of the future consequences of each action. The analysis is completed once we reach the initial stage.”

Applying backward induction to the two-stage litigation process described in Figure 1(b) suggests that the credibility of the plaintiff’s threat should first be assessed as of the breakpoint between Stages 1 and 2. At that point, if the plaintiff does not abandon the lawsuit she can spend 70 in Stage 2 to obtain a payment of 100, a proposition that the plaintiff will value at 30. Thus, if the plaintiff can get to the beginning of Stage 2, the plaintiff will rationally accept any settlement in excess of 30 rather than proceed to trial. This is the plaintiff’s minimum demand if she decides not to abandon the litigation at that stage. From the defendants’ perspective, if the plaintiff decides to proceed at the beginning of Stage 2, then the defendant can be held liable for the judgment of 100, but will also have to incur additional litigation costs of 70, for a total additional outlay of 170. Thus, to the defendant, any settlement for an amount less than 170 is preferable to trial, when viewed as of the beginning of Stage 2. It follows that 170 is the defendant’s maximum offer at that point.

Therefore, there is a bargain to be struck as of the beginning of Stage 2 if the plaintiff decides not to abandon. The plaintiff will rationally settle for any amount greater than or equal to 30 while the defendant will pay any amount less than or equal to 170. Because the parties have equal bargaining power they will settle the litigation at the beginning of Stage 2 for the midpoint between their respective reservation demands and offers. Here that amount is 100 because $100 = (0.5)(30+170)$.

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32 Id.
Having determined that the case would rationally settle at the beginning of Stage 2 for 100, the litigants’ calculations as of the beginning of Stage 1 now look quite different. The plaintiff understands that for the investment of 70 in Stage 1, she can force the defendant to the beginning of Stage 2 where the defendant will rationally pay 100 to settle the lawsuit. The plaintiff will therefore rationally demand a payment of at least 30 not to file the lawsuit prior to incurring Stage 1 expenses (i.e., the expected value of the settlement at the start of Stage 2, 100, less the cost of pursuing the litigation to that point, 70). The defendant realizes at the beginning of Stage 1 that he can be forced to pay 70 to reach a situation at the beginning of Stage 2 where he will rationally pay 100 to be rid of the litigation. The defendant will therefore rationally agree to pay any amount less than 170 to be rid of the lawsuit at its inception. Again, because the parties have equal bargaining power the litigants will split the difference between their reservation bids and offers to settle the litigation. The lawsuit therefore settles for 100 at its inception. This simple model of litigation with divisible litigation expenditures thus demonstrates that NEV lawsuits can be credible if litigation expenses can be staged.

B. NEV Litigation With Learning Options and Abandonment Options

In practice, litigation involves learning as litigants adjust their strategies in response to new information about the facts or the law. Divisibility is likely to be associated with the disclosure of new information and with the plaintiff’s subsequent ability to abandon her lawsuit in response to the disclosure of that information. The option to abandon a lawsuit in the simple two-stage process, as just described, might therefore more naturally arise after a court has issued a ruling on a motion for summary judgment or on a motion to dismiss for failure to state a claim. Indeed, standard option theory suggests that litigants will rationally exercise abandonment options at the point where new information is revealed and will not exercise abandonment options early. The revelation of new information can, however, dramatically change the dynamics of the backward-induction settlement process.

33 Option theory teaches that early exercise of an American call option under plausible conditions is generally a suboptimal strategy. See, e.g., Robert C. Merton, *Theory of Rational Option Pricing*, 4 BELL J. ECON. & MGMT. SCI. 141, 144-45 (1973) (Theorem 2). Experience teaches that lawsuits tend to settle at discrete points where significant information is disclosed or where additional new commitments of resources (i.e., premium payments) are necessary. These two observations are, we suggest, rationally related and are consistent with a real-options model of litigation in which parties behave rationally by not exercising options too early and by settling at points where major sequential premium payments must be made.
We illustrate the implications of learning and abandonment options through a simple modification of Bebchuk’s two-stage model. As is the case in Bebchuk’s model, a payment of 70 is required to initiate litigation in Stage 1. However, at the beginning of Stage 2, the court announces its ruling on a pending motion for summary judgment that defines the damage formula to be applied to plaintiff’s claims. The selection of the damage formula defines whether the award will be in the amount A or B.

In order to generate a mean preserving spread with a value of 100, which is the expected value of the judgment in Bebchuk’s model, and in order to preserve the assumption that \( p = 0.5 \), the values of A and B must be constrained so that \( 0.5A + 0.5B = 100 \).\(^{34}\) Thus, if \( A = 100 \), then \( B = 100 \); if \( A = 160 \), then \( B = 40 \), because \( 100 = (0.5)\cdot160 + (0.5)\cdot40 \); if \( A = 200 \), then \( B = 0 \), because \( 100 = (0.5)\cdot200 + (0.5)\cdot0 \); and if \( A=300 \), then \( B = -100 \), because \( 100 = (0.5)\cdot300 + (0.5)\cdot(-100) \).\(^{35}\) As previously explained, this constraint requires that the distribution describing the uncertainty litigants face belongs to a family of probability distributions that are mean-preserving spreads of each other.\(^{36}\) The first moment of these distributions is constrained to equal a pre-set value whereas the second and higher moments of the distribution are allowed to vary. We concede that the constraint imposed by the mean preserving spread requirement is unrealistic because the revelation of new information is, in practice, also likely to change expected values. The imposition of this constraint does, however, allow us to focus exclusively on the extent to which a lawsuit’s settlement value can depend on a learning process rather than on the implications of any variations in the expected value of the judgment.

After the information has been revealed at the beginning of Stage 2 the plaintiff has an abandonment option and can decide whether she wishes to continue the lawsuit by paying Stage 2 litigation costs of 70, which will also force the defendant to incur Stage 2 litigation costs of 70. The expected value of the lawsuit is thus again -40 while the expected value of the verdict remains at 100, just as in Bebchuk’s model. Panel 1(c) illustrates the operation of this model.

\(^{34}\) The model can also be developed where the outcomes (A and B) are fixed and the probabilities vary, or if both vary, provided that the mean or expected value of judgment is fixed at 100.

\(^{35}\) When A and B are both non-negative they can be interpreted as describing potential payoffs to the plaintiff. When one of the outcomes is negative, it can be interpreted either as an adverse result on a counterclaim, or as the imposition of a reputational cost on the plaintiff that generates an equal and offsetting reputational gain to the defendant. See infra p. 19-20.

\(^{36}\) See supra note 5 and accompanying text.
Our analysis suggests, however, that the values assigned to A and B have a dramatic effect on the settlement value of the litigation even if those outcomes are always constrained to have an expected value of 100. To illustrate, we first describe a situation in which the introduction of the learning option does not alter the lawsuit’s pure divisibility value. In these situations, the information learned is worthless because it does not influence either litigant’s rational settlement behavior. We then demonstrate how the addition of a learning option can cause litigants to settle for amounts that are either less than or greater than the pure divisibility values calculated by Bebchuk even though the model preserves all of Bebchuk’s other assumptions. In each of these contexts, the information disclosed during the litigation process has real economic value even though it does not change the expected value of the process. We then present a brief intuitive explanation of why the introduction of learning even in the context of a mean preserving spread, can dramatically alter a lawsuit’s settlement value and expand on that explanation with a series of graphic illustrations that help visualize the model’s operation.

1. Information Revelation that Does Not Alter the Pure Divisibility Settlement Values

We first provide an example of a situation in which the introduction of a learning option does not alter the pure divisibility settlement value. Consider a situation in which the court’s ruling at the beginning of Stage 2 will result in damages of A = 120 and B = 80. If the court selects A, then the plaintiff will proceed with the litigation at the beginning of Stage 2 because she then has to invest 70 to receive a payoff of 120. The plaintiff would then accept a settlement of any amount equal to or greater than 50. The defendant would rationally offer any amount equal to or less than the avoided litigation cost of 70 plus the anticipated judgment of 120, or 190. Assuming equal bargaining power, the case would settle for 120 because 120 = 0.5(50+190).

If, however, the court selects outcome B, then the plaintiff would accept any amount equal to or greater than the expected value of the judgment, 80, less Stage 2 litigation costs of 70, or 10. The defendant would rationally offer any amount equal to or less than the avoided litigation cost of 70 plus the anticipated judgment of 80, or 150. The parties’ equal bargaining power indicates that the case would then settle for 80= 0.5(10+150).
Viewed from the vantage point of the beginning of the litigation, however, there is a 50% probability of a 120 settlement because Outcome A is selected and a 50% probability of an 80 settlement because Outcome B is selected. The expected value of the settlement viewed as of Stage 1, before the uncertainty is resolved, is thus \((0.5)\cdot120 + (0.5)\cdot80\), which again is 100. The plaintiff, however, has to invest 70 in Stage 1 to create the opportunity to force a settlement of 100. The plaintiff will therefore accept any settlement with a value equal to or greater than 30 at the inception of the litigation. If the plaintiff initiates the litigation the defendant will understand that she will have to spend 70 in Stage 1 in order to be pressed to a point where she will rationally settle for 100. The parties will therefore split the difference between the plaintiffs’ minimum demand of 30 and the defendant’s maximum offer of 170 and will settle at 100, just as occurs in a pure divisibility model with no learning.

It is instructive to observe that if the probability distribution of the information to be revealed at the beginning of Stage 2 is degenerate, i.e., \(A=B=100\), then no information is effectively revealed and Bebchuk’s pure divisibility model is a special case of the model described herein. This example also helps demonstrate that not every piece of information learned in the course of litigation is economically valuable. It further helps establish a foundation for the intuition that the value of information can depend both on the variance of the uncertainty to be resolved (the variance has to be large enough in order for the information to have value and the larger the variance resolved the more valuable the information), and on the cost of obtaining that information (the lower the litigation costs that have to be incurred to learn the information, the more likely it is that the information will have net value).

2. An Example of Information Revelation that Reduces the Pure Divisibility Settlement Value

Now consider a situation in which \(A = 180\) and \(B = 20\). If the court picks A then the plaintiff will invest an additional 70 to obtain an outcome of 180 at the end of Stage 2, and will accept any settlement with a value of at least 180 less the litigation cost of 70, or 110. The defendant will pay any value less than the anticipated judgment of 180 plus the additional litigation costs of 70, or 250. The parties will settle for 180 because that amount splits the difference between the minimum demand of 110 and the maximum offer of 250, i.e., \(180 = 0.5(110+250)\).
If, however, the court selects B then the plaintiff will abandon the litigation rather than invest 70 to obtain 20. Outcome B, in other words, means that the plaintiff has no credible threat in Stage 2.

Viewed as of Stage 1, prior to the revelation of the information, the plaintiff has to pay Stage 1 litigation expenses of 70 to obtain an expected value of 90 which reflects the 50% probability of a settlement of 180 at the beginning of Stage 2. That opportunity has a net expected value of 20= 90-70, which also defines the plaintiff’s minimum demand at the beginning of Stage 1. As of the beginning of Stage 1 the defendant would rationally pay any amount less than or equal to the expected value of the outcome in the event that the court selects A, i.e., 90, plus the Stage 1 litigation costs that she would incur if the litigation ensued. The defendant would therefore make a maximum offer of 160=90+70. Because of equal bargaining power the litigants split the difference between the minimum demand of 20 and the maximum offer of 160 and settle for 90, or 10 less than the same lawsuit’s pure divisibility value.

Given this parameterization of A and B, the introduction of the information option causes the case to settle for an amount lower than predicted in a pure divisibility model notwithstanding the fact that the expected value of the outcome remains fixed at 100 and costs also remain fixed at 70 per stage, just as in Bebchuk’s model. This example also illustrates that the introduction of learning does not invariably increase the value of the lawsuit to a plaintiff even though the plaintiff retains exclusive control over the ability to exercise the abandonment option contingent on the information that is revealed. It also helps establish the intuition that information can cause a lawsuit to become contingently non-credible, i.e., a lawsuit will pay off for a plaintiff only if some information pans out in favor of the plaintiff or if some legal rulings break in plaintiff’s direction, and that the existence of such a contingent non-credibility can cause a reduction in the lawsuit’s settlement value.

3. An Example of Information Revelation that Increases the Pure Divisibility Settlement Value

Consider now a situation in which the court’s ruling at the beginning of Stage 2 results in an outcome either of A = 260 or B = - 60. The negative value of B implies that if the plaintiff decides to continue to pursue the litigation then the plaintiff might have to make a payment of 60
to the defendant because of: (a) the success of a counterclaim against the plaintiff that causes recovery by the defendant in the amount of 60; (b) the award of sanctions or fees against the plaintiff and in favor of the defendant in the amount of 60; or (c) the existence of harm to plaintiff’s reputation in the amount of 60 that generates an equal and offsetting benefit to defendant’s reputation.

If the court selects A, then the plaintiff’s minimum demand will be the anticipated outcome of 260 less Stage 2 litigation cost of 70, or 190. The defendant’s maximum offer will be the anticipated outcome of 260 plus avoided Stage 2 litigation costs of 70, or 330. Because of equal bargaining power the case would then settle for 260= 0.5(190+330).

If, however, the court selects outcome B, the plaintiff will simply drop the claim because it would be irrational for the plaintiff to pay an additional 70 only to experience a harm of an additional 60.

Thus, viewed from the perspective of the beginning of Stage 1, the plaintiff has a 50% chance of outcome A, which has a settlement value of 260, and a 50% chance of outcome B which has a settlement value of 0. The expected value of the litigation prior to the revelation of the information at the beginning of Stage 2 is thus 130=(0.5)·260. Viewed as of the beginning of Stage 1, the plaintiff’s minimum demand would be 130 less Stage 1 litigation costs of 70, or 60. The defendant’s maximum offer would be the expected settlement at the beginning of Stage 2, which is 130, plus avoided Stage 1 litigation costs of 70, or 200. Because of equal bargaining power the litigants again split the difference between the minimum demand of 60 and the maximum offer of 200, and settle for 130= 0.5(60+200).

Here, the introduction of the information option causes the parties to settle for an amount greater than 100, the value predicted in Bebchuk’s parameterization of the pure divisibility model. This example thus illustrates conditions under which the introduction of learning can cause the value of a settlement to increase. The example also helps introduce the intuition that if the variance of the information to be revealed continues to increase beyond the levels described in this example, then the value of the settlement will also continue to increase because if alternative B realizes, the plaintiff can always cut off the potential of further and larger losses by simply abandoning the litigation. At that point, the larger the value of A the larger the value of the settlement that the plaintiff can rationally demand and that the defendant will rationally pay. This intuition leads to the further insight that, although the litigants are risk neutral, there exist
conditions under which the defendant will appear to act as though she is risk averse by increasing the amount she is willing to pay in settlement as variance increases while the plaintiff will appear to be risk-seeking by increasing the amount she demands in settlement as variance increases.

4. **A Transition Phase or “Dead Zone”**

   As should be apparent from the three preceding examples, it is possible to parameterize our model so that lawsuit’s settlement value initially equals its pure divisibility value (e.g. when A= 120 and B= 80 the lawsuit settles for 100). However, as the variance increases the settlement value drops below the pure divisibility settlement value (e.g., when A = 180 and B= 20 the case settles for 90). But as the variance continues to increase, the settlement value also appears to increase to exceed the pure divisibility settlement value (e.g., A = 260 and B = -60 the case settles for 130). These examples suggest the existence of a critical level of variance at which the value of the lawsuit at least initially declines and after which it rises.

   Indeed, as we now demonstrate, in the case of NEV litigation, there can exist two critical values of variance at which point settlement values become discontinuous. At the lower critical variance level, the lawsuit’s settlement value suddenly drops from its pure divisibility value to zero. The lawsuit’s settlement value then remains at zero until its variance increases to reach the second critical value at which point the lawsuit again becomes credible. Beyond that second critical value the settlement value of the lawsuit continues to increase monotonically in the underlying variance. Put another way, NEV lawsuits can exhibit “transition phases” or “dead zones” over which the plaintiff’s claim is not credible. For variances below the lower bound of this transition phase we demonstrate that the lawsuit is credible and has a settlement value equal to its pure divisibility value. For variances greater than the upper bound of this transition phase the lawsuit initially has a settlement value less than its pure divisibility value. The settlement value then, however, continues to increase monotonically as variance increases and can far exceed the pure divisibility value.

   In particular, we now demonstrate that given Bebchuk’s parameterization of his model, where the expected value of the verdict is 100 and each party incurs litigation costs of 70 in each stage, that the transition phase spans the interval from A=130 and B=70 to A=140 and B=60. For values of A that are lower than 130, the settlement value will always be 100. For values of A
greater than 140, the settlement value initially equals 70 and then monotonically increases as the variance increases. For values of A between 130 and 140 the lawsuit will not be credible. Thus, the assertion that a NEV lawsuit parameterized as in Bebchuk will always be credible and will always have the settlement value suggested by his analysis depends critically on assumptions about the value of the information, if any, that is disclosed during the litigation process.

We begin by first examining settlement dynamics when $A = 130$ and $B = 70$. If the court selects $A$, then the plaintiff’s minimum demand is $130$ less the Stage 2 litigation costs of $70$, or $60$. The defendant’s maximum offer is $130$ plus avoided litigation costs of $70$, or $200$. The case would then settle for the midpoint between the demand and offer, or $130 = 0.5(60+200)$. If the court selects $B$ then the plaintiff demands at least $70$ less litigation costs of $70$, or $0$, and the claim is then not credible. The plaintiff will then drop the lawsuit. In that event, viewed from the perspective of Stage 1, the case has a $50\%$ probability of a settlement of $130$ and a $50\%$ probability of a settlement of $0$, for an expected value of $65$. However, it makes no sense for a plaintiff to file the lawsuit because the Stage 1 litigation costs of $70$ exceed the lawsuit’s expected value of $65$. The claim as a whole is therefore not credible.

Observe, however, that if the previous example is changed ever so slightly so that the values are $A = 130 - \varepsilon$ and $B = 70 + \varepsilon$, where $\varepsilon$ denotes a small positive number, then the lawsuit would settle for $100$. If the court selects $A$ then the plaintiff will accept no less than $130 - \varepsilon$ less litigation costs of $70$, or $60 - \varepsilon$. The defendant will offer no more than $130 - \varepsilon$ plus avoided litigation costs of $70$, or $200 - \varepsilon$. In that event the litigation settles for the midpoint of $130 - \varepsilon = 0.5(60-\varepsilon+200-\varepsilon)$.

If the court selects $B$ then the plaintiff will accept any amount in excess of $70 + \varepsilon$ less litigation costs of $70$, or $\varepsilon$. The defendant will pay any amount less than $70 + \varepsilon$ plus avoided litigation costs of $70$, or $140 + \varepsilon$. The midpoint of the demand and offer is thus $70 + \varepsilon$. The expected value of these anticipated settlements is thus $0.5(130 - \varepsilon) + 0.5(70 + \varepsilon)$, which is $100$.

Viewed from the beginning of Stage 1, the plaintiff would have to spend $70$ force a settlement of $100$ and the defendant would be forced to incur costs of $70$ to pay a settlement of $100$. As previously demonstrated, this situation induces a settlement at $100$ and demonstrates that the discontinuity arises immediately when $A$ reaches $130$.

Now consider the settlement value of the lawsuit when $A = 140$ and $B = 60$. If the court selects $A$ then the plaintiff will demand at least $140$ less litigation costs of $70$, or $70$. The
defendant will offer no more than 140 plus avoided litigation costs of 70, or 210. The settlement midpoint is \( 140 = 0.5(70+210) \). If the court selects B then the plaintiff has no credible threat because it would be irrational to spend 70 in pursuit of 60. Viewed prior to the resolution of the uncertainty, the lawsuit thus has an expected value of 0.5 (140+0), or 70. Viewed from the perspective of the beginning of Stage 1, however, the lawsuit lacks credibility because it would not be rational for the plaintiff to spend 70 in pursuit of 70.

Notice that if the previous example is changed ever so slightly so that the values are \( A = 140 + \varepsilon \) and \( B = 60 - \varepsilon \), then the lawsuit would settle for 70. If the court selects A then the plaintiff will accept no less than \( 140 + \varepsilon \), less litigation costs of 70, or \( 70 + \varepsilon \). The defendant will offer no more than \( 140 + \varepsilon \), plus avoided litigation costs of 70, or \( 210 + \varepsilon \). In that case the litigation would settle for the midpoint of \( 140 + \varepsilon = 0.5(70+\varepsilon+210+\varepsilon) \). However, if the court selects B, then the plaintiff’s claim lacks credibility because the plaintiff will not invest 70 in pursuit of 60. The lawsuit’s settlement value prior to the revelation of the information is thus viewed as a 50% probability of a settlement value of \( 140 + \varepsilon \), which is \( 70 + \varepsilon/2 \). Viewed as of the beginning of Stage 1, the plaintiff would demand a minimum of the second stage settlement value, \( 70 + \varepsilon/2 \), less litigation costs of 70, or \( \varepsilon/2 \). The defendant would offer nothing more than \( 70 + \varepsilon/2 \) plus avoided litigation costs of 70, or \( 140 + \varepsilon/2 \). Because the case settles for the midpoint of the demand and offer its settlement value is \( 70 + \varepsilon/2 = 0.5[\varepsilon/2+140+\varepsilon/2] \).

By implication, all values of A equal to or greater than 130 and equal to or less than 140 will have a settlement value of 0. To illustrate this point, consider the case of \( A = 135 \) and \( B = 65 \). If the court selects \( A = 135 \), then the plaintiff demands at least 135 less litigation costs of 70, or 65. The defendant offers no more than 135 plus avoided litigation costs of 70, or 205. In that event, the case settles for the midpoint of 135. If the court selects B, then the plaintiff does not have a credible threat because she will have to spend 70 in order to recover 65. In that event, viewed prior to the information revelation, the case has a 50% probability of a settlement of 135, yielding an expected value of 67.5. The claim would, however, lack credibility because the plaintiff would have to invest 70 in Stage 1 for a payoff with an expected value of only 67.5.

The implications of this example are quite intriguing. When learning is possible settlement values are not necessarily smooth functions of variance or of other parameters of the model, at least in the case of NEV litigation. The intuition behind this finding is that the presence of staged, lumpy litigation costs can cause discontinuities in settlement values because the
lumpiness in litigation costs can induce both a total and contingent loss of credibility. As variance increases beyond the first critical level, one leg of the distribution loses credibility but the second leg does not yet have sufficient value to make it worthwhile for the plaintiff to bear Stage 1 litigation costs. The result is a total loss of credibility. However, as variance increases, the value of the leg that is credible in Stage 2 eventually increases to a point at which it becomes worthwhile for the plaintiff to bear Stage 1 litigation costs. Only at that stage does the lawsuit then again become credible, and that point of credibility defines the second critical level of variance. Beyond this point, the lawsuit is contingently credible.

5. Visualizing Settlement Values

Table 1 charts the settlement values described in the preceding examples as a function of the underlying variance. Figure 2 graphs those same results. The technique used to generate Table 1 also defines the construction of a simple computer program that can generate settlement values in these learning models and provides insight into the algebraic solutions to the model presented in Section IV of this paper.

The first two columns of Table 1 describe the variance of the underlying distribution through the values A and B. Columns 3 and 4 describe the plaintiff’s minimum demand and the defendant’s maximum offer in the event the result is A. These values are calculated by subtracting Stage 2 litigation costs from A to derive the plaintiff’s minimum demand in Column 3 and by adding Stage 2 litigation costs to A to derive the defendant’s maximum offer in Column 4. Columns 5 and 6 describe the plaintiff’s minimum offer and the defendant’s maximum demand in the event the result is B. These values are calculated in Column 5 by subtracting Stage 2 litigation costs from A to derive the plaintiff’s minimum demand, with the proviso that if the result is non-positive the demand is zero because the litigation would then not be credible. The defendant’s maximum offers in Column 6 are calculated by adding the avoided litigation costs of 70 to the value of B, with the proviso that the plaintiff’s matching minimum demand must be a positive number, otherwise the claim lacks credibility and the maximum offer will be zero.

Column 7 describes the value of the litigation before the information is revealed and before the litigants have incurred their Stage 1 litigation costs. Because outcomes A and B are equally probable, and because the litigants have equal bargaining power, the Stage 2 settlement...
value described in Column 7, or \( S_2 \), can be calculated by simply taking the average of the four values in each row’s corresponding Columns 3, 4, 5, and 6.

The plaintiff’s minimum demand in Stage 1, as described in Column 8, can be calculated by subtracting Stage 1 litigation costs from \( S_2 \) with the proviso that if the result is non-positive the claim lacks credibility and will not be brought. For all such instances the entry in Column 8 is zero. The defendant’s maximum offer in Stage 1, as described in Column 9 can be calculated by adding Stage 1 litigation costs to \( S_2 \) with the proviso that, if the claim is not credible because the plaintiff’s minimum demand as reflected in Column 8 is zero, then the defendant’s maximum offer is also zero. Because the litigants have equal bargaining power, the initial settlement value of the lawsuit is reflected in Column 10 which can be calculated as the midpoint between the values in Columns 8 and 9, the corresponding minimum demands and maximum offers.

Figure 2 plots the settlement values in Column 10 as a function of the variance of the information to be disclosed as measured by the value of \( A \) in Column 1.

As is apparent from Table 1 and Figure 2, the lawsuit’s settlement value as parameterized herein, is constant at its pure abandonment option value of 100 for all values of \( A < 130 \). It then drops to 0 for all values of \( 130 = A = 140 \), but then jumps to \( 70 + e/2 \) for \( A = 140 + e \), and continues to climb at the rate of one half unit of settlement value for each unit increase in \( A \).

6. **The Intuition Behind the Model’s Results**

   Although at first glance there is a bit of complexity underlying the calculation of the settlement results generated to this stage, it is useful to observe that some simple intuition helps explain the operation of the model and that it can be further useful to characterize the model as a compound real option.

   Because we have constrained the underlying uncertainty to take the form of a binary variable, it is possible to frame the valuation of the litigation just prior to the resolution of the underlying uncertainty as being driven by two branches of a decision tree where both branches can describe credible threats, where only one branch can describe a credible threat, or where neither branch describes a credible threat. The credibility of each branch depends on whether the corresponding payoff exceeds the additional Stage 2 litigation costs that would have to be incurred by the plaintiff to collect that payoff. In the argot of option theory, the Stage 2 litigation
costs can be viewed as an additional premium that would have to be paid by the plaintiff in the event of each payoff. The simple test of credibility is whether the premium to be paid for each option is then greater or less than the corresponding payoff. If the premium costs more than the payoff, the plaintiff won’t buy that branch of the decision tree and it can be trimmed from the decision process as representing a non-credible outcome.

Stage 1 litigation costs can then also be viewed as a premium that the plaintiff must pay in order to determine whether it wants to buy the learning option to resolve at the beginning of Stage 2 the uncertainty that she faces.

In the examples just presented, when variance is sufficiently low, each branch remains credible but the information that is revealed has no value in addition to the litigation’s pure abandonment value. However, when A hits 130, the branch represented by B loses credibility in Stage 2 and there is insufficient mass on Branch A to cause that branch to remain credible in the face of Stage 1 litigation costs of 70. Only when A passes 140 does the 50% probability of A give it sufficient mass to overcome the fixed Stage 1 cost, or premium, of 70.

Beyond that point, the value of the litigation is similar to the value of a traditional financial call option in that the variance of the underlying is the driving force in the valuation of the call option. Indeed, because option valuation models typically assume that the current price of the underlying is an unbiased estimator of its future expected value, our assumption that the information to be revealed in the context of the lawsuit has a mean preserving spread is, in a sense, equivalent to the assumption that the expected value of a financial asset remains fixed for purposes of option valuation.

The analogy to financial options diverges, however, in a very important manner in this model. In a financial option, the purchaser of the option pays the premium to the seller. Here, the purchaser has to pay the premium to a third party, say a lawyer, and the seller of the option, the defendant, receives none of that premium. Even worse from the defendant’s perspective if the plaintiff decides to proceed with the litigation the defendant then also has to pay a “premium” to a separate group of third parties, its own lawyers. The plaintiff’s threat thus has two components: it can force the defendant to pay a judgment and it can force the defendant to incur defense costs separate and apart from the existence of a judgment.

Needless to say, a plaintiff’s ability to impose costs on a defendant, and thereby to extract a settlement not because the plaintiff’s claim has great intrinsic merit but because it will be very
expensive for the defendant to defend against the claim, is modulated by the fact that the plaintiff has to bear its own costs in the litigation. If, however, the plaintiff’s costs are relatively low compared to defendant’s the result can intuitively be an equilibrium in which plaintiffs are able to extract significant settlements simply because they have leverage in imposing litigation costs and not because there is great substantive merit in the claims being pursued.

Indeed, we later extend this observation to suggest that it is possible to decompose the settlement value of every lawsuit into two distinct components: the value attributable to the threat of a judgment in favor of the plaintiff and the value attributable to the threat of being able to force the defendant to pay substantial attorneys fees in the course of the litigation. We will further suggest that the “merits” of a lawsuit can be measured by the extent to which the threat of a judgment drives settlement values as opposed to the threat of attorneys’ fees. The larger the percentage of the settlement that is attributable to the prospect of a judgment, rather than to the plaintiff’s ability to extract avoided litigation costs the more credible it is to claim that the case is brought for its “merits.”

B. Positive Net Expected Value Litigation

The preceding discussion focused on NEV litigation. The presence of learning and abandonment options can, however, also have significant implications for the settlement value of PEV litigation. To illustrate the implications of information and abandonment on PEV litigation we first analyze the pure abandonment option settlement value of a PEV lawsuit. We then extend the analysis by adding information revelation and describing situations in which information revelation will either leave the pure abandonment option settlement value unchanged, decrease that value, or increase that value. We further demonstrate that PEV litigation can also display discontinuities in settlement value, although we later demonstrate that there are no transition zones in PEV litigation.

We illustrate these findings with the example of a lawsuit that has an expected judgment of 100 where total litigation costs for the plaintiff and defendant are each 90. Stage 1 costs are 10 while Stage 2 costs are 80 for each litigant. The lawsuit thus has an expected value of 10 and, in the standard single stage expected value model, would settle for 100.
1. The Pure Divisibility Value of the Settlement

We initially assume that A=100 and B=100. Accordingly, there is no financially meaningful information to be disclosed at the end of Stage 1 and the settlement value of this lawsuit will track the pure divisibility value of the suit.

To wit, if the court selects A then the plaintiff can spend 80 to collect 100, and therefore has a minimum demand of 20. The defendant will be willing to pay 100 plus the avoided litigation costs of 80, and will therefore have a maximum offer of 180. Assuming equal bargaining power, the parties would agree to settle at Stage 2 for 100 = 0.5(20 + 180). The identical result follows in the event the court selects B. Accordingly, the lawsuit would settle for 100 at the beginning of Stage 2. Continuing backwards in time, at Stage 1, the plaintiff knows that she can obtain a settlement of 100 at Stage 2 by spending 10. The plaintiff therefore establishes a minimum demand of 90 = 100 - 10. A rational defendant is willing to pay any settlement amount less than 100 plus the avoided litigation costs of 10, or 110, to avoid the lawsuit at its inception. Assuming equal bargaining power, the parties will settle at Stage 1 for 100 = 0.5(90 + 110).

2. An Example of Information Revelation that Does Not Alter Settlement Values

Consider a situation in which the court’s ruling at the beginning of Stage 2 results in an outcome either of A = 110 or B = 90. If the court selects A, then the plaintiff’s minimum settlement demand will be the anticipated payoff of 110 less the Stage 2 litigation costs of 80, or 30. The defendant’s maximum offer would equal the anticipated judgment of 110 plus avoided litigation costs of 80, or 190. Assuming equal bargaining power, the case would then settle for 110 = 0.5(30+190).

If, however, the court selects B, then the plaintiff would have a minimum demand equal to the expected judgment of 90 less litigation costs of 80, or 10. The defendant would have a maximum offer of 90 plus the avoided litigation cost 80, or 170. Assuming equal bargaining power, the case would then settle for 90 = 0.5(10+170).

Viewed from the start of the litigation, however, there is a 50% probability of a 110 settlement if A is selected and a 50% probability of a 90 settlement if B is selected. The
expected value of the settlement at the beginning of Stage 2 is thus $100 = (0.5)\cdot110 + (0.5)\cdot90$. Continuing the backward induction process into Stage 1, the plaintiff understand that she can incur litigation costs of 10 to force a settlement of 100, while the defendant recognizes that he can be forced to incur litigation expenses of 10 as a prelude to paying a settlement of 100. The parties, having equal bargaining power and therefore settle for 100.

Information revelation in this example thus does not alter the pure divisibility settlement value of the lawsuit.

3. **An Example of Information Revelation that Reduces Settlement Value**

Now consider a situation in which the court’s ruling at the beginning of Stage 2 results in damages of either $A = 140$ or $B = 60$. If the court selects $A$, then the plaintiff’s minimum demand is the value of the expected judgment, 140, less litigation costs of 80, or 60. The defendant’s maximum offer is the value of the judgment, 140, plus avoided litigation costs of 80, or 220. With equal bargaining power the lawsuit would then settle for $140 = 0.5(60 + 220)$.

If the court selects $B = 60$, then the plaintiff will abandon the lawsuit because it makes no sense to spend 80 in pursuit of a judgment of 60. The litigation then becomes non-credible.

Viewed from the beginning of Stage 1, though, a plaintiff has to pay 10 for a 50% probability of a settlement of 140 at the start of Stage 2. The plaintiff’s minimum demand is thus $60 = 0.5(140) – 10$. The defendant’s maximum offer is the expected value of the Stage 2 settlement, 70, plus the avoided litigation costs of 10, or 80. Assuming equal bargaining power, the case settles for $70 = 0.5(60 + 80)$.

As this example illustrates, there are conditions under which the presence of an information revelation option causes the lawsuit’s settlement value to decline below its pure divisibility settlement value.

4. **An Example of Information Revelation that Increases Settlement Value**
Consider now a situation in which the court’s ruling at the beginning of Stage 2 results in an outcome either of A = 260 or B = -60. If the court selects A, then the plaintiff’s minimum demand will be the expected value of the judgment, 260, less Stage 2 litigation costs of 80, or 180. The defendant’s maximum offer will be the value of the judgment plus avoided litigation costs of 80, or 340. The parties would then split the difference between the minimum demand and maximum offer and settle for 260 = 0.5(180+340).

If, however, the court selects outcome B, the plaintiff will simply drop the claim because it would be irrational for the plaintiff to pay an additional 80 only to suffer a harm of an additional 60. Outcome B thus causes the loss of credibility.

Viewed now from the perspective of the beginning of Stage 1, the plaintiff has a 50% chance of outcome A, which has a settlement value of 260, and the expected value of pursuing the litigation to the beginning of Stage 2 is thus 130=0.5·260. The plaintiff’s minimum demand at the beginning of Stage 1 would therefore be 130 less Stage 1 litigation costs of 10, or 120. The defendant’s maximum offer would be the expected settlement value of 130, plus Stage 1 litigation costs of 10, or 140. Because of equal bargaining power, the case would settle for 130=0.5(120+140). Here, the introduction of the information option causes the parties to settle for an amount greater than the pure divisibility value of the litigation.

5. A Transition Phase

As the value of A increases from 100, i.e., as the variance of the information increases, the lawsuit’s settlement value initially equals its pure abandonment settlement value. At some point, however, the variance reaches a critical value at which the lawsuit’s settlement value becomes discontinuous. We demonstrate the existence of this discontinuity in our example by first examining settlement dynamics when A=120 and B=80. Just as a matter of intuition, the attentive reader might suspect that this would be the point of discontinuity because it is the point at which one of the branches of the decision tree first loses the mass necessary to support Stage 2 litigation costs of 80.

If the court selects A, then the plaintiff’s minimum demand will be the value of the judgment, 120, less the Stage 2 litigation costs, 80, or 40. The defendant’s maximum offer will then be the value of the expected judgment, 120, plus avoided litigation costs of 80, or 200.
Because the parties split the difference between their minimum demand and maximum offer the settlement value of the suit at this point would be 120=0.5(40+200).

If the court selects B then the plaintiff’s suit is not credible because the plaintiff would have to spend 80 to gain 80. In that event, because the probability that the court will select A is 0.5, the expected value of the lawsuit as of the end of Stage 1 is 60=0.5(120).

To initiate the lawsuit, however, the plaintiff would have to incur Stage 1 litigation costs of 10 in order to gain the benefit of a settlement valued at 60. The plaintiff’s minimum demand is thus 50. The defendant would perceive that the plaintiff has the credible threat of forcing him to incur Stage 1 litigation costs of 10 only to have to pay a settlement of 60. The defendant would therefore have a maximum offer of 70. Because the litigants have equal bargaining power, the case settles for 60 = 0.5(50+70).

Notice, however, that if the previous example is changed ever so slightly so that the values are $A = 120-\varepsilon$ and $B = 80+\varepsilon$, where $\varepsilon$ denotes a small positive number, then the lawsuit would settle for 100, just as it does when $A=100$ or $110$. This result follows because if the court selects A then the plaintiff’s minimum demand will be $120 - \varepsilon - 80$, or $40 - \varepsilon$; and the defendant’s maximum offer will be $120 - \varepsilon + 80$, or $200 - \varepsilon$. The midpoint of the demand and offer is $120-\varepsilon$.

If the court selects B then the plaintiff’s minimum demand will be $80 + \varepsilon - 80$, or $\varepsilon$; and the defendant’s maximum offer will be $80 + \varepsilon + 80$, which is $160 + \varepsilon$. In that case, the litigation settles for the midpoint of the minimum demand and maximum offer, or $80 + \varepsilon$. The expected value of these two settlements is then $100=0.5(120-\varepsilon+80+\varepsilon)$.

As the analysis continues backward into Stage 1, the plaintiff’s minimum demand would be 100 less Stage 1 litigation costs of 10, or 90. The defendant’s maximum offer would be 100 plus Stage 1 litigation costs of 10, or 110. The lawsuit would then settle for the midpoint of 100.

Notice, however, what occurs when $A$ moves beyond 120 to $120 + \varepsilon$ and $B = 80 - \varepsilon$. If the court selects A, then the plaintiff’s minimum demand is $120 + \varepsilon - 80$, or $40 + \varepsilon$. The defendant’s maximum offer is no more than $120 + \varepsilon + 80$, or $200 + \varepsilon$. In that case the litigation would settle for the midpoint value of $120 + \varepsilon = 0.5(40+\varepsilon+200+\varepsilon)$.

If the court selects B, then the plaintiff’s claim lacks credibility. The settlement value of the lawsuit at the end of Stage 1 is thus viewed as a 50% probability of a settlement value of $120 + \varepsilon$, which is $60 + (\varepsilon/2)$. Viewed from the beginning of Stage 1, the plaintiff’s minimum demand
is $60 + (\varepsilon/2) - 10$, or $50 + \varepsilon/2$. The defendant’s maximum offer is $60 + (\varepsilon/2) + 10$, or $70 + (\varepsilon/2)$. Because the case settles for its midpoint, the settlement value is $60 + (\varepsilon/2)$.

5. Visualizing Settlement Values

Table 2 describes settlement values for this PEV lawsuit as a function of the variance of the underlying uncertainty. The construction of Table 2 is identical to that of Table 1, with the difference being that Stage 2 litigation costs are 80 and Stage 1 costs are 10. Figure 3 graphs the results derived in Table 2.

As is apparent from a simple examination of Table 2 and Figure 3, the litigation’s settlement value is fixed at its pure abandonment option value of 100 until $A$ reaches 120, at which point the settlement value drops to 60. The decline is, as we later demonstrate, defined by half of the Stage 2 litigation costs, which here amounts to $40=80/2$. Further, once $A$ reaches beyond 120, the lawsuit’s settlement value again increases at the rate of one half unit for each unit increase in $A$.

6. The Intuition Behind the Model’s Results

The intuition behind the model’s results in the case of PEV litigation is essentially identical to the intuition in the case of NEV litigation. The major difference in the two situations is that the fact that a lawsuit is PEV places a constraint on the size of the premia that can be charged to the plaintiff for the right to exercise the option to continue with the litigation. In the limit, the premium in any stage cannot exceed the expected value of the litigation, and if the premium in any stage reaches that value, the remaining premia must be zero, otherwise the lawsuit would not be PEV. As a consequence of this constraint, we later demonstrate that it is never possible for both legs of PEV lawsuit to become non-credible and PEV lawsuits therefore never display transition zones, or dead zones.

IV. Algebraic Solutions
To recapitulate the operation of the model, two rational, risk neutral litigants are engaged in a lawsuit that is conducted in two stages. At the beginning of Stage 2, after having incurred Stage 1 litigation costs but prior to committing to Stage 2 litigation expenses, the court reveals a decision that has a payoff of either A or B. The plaintiff thus has the option to invest Stage 1 litigation costs in order to learn the information to be disclosed at the beginning of Stage 2, and then has the option to abandon the lawsuit if the plaintiff learns unfavorable information.

The lawsuit has an expected judgment of \( \mu = pA + (1-p)B \), where \( \mu \) and \( p \) are fixed. Because of the constraint that \( \mu \) and \( p \) are fixed, as \( A \) varies, \( B \) must also vary by an equal and offsetting amount. The mean value of the judgment is thus fixed but its variance is allowed to change.

Plaintiff’s litigation costs are \( C_p = C_{p1} + C_{p2} = 0 \), and defendant’s litigation costs are \( C_d = C_{d1} + C_{d2} = 0 \), where \( C_{ij} = 0 \) for all \( i,j \). The plaintiffs’ relative bargaining power is described by \( a \). We initially assume that the parties have equal bargaining power, or \( a = 0.5 \). The litigants have common knowledge of the model’s parameters and homogeneous expectations as to the information to be revealed as of the beginning of Stage 2.

We begin our analysis with a series of seven propositions concerning the credibility of plaintiff claims in our two-stage real option model of litigation. We focus initially on these conditions because credibility is a necessary and sufficient condition for the defendant to be willing to make a positive settlement payment to the plaintiff in equilibrium. Indeed, unless the lawsuit is credible, it will never be brought. Credibility conditions are thus tantamount to existence propositions.

A. Credibility Conditions

Proposition 1 describes the general condition for credibility as it applies to both positive expected value (PEV) and negative expected value (NEV) litigation.

**Proposition 1**: A lawsuit is credible in the sense of having a positive initial settlement value, \( S^* \), (i.e., a defendant will rationally make a positive payment to settle the lawsuit before the beginning of Stage 1) iff the plaintiff has a credible threat at the beginning of each stage to continue with the lawsuit. The necessary and sufficient conditions for credibility at
beginning of Stage 2, prior to disclosure of the information, are: $A > C_{p2}$ or $B > C_{p2}$ or both. The necessary and sufficient condition for credibility at the beginning of Stage 1 is: $S_2 > C_{p1}$, where $S_2$ is the settlement value at the beginning of stage 2. The option settlement value of the lawsuit measured prior to Stage 1 litigation costs is:

$$S^* = \frac{1}{2}\{\max (0, S_2 - C_{p1}) + (S_2 + C_{d1})\text{Inv}[S_2 > C_{p1}]\},$$

where $\text{Inv}[S]$ is one if the statement $S$ is true and zero if $S$ is false.

**Proof:** At the beginning of stage 2, before the parties learn the court’s ruling & before the plaintiff decides whether to spend $C_{p2}$, the plaintiff’s minimum demand,

$$\text{Min Demand}_2 = p[\max(0, A - C_{p2})] + (1-p)[\max(0, B - C_{p2})].$$

Define the Inversion bracket, $\text{Inv}[S]$ to be one if the statement $S$ is true and zero if $S$ is false. Then, the defendant’s maximum offer,

$$\text{Max Offer}_2 = p(A + C_{d2})\text{Inv}[A > C_{p2}] + (1-p)(B + C_{d2})\text{Inv}[B > C_{p2}],$$

Thus, assuming equal bargaining power, the settlement value at the beginning of stage 2,

$$S_2 = (\text{Min Demand}_2 + \text{Max Offer}_2)$$

At the beginning of stage 1, before the plaintiff decides whether to spend $C_{p1}$, the settlement value is

$$S^* = \frac{1}{2}(\text{Min Demand}_1 + \text{Max Offer}_1),$$

where

$$\text{Min Demand}_1 = \max (0, S_2 - C_{p1})$$

$$\text{Max Offer}_1 = (S_2 + C_{d1})\text{Inv}[S_2 > C_{p1}]$$

Thus, from the above expressions for $S_2$ and $S^*$, it is clear that if $A > C_{p2}$ or $B > C_{p2}$ or both, and $S_2 > C_{p1}$, the lawsuit is credible overall for the plaintiff in the sense that $S^* > 0$. Conversely, if $S^* > 0$, then $S_2 > C_{p1}$ and either $A > C_{p2}$ or $B > C_{p2}$ or both. Notice that $\text{Min Demand}_2$ involves expressions for the payoff of a call option written on the random variable $X$, with a strike price of $C_{p2}$ and $\text{Min Demand}_1$ is an expression for the payoff of a call option written on the settlement value at the beginning of stage 2, with a strike price of $C_{p1}$.

Proposition 1 establishes the foundation from which it is possible to describe the credibility of all PEV and NEV litigation. We first demonstrate that, as intuition suggests, all PEV lawsuits are credible.
Proposition 2: All PEV lawsuits are credible for every level of variance, i.e., for any values of A and B.

Proof: A PEV lawsuit satisfies: \( \mu > C_p = C_{p1} + C_{p2} > C_{p2} \).

Suppose that \( A < C_{p2} \), then we argue by contradiction that \( B > C_{p2} \) must hold. For if both \( A < C_{p2} \), and \( B < C_{p2} \); then, \( pA < pC_{p2} \), \( (1 - p)B < (1 - p)C_{p2} \), and so \( \mu = pA + (1 - p)B < pC_{p2} + (1 - p)C_{p2} = C_{p2} \), which contradicts \( \mu > C_{p2} \). Thus, the credibility constraints at stage 2 hold (i.e., both legs cannot be non-credible). As for the credibility constraint at stage 1 that \( S_2 > C_{p1} \), suppose that both \( A > C_{p2} \) and \( B > C_{p2} \). Then,

\[
S_2 = \frac{1}{2} [\min \text{Demand}_2 + \max \text{Offer}_2]
\]

\[
= \frac{1}{2} [p(A - C_{p2}) + (1 - p)(B - C_{p2}) + p(A + C_{d2}) + (1 - p)(B + C_{d2})]
\]

\[
= \frac{1}{2} [2pA + 2(1 - p)B + C_{d2} - C_{p2}]
\]

\[
= \mu + \frac{1}{2}(C_{d2} - C_{p2})
\]

If \( S_2 < C_{p1} \), then \( \mu + \frac{1}{2}(C_{d2} - C_{p2}) < C_{p1} \), so that \( \mu + \frac{1}{2}(C_{d2}) < (1/2)C_{p2} + C_{p1} \), and \( \mu < \mu + \frac{1}{2}(C_{d2}) < C_{p1} + (1/2)C_{p2} < C_{p1} + C_{p2} = C_p \), which contradicts \( \mu > C_p \). Suppose that \( A > C_{p2} \), but \( B < C_{p2} \). Then, \( S_2 = p[A + \frac{1}{2}(C_{d2} - C_{p2})] \). We argue by contradiction that \( S_2 > C_{p1} \) must hold because \( S_2 < C_{p1} \iff pA < C_{p1} + (p/2)(C_{p2} - C_{d2}) \). But now,

\[
\mu = pA + (1 - p)B
\]

\[
< pA + (1 - p)C_{p2} \text{, because we assumed here that } B < C_{p2} \iff (1 - p)B < (1 - p)C_{p2}
\]

\[
< C_{p1} + (p/2)(C_{p2} - C_{d2}) + (1 - p)C_{p2}, \text{ because we assumed } pA < C_{p1} + (p/2)(C_{p2} - C_{d2})
\]

\[
< C_{p1} + (p/2)(C_{p2}) + (1 - p)C_{p2}, \text{ because } (p/2)C_{d2} > 0
\]

\[
< C_{p1} + (1/2)(p + 2 - 2p)(C_{p2}) = C_{p1} + (1/2)(2 - p)(C_{p2})
\]

\[
< C_{p1} + C_{p2} = C_p, \text{ because } (1/2)(2 - p) = 1 - (p/2) < 1.
\]

But, \( \mu < C_p \) contradicts \( \mu > C_p \).

Similarly, if we suppose that \( B > C_{p2} \), but \( A < C_{p2} \); then, \( S_2 = (1 - p)[B + \frac{1}{2}(C_{d2} - C_{p2})] \). We argue by contradiction that \( S_2 > C_{p1} \) must hold because \( S_2 < C_{p1} \iff (1 - p)[B + \frac{1}{2}(C_{d2} - C_{p2})] < C_{p1} \iff (1 - p)B < C_{p1} + (1 - p)(1/2)(C_{p2} - C_{d2}) \). But now,

\[
\mu = pA + (1 - p)B
\]

\[
< pC_{p2} + (1 - p)B, \text{ because we assumed that } A < C_{p2} \iff pA < pC_{p2}
\]

\[
< pC_{p2} + C_{p1} + (1 - p)(1/2)(C_{p2} - C_{d2}), \text{ because } (1 - p)B < C_{p1} + (1 - p)(1/2)(C_{p2} - C_{d2})
\]

\[
< pC_{p2} + C_{p1} + (1 - p)(1/2)C_{p2}, \text{ because } (1-p)(1/2)C_{d2} > 0
\]
< C_{p1} + [p + (1 - p)(1/2)](C_{p2}) = C_{p1} + (1/2)(2p + 1 - p)(C_{p2}) = C_{p1} + (1/2)(p + 1)(C_{p2})
< C_{p1} + C_{p2} = C_p, because (p + 1)/2 < 1 ⇔ p + 1 < 2
But, µ < C_p contradicts µ > C_p.

The credibility of NEV lawsuits is not, however, as obvious. In Section III we demonstrated that credible NEV lawsuits existed by exploring the model’s equilibrium settlement value when: p = ½, A = 120, B = 80, µ =100, and C_{p1} = C_{d1} = C_{p2} = C_{d2} = 70. Under those circumstance, S^* = 100 = S_2 = µ. A constructive proof of the conditions that are sufficient for a credible NEV lawsuit follows.

**Proposition 3**: Credible NEV (Negative Expected Value) lawsuits exist.

**Proof**: A NEV lawsuit satisfies: µ < C_p = C_{p1} + C_{p2}. In order to be a credible lawsuit, by Proposition 1, at the beginning of stage 2, it must be that A > C_{p2} or B > C_{p2} or both. If both A > C_{p2} or B > C_{p2}, then S_2 = µ + ½(C_{d2} - C_{p2}). To satisfy the credibility constraint at stage 1, namely, S_2 > C_{p1} requires that µ + ½(C_{d2} - C_{p2}) > C_{p1}. This can be done for choices of µ, C_{d2}, C_{p2}, and C_{p1}, while still preserving the NEV condition that µ < C_p = C_{p1} + C_{p2}, by choosing C_{p2} to be sufficiently large. If A > C_{p2}, but B < C_{p2}, then, S_2 = p[A + ½(C_{d2} - C_{p2})]. To satisfy the credibility constraint at stage 1, namely, S_2 > C_{p1} requires that p[A + ½(C_{d2} - C_{p2})] > C_{p1}. This can be done for choices of p, A, C_{d2}, C_{p2}, and C_{p1}, while still preserving the NEV condition that µ = pA + (1 – p) B < C_p = C_{p1} + C_{p2}, by choosing C_{p2} to be sufficiently large. Finally, if B > C_{p2}, but A < C_{p2}, then, S_2 = (1 - p)[B + ½(C_{d2} - C_{p2})]. To satisfy the credibility constraint at stage 1, namely, S_2 > C_{p1} requires that (1 - p)[B + ½(C_{d2} - C_{p2})] > C_{p1}. This can be done for choices of p, B, C_{d2}, C_{p2}, and C_{p1}, while still preserving the NEV condition that µ = pA + (1 – p) B < C_p = C_{p1} + C_{p2}, by choosing C_{p2} to be sufficiently large.

As the previous proof suggests, some NEV lawsuits may be credible for every level of variance. This is demonstrated by the following numerical example: p = ½, C_{p1} = C_{d1} = 40, C_{p2} = C_{d2} = 70, µ = 100. This lawsuit is NEV because 100-110 = -10. At zero variance, the lawsuit is credible with a settlement value of 100. As A increases, the option settlement value remains at 100, until A = 130 (and so B = 70). At that point, if the court selects B, the plaintiff will abandon
the lawsuit. If the court selects A, the plaintiff has a credible threat to proceed at stage 2 because 130 > 70. Note: \[S_2 = p[A + \frac{1}{2}(C_{d2} - C_{p2})] = \frac{1}{2}(130) = 65 > 40.\] S* drops discontinuously from 100 to 65 at \(A = 130\) and then as A increases above 130, \(S^* = S_2 = pA\). A constructive proof of the conditions that are sufficient for a NEV lawsuit to be credible for every level of variance follows.

**Proposition 4**: Some NEV lawsuits are credible for every level of variance.

**Proof**: A NEV lawsuit satisfies: \(\mu < C_p = C_{p1} + C_{p2}\). For such a NEV lawsuit to be credible when there is zero variance, requires that in stage 2, \(A = \mu = B > C_{p2}\). Such a stage 2 credibility constraint is consistent with the NEV condition if \(C_{p1}\) is sufficiently large. The stage 1 credibility constraint requires that \(S_2 > C_{p1}\), where \(S_2 = \frac{1}{2}(\text{Min Demand}_2 + \text{Max Offer}_2)\), with \(\text{Min Demand}_2 = \max(0, A - C_{p2})\) and \(\text{Max Offer}_2 = (A + C_{d2})\text{Inv}[A > C_{p2}]\). Because we assume there is credibility at stage 2, i.e., \(A > C_{p2}\); \(S_2 = \frac{1}{2}((A - C_{p2}) + (A + C_{d2})) = \frac{1}{2}(2A + C_{d2} - C_{p2}) = \mu + \frac{1}{2}(C_{d2} - C_{p2})\) because \(A = B = \mu\). The stage 1 credibility constraint, \(S_2 > C_{p1}\) holds if \(C_{p1}\) is not too large. To be precise, a NEV lawsuit is credible when there is zero variance iff \(C_{p2} < \mu < C_p = C_{p1} + C_{p2}\) and \(C_{p1} - \frac{1}{2}(C_{d2} - C_{p2}) < \mu < C_p = C_{p1} + C_{p2}\). For such a credible NEV lawsuit, the settlement value when there is zero variance, \(S^* = \frac{1}{2}[(S_2 - C_{p1}) + (S_2 + C_{d1} - C_{p1})] = \frac{1}{2}[(2S_2 + C_{d1} - C_{p1}) = S_2 + \frac{1}{2}(C_{d1} - C_{p1}) = \mu + \frac{1}{2}(C_{d2} - C_{p2}) + \frac{1}{2}(C_{d1} - C_{p1}) = \mu + \frac{1}{2}(C_{d2} - C_{p1}) = \mu + \frac{1}{2}(C_d - C_p)\) until A reaches the critical value \((1/p)[\mu - (1-p)C_{p2}] \iff B = C_{p2}\), at which point, if the court selects B, the plaintiff will abandon the lawsuit.

If the court selects A, the plaintiff will have a credible threat to proceed at stage 2 because \((1/p)[\mu - (1-p)C_{p2}] > C_{p2} \iff [\mu - (1-p)C_{p2}] > pC_{p2} \iff \mu > C_{p2}\), which is the stage 2 credibility constraint when there is zero variance that we already assumed above. Notice that in this case, \(S_2 = p[A + \frac{1}{2}(C_{d2} - C_{p2})] = \mu - (1-p)C_{p2} + (p/2)(C_{d2} - C_{p2}) = \mu + C_{p2} + (p/2)(C_{d2} - C_{p2}) > \mu + (p/2)(C_{d2} - C_{p2})\). Thus, the stage 1 credibility constraint, \(S_2 > C_{p1}\) holds iff \(\mu + (p/2)(C_{d2} - C_{p2}) > C_{p1}\), i.e., if \(C_{p1}\) is not too large. To be precise, a NEV lawsuit is credible when there is positive variance iff \(C_{p2} < \mu < C_p = C_{p1} + C_{p2}\) and \(C_{p1} - (p/2)(C_{d2} - C_{p2}) < \mu < C_p = C_{p1} + C_{p2}\). For such a credible NEV lawsuit, the settlement value when there is positive variance, \(S^* = pA + (p/2)(C_{d2} - C_{p2}) + \frac{1}{2}(C_{d1} - C_{p1})\). Finally, notice that because \(p < 1\), \((p/2)(C_{d2} - C_{p2}) < (1/2)(C_{d2} - C_{p2})\) and so, \(C_{p1} - (p/2)(C_{d2} - C_{p2}) > C_{p1} - (1/2)(C_{d2} - C_{p2})\). In other words, the conditions for a NEV lawsuit
to be credible when there is positive variance are more stringent than the conditions for a NEV lawsuit to be credible when there is zero variance.

An intriguing implication of the analysis of NEV litigation to this point is that it seems that the credibility of an NEV claim is more likely the higher is the variance of the information that is to be disclosed. This intuition is correct, and supports a strong proposition regarding the potential credibility of every NEV lawsuit.

**Proposition 5:** Every NEV lawsuit is credible for a sufficiently high level of variance.

**Proof:** A NEV lawsuit satisfies: \( \mu < C_p = C_{p1} + C_{p2} \). In order to be a credible lawsuit, by Proposition 1, at the beginning of stage 2, it must be that \( A > C_{p2} \) or \( B > C_{p2} \) or both. If \( A < C_{p2} \), then we can ensure that \( B > C_{p2} \) must hold for a sufficiently high level of variance by simply increasing \( B \) and simultaneously decreasing \( A \) to preserve the value of \( \mu \). Thus, the credibility constraints at stage 2 hold (i.e., both legs cannot be non-credible). As for the credibility constraint at stage 1 that \( S_2 > C_{p1} \), note that as the variance increases, either \( A > C_{p2} \) or \( B > C_{p2} \) fails to hold. Without any loss of generality, suppose that eventually \( A > C_{p2} \), but \( B < C_{p2} \). Then, \( S_2 = p[A + 1/2(C_{d2} - C_{p2})] \). To ensure this expression is greater than \( C_{p1} \), just increase \( A \) (and correspondingly, the variance).

The fact that every NEV lawsuit is credible for a sufficiently high level of variance does not, however, prove that every NEV lawsuit is credible over every level of variance. To illustrate this point, consider an NEV lawsuit where, as analyzed in Part III: \( p = 1/2, C_{p1} = C_{d1} = C_{p2} = C_{d2} = 70, \mu = 100 \). Start where \( A = B = 100 \) (zero variance). As \( A \) increases from 100 to 130 - \( \varepsilon \) (and correspondingly, \( B \) decreases from 100 to 70 + \( \varepsilon \)), the lawsuit is credible and has an option settlement value of 100. But at \( A = 130 \) (and \( B = 70 \)), the lawsuit lacks credibility, i.e. it has 0 option settlement value. Lawsuits continue to lack credibility for all values of \( A \in [130, 140] \) (and \( B \in [60, 70] \)). For \( A = 140 + \varepsilon \) (and \( B = 60 - \varepsilon \)), the lawsuit is credible and has an option settlement value of 70. For \( A = 180 \) (and \( B = 20 \)), the lawsuit is credible and has an option settlement value of 90. At \( A = 200 \) (and \( B = 0 \)), the lawsuit is credible and has an option settlement value of 100. At \( A = 200 + \varepsilon \) (and \( B = -\varepsilon \)), the lawsuit is credible and has an option
settlement value of $100 + (\varepsilon/2)$. A constructive proof of the conditions that are sufficient for a NEV lawsuit to be credible for only certain levels of variance follows.

**Proposition 6**: There exist a set of NEV lawsuits that are credible only over certain ranges of variance.

**Proof**: From proposition 4, we know that a NEV lawsuit is credible when there is zero variance iff $C_{p2} < \mu < C_{p} = C_{p1} + C_{p2}$ and $C_{p1} - \frac{1}{2} (C_{d2} - C_{p2}) < \mu < C_{p} = C_{p1} + C_{p2}$. Moreover, from proposition 4, we also know that as A increases, the option settlement value remains at $\mu + \frac{1}{2}(C_{d} - C_{p})$ until A reaches the critical value $(1/p)[\mu - (1-p)C_{p2}] \iff B = C_{p2}$, at which point, if the court selects B, the plaintiff will abandon the lawsuit. If the court selects A, the plaintiff will have a credible threat to proceed at stage 2. Finally, from proposition 4, we know the stage 1 credibility constraint, $S_2 > C_{p1}$ holds iff $\mu + (p/2)(C_{d2} - C_{p2}) > C_{p1}$, i.e. if $C_{p1}$ is not too large. Thus, if $C_{p1}$ is sufficiently large, then the plaintiff will not file the lawsuit because $S^* = 0$. But, eventually for large enough values of A, $S_2 = p\{A + \frac{1}{2}(C_{d2} - C_{p2})\}$ will exceed $C_{p1}$, so that it will again become credible for the plaintiff to proceed at stage 1. Thus, if $C_{p1}$ is sufficiently large, then the plaintiff will have a credible lawsuit when $A = B = \mu$ (i.e., the variance is zero) until A reaches the critical value $(1/p)[\mu - (1-p)C_{p2}]$ at which point $S^* = 0$ and the lawsuit loses credibility for the plaintiff until A becomes sufficiently large.

As suggested by the prior proofs, it is also true that if A and B are both restricted to be non-negative, then some NEV lawsuits are never credible. The intuitive meaning of this constraint is that the judgment can never go against the plaintiff so badly that the plaintiff is forced to suffer a loss of wealth as the consequence of the court’s judgment, as opposed to the loss in wealth generated by the need to bear litigation expenses. We demonstrate this point with this example: $p = \frac{1}{2}, C_{p1} = C_{d1} = C_{p2} = C_{d2} = 700, \mu = 100$. This lawsuit is NEV because $100-1400 = -1300$. It is not credible when $A = B = \mu = 100$ (i.e., the variance is zero) because $C_{p2} = 700 > 100 = A$. Also, if B is required to be non-negative, the largest value A can take on is 200 because $p = \frac{1}{2}$ and $\mu = 100$. But for $A = 200$ (and $B = 0$), it is not credible for the plaintiff to proceed with the lawsuit in stage 2 given $C_{p2} = 700$ (any value of $C_{p2}$ over 200 will suffice). In fact, for the above particular values of $p$, $\mu$, and the litigation costs, a lawsuit will not be credible.
until $A = 1400$ (and correspondingly, $B = -1200$) because at that point, $A > 700$ and $S_2 = A/2 > 700$ and $S^* = A/2 = 700$. A constructive proof of the conditions under which NEV lawsuits are never credible if $A$ and $B$ are both constrained to be positive follows.

**Proposition 7:** If $A \geq 0$ and $B \geq 0$, then some NEV lawsuits are never credible.

**Proof:** Recall that a NEV lawsuit satisfies: $\mu < C_p = C_{p1} + C_{p2}$ and that $\mu = pA + (1 - p)B$. It is not credible when $A = B = \mu$ (i.e., the variance is zero) if we assume that $C_{p2} > \mu$. If both $A \geq 0$ and $B \geq 0$, then with $p$ and $\mu$ fixed, there is a maximum value that $A$ can take on, namely $\mu/p$ (equivalently, when $B = 0$). Consider NEV lawsuits with plaintiff’s litigation costs in stage 2 satisfying $C_{p2} > \mu/p$. Because $p < 1$, $\mu/p > \mu$, so if we assume that $C_{p2} > \mu/p > \mu$, then for such NEV lawsuits, by construction, it is not credible for the plaintiff to proceed with the lawsuit in stage 2 for all values of $A$ from 0 to $\mu/p$. If both $A \geq 0$ and $B \geq 0$, then these are the only feasible values for $A$. Thus, NEV lawsuits with $C_{p2} > \mu/p$ and both $A \geq 0$ and $B \geq 0$ are never credible. \[\]

**B. Option Settlement Value and Divisibility Settlement Value**

Having mapped the circumstances under which PEV and NEV lawsuits are or are not credible, we next continue with a set of four propositions that compare and contrast the option settlement value of a lawsuit with the divisibility settlement value of the same lawsuit. Recall that the divisibility value is equivalent to the equilibrium settlement value calculated by Bebchuk. These propositions establish that Bebchuk’s model is a special case of the model presented herein in which information has no value. The propositions also describe the value of information in our model, which can be measured by the difference between the lawsuit’s option settlement value when the variance is positive and the lawsuit’s option settlement value when the variance is zero, that is, the lawsuit’s divisibility settlement value. We further demonstrate that the value of information, so measured, can be positive or negative and is a function of the underlying variance.

**Proposition 8:** If the variance of the uncertainty that the court resolves is zero, meaning that $A = B$, and if the lawsuit is credible, then the option settlement value of the lawsuit equals its
divisibility settlement value. This demonstrates that Bebchuk’s model with divisible litigation costs is a special case of our model where the variance of the uncertainty that the court resolves is zero. To say the variance of the uncertainty that the court resolves is zero means the court’s ruling reveals no payoff-relevant information.

**Proof:** If $A = B$, then in stage 2, the plaintiff’s minimum demand, 
$\text{Min Demand}_2 = \max(0, A - C_{p2})$ and the defendant’s maximum offer, 
$\text{Max Offer}_2 = (A + C_{d2})\text{Inv}[A > C_{p2}]$

Thus, the option settlement value at the beginning of stage 2,
$S_2 = \frac{1}{2}(\text{Min Demand}_2 + \text{Max Offer}_2)$
$= \frac{1}{2}\{\max(0, A - C_{p2}) + (A + C_{d2})\text{Inv}[A > C_{p2}]\}$
$= \frac{1}{2}\{(A - C_{p2}) + (A + C_{d2})\}$ because we assumed the lawsuit is credible, meaning that $A > C_{p2}$
$= \frac{1}{2}(2A + C_{d2} - C_{p2})$
$= \mu + \frac{1}{2}(C_{d2} - C_{p2})$ because $A = B = \mu$

From proposition 1, the option settlement value of a lawsuit is equal to
$S^* = \frac{1}{2}\{\max(0, S_2 - C_{p1}) + (S_2 + C_{d1})\text{Inv}[S_2 > C_{p1}]\}$

At stage 1, by assumption, $S_2 > C_{p1}$ (credibility of the lawsuit); so that
$S^* = \frac{1}{2}\{(S_2 - C_{p1}) + (S_2 + C_{d1})\}$
$= \frac{1}{2}\{(2S_2 + C_{d1} - C_{p1})\}$
$= S_2 + \frac{1}{2}(C_{d1} - C_{p1})$
$= \mu + \frac{1}{2}(C_{d2} - C_{p2}) + \frac{1}{2}(C_{d1} - C_{p1})$
$= \mu + \frac{1}{2}(C_{d} - C_{p})$, the divisibility settlement value.

More broadly, information will not have value to the litigants if they do not change their actions as a function of the information that is revealed. It follows that the option settlement value of a lawsuit should also equal its divisibility value if the information is worthless to the litigants. Proposition 9 demonstrates this point.

**Proposition 9:** For a credible lawsuit, if $A > C_{p2}$ and $B > C_{p2}$ (the lawsuit is credible in stage 2 under either court ruling), then the option settlement value of a lawsuit equals the divisibility settlement value.
Proof: If both $A > C_{p2}$ and $B > C_{p2}$, then

$$S_2 = \frac{1}{2}[\text{Min Demand}_2 + \text{Max Offer}_2]$$

$$= \frac{1}{2}[p(A - C_{p2}) + (1 - p)(B - C_{p2})]$$

$$+ p(A + C_{d2}) + (1 - p)(B + C_{d2})]$$

$$= \frac{1}{2}[2pA + 2(1 - p)B + C_{d2} - C_{p2}]$$

$$= \mu + \frac{1}{2}(C_{d2} - C_{p2})$$

At stage 1, by assumption, $S_2 > C_{p1}$ (credibility of the lawsuit); so that

$$S^* = \frac{1}{2}[(S_2 - C_{p1}) + (S_2 + C_{d1})]$$

$$= \frac{1}{2}[2S_2 + C_{d1} - C_{p1}]$$

$$= S_2 + \frac{1}{2}(C_{d1} - C_{p1})$$

$$= \mu + \frac{1}{2}(C_{d2} - C_{p2}) + \frac{1}{2}(C_{d1} - C_{p1})$$

$$= \mu + \frac{1}{2}(C_d - C_p), \text{ the divisibility settlement value}$$

The divisibility settlement value will, on occasion, be an upper bound for the option settlement value. This finding is significant because it demonstrates, as has already been illustrated, that there are circumstances in which the addition of learning and abandonment options can actually reduce the lawsuit’s settlement value below its simple divisibility value.

Proposition 10: If the outcomes $A$ and $B$ are both non-negative and $C_{d2} = C_{p2}$, then the divisibility settlement value is an upper bound for the option settlement value.

Proof: How can a credible lawsuit have an option settlement value that differs from the divisibility settlement value?

Suppose that $A > C_{p2}$, but $B < C_{p2}$. Then,

$$S_2 = \frac{1}{2}[\text{Min Demand}_2 + \text{Max Offer}_2]$$

$$= \frac{1}{2}[p(A - C_{p2}) + p(A + C_{d2})]$$

$$= \frac{1}{2}[2pA + p(C_{d2} - C_{p2})]$$

$$= p(A + \frac{1}{2}(C_{d2} - C_{p2})$$

At stage 1, if $S_2 > C_{p1}$ (credibility of the lawsuit); then

$$S^* = \frac{1}{2}[(S_2 - C_{p1}) + (S_2 + C_{d1})]$$

$$= \frac{1}{2}[2S_2 + C_{d1} - C_{p1}]$$
\[ S_2 = \frac{1}{2}(S_2 - C_{p1}) + (S_2 + C_{d1}) \]
\[ = \frac{1}{2}(2S_2 + C_{d1} - C_{p1}) \]
\[ = S_2 + \frac{1}{2}(C_{d1} - C_{p1}) \]
\[ = (1 - p)B + (1 - p)(1/2)(C_{d2} - C_{p2}). \]

Similarly if \( B > C_{p2} \), but \( A < C_{p2} \); then,
\[ S_2 = \frac{1}{2}[\text{Min Demand}_2 + \text{Max Offer}_2] \]
\[ = \frac{1}{2}(1 - p)(B - C_{p2}) + (1 - p)(B + C_{d2}) \]
\[ = \frac{1}{2}[2(1 - p)B + p(C_{d2} - C_{p2})] \]
\[ = (1 - p)[B + \frac{1}{2}(C_{d2} - C_{p2})] \]
At stage 1, by assumption, \( S_2 > C_{p1} \) (credibility of the lawsuit); so that
\[ S^* = \frac{1}{2}(S_2 - C_{p1}) + (S_2 + C_{d1}) \]
\[ = \frac{1}{2}(2S_2 + C_{d1} - C_{p1}) \]
\[ = S_2 + \frac{1}{2}(C_{d1} - C_{p1}) \]
\[ = (1 - p)B + (1 - p)(1/2)(C_{d2} - C_{p2}) + \frac{1}{2}(C_{d1} - C_{p1}), \] which differs from the divisibility settlement value, \( \mu + \frac{1}{2}(C_d - C_p) \), by \( pA + (p/2)(C_{d2} - C_{p2}). \)

These findings now help us define the necessary and sufficient conditions under which the expected value of the judgment (not the net expected value of the lawsuit itself) will equal both the lawsuit’s pure divisibility value and its option settlement value.

**Proposition 11**: For a credible lawsuit, if \( A > C_{p2} \) and \( B > C_{p2} \) and \( C_d = C_p \), then \( \mu \) (the expected value of the judgment ) equals the divisibility settlement and the option settlement value.

**Proof**: The divisibility settlement value is \( \mu + (1/2)(C_d - C_p) \); so if \( C_d = C_p \), then the divisibility settlement value equals \( \mu \). If \( A > C_{p2} \) and \( B > C_{p2} \), then proposition 9 ensures that the divisibility settlement equals the option settlement value.

**C. Comparative Statics**

We begin our comparative statics analysis by offering two propositions that describe changes in the lawsuit’s option settlement value as a function of changes in the values of \( A \), or
equivalently, $B$, or still equivalently, the variance. Note that if $X$ denotes the random variable which takes on the values of either $A$ or $B$, then $\text{Var}(X) = s^2 = E[(X - \mu)^2] = E[X^2 - 2\mu X + \mu^2] = E[X^2] - 2\mu E[X] + E[\mu^2] = E[X^2] - 2\mu^2 + \mu^2 = E[X^2] - \mu^2 = pA^2 + (1 - p)B^2 - \mu^2 = pA^2 - \mu^2 + (\mu - pA)B$, because $(1 - p) B = \mu - pA$ from $\mu = pA + (1 - p)B$. Thus, $\text{Var}(X) = s^2 = pA^2 - \mu^2 + [(\mu - pA)^2]/(1 - p)$, because $B = (\mu - pA)/(1 - p)$. This demonstrates that $\text{Var}(X) = s^2$ is a function of $A$ (or $B$ because of the assumption of the mean preserving spread). It is a monotone function of $A$ because $\frac{ds^2}{dA} = 2pA + [(-2p\mu + 2p^2A)/(1 - p)] = 2p[A - (\mu + pA)/(1 - p)] = 2p[A(1 - p) - (\mu + pA)]/[1 - (1 - p) > 0$ if $A > \mu$ or $< 0$ if $A < \mu$. We then proceed to demonstrate that the model’s equilibrium settlement value can also be quite sensitive to variations in other model parameters. Some of these relationships are far from intuitive.

**Proposition 12:** As $A$ increases from $\mu$, where the option settlement value coincides with the divisibility settlement value, there exists a value of $A$ at which the option settlement value differs from the divisibility settlement value. If the lawsuit is not credible at Stage 1, then the option settlement value is constant at zero until $A$ rises enough for the lawsuit to become credible for the plaintiff at stage 1. Once the lawsuit is credible at Stage 1, the option settlement value is a monotonically increasing affine function of $A$. The value of this affine function is initially less than the divisibility settlement value if the divisibility settlement value is positive, but at some value of $A$, this affine function equals the divisibility settlement value, and for all values of $A$ after that, this function exceeds the divisibility settlement value. The discontinuity in the option settlement value occurs when $A$ is sufficiently large.

**Proof:** This proposition derives comparative statics for the option settlement value as a function of $A$ (or $B$ or $\text{Var}(X) = s^2$). Graphically, this proposition involves plotting $S^*$ against $A$. Draw a diagram that has $A = B = \mu$ (zero variance) as the origin with $S^* = \mu + \frac{1}{2}(C_d - C_p)$. As $A$ increases, $S^*$ remains at $\mu + \frac{1}{2}(C_d - C_p)$, until $A = (1/p)[\mu - (1-p)C_{p2}] (\iff B = C_{p2})$, at which point, if the court selects $B$, the plaintiff will abandon the lawsuit. If the court selects $A$, the plaintiff will have a credible threat to proceed at stage 2 if $A > C_{p2} (\iff B = C_{p2})$. If not, the plaintiff would not file the lawsuit because $S_2 = 0$. If the plaintiff has a credible threat to proceed at stage 2, then $S_2 = p(A + \frac{1}{2}(C_{d2} - C_{p2}))$. The plaintiff at stage 1 only proceeds if doing so is credible, i.e. $S_2 > C_{p1} (\iff \mu + ((p/2)-1)C_{p2} + (p/2)C_{d2} > C_{p1})$. If not, the plaintiff would not file
the lawsuit because \( S^* = 0 \). If \( S_2 > C_{p1} \), then \( S^* = pA + (p/2)(C_{d2} - C_{p2}) + \frac{1}{2}(C_{d1} - C_{p1}) \). Thus, \( S^* \) drops discontinuously to

\[
S^* = \{ pA + (p/2)(C_{d2} - C_{p2}) + \frac{1}{2}(C_{d1} - C_{p1}) \} \text{Inv}[A > C_{p2}] \text{Inv}[p\{ A + \frac{1}{2}(C_{d2} - C_{p2}) \} > C_{p1}]
\]

For large enough values of \( A \), \( S_2 = p\{ A + \frac{1}{2}(C_{d2} - C_{p2}) \} \) will exceed \( C_{p1} \), so that it will be credible for the plaintiff to proceed at stage 1.

The discontinuity in \( S^* \) occurs when \( A = \max\{(1/p)[\mu - (1-p)C_{p2}], C_{p2}, (1/p)C_p - \frac{1}{2}(C_{d2} - C_{p2})\} \).

As previously suggested, the dominant models of litigation indicate that variance will affect settlement value only if the litigants are not risk neutral. As has repeatedly been demonstrated in this paper, however, variance can determine option settlement values for reasons unrelated to attitudes towards risk. Instead, once variance becomes sufficiently large that it signals the existence of economically valuable information, variance affects settlement values because it determines the parties’ optimal strategies and thereby determines equilibrium settlement values. Indeed, as we now demonstrate, once variance is sufficiently large, the option settlement value is monotonically increasing in variance and the plaintiff will therefore appear to be risk loving because she demands increasingly large payments to settle increasingly risky cases, while the defendant appears to be risk averse because he is willing to make increasingly large payments to settle increasingly risky cases, even though both litigants are in fact risk neutral.

**Proposition 13:** For the range of \( A \) values for which the option settlement values are increasing, (i.e., over the affine range), plaintiffs will act as if they are risk seeking and defendants will act as though they are risk averse, although both are risk neutral.

**Proof:** For the range of \( A \) values for which \( S_2 = p\{ A + \frac{1}{2}(C_{d2} - C_{p2}) \} > C_{p1} \), and \( A > C_{p2} \), \( S^* = [ pA + (p/2)(C_{d2} - C_{p2}) + \frac{1}{2}(C_{d1} - C_{p1}) ] \).

This is an increasing function of \( A \), as are both the plaintiff’s minimum demands and defendant’s maximum offers in both periods. In this sense, plaintiffs will act as if they are risk seeking and defendants will act as though they are risk averse.
To this point, we have not analyzed the implications of changes in the litigation costs borne by the parties. The next proposition demonstrates that if plaintiff’s litigation costs decrease while all other parameters of the model remain fixed, including defendant’s litigation costs, not only will the lawsuit’s option settlement value increase, but so will the size of the discontinuity and its location measured as a function of A.

Proposition 14: As the plaintiff’s litigation costs decrease (increase), ceteris paribus, all these increase (decrease): the option settlement value; the size of the discontinuity measured as the difference between the divisibility settlement value and the option settlement value after the discontinuity; and the point of discontinuity of the option settlement value as a function of A.

Proof. The divisibility settlement value is \( \mu + \frac{1}{2}(C_d - C_p) \). The option settlement value when it differs from this and is not zero is \( S^* = [pA + (p/2)(C_{d2} - C_{p2}) + \frac{1}{2}(C_{d1} - C_{p1})] \). This expression increases as the plaintiff’s litigation costs decreases, ceteris paribus. Also, the difference between the divisibility settlement value and the option settlement value after its discontinuity is the absolute value of \( (1 - p)B + \{(1 - p)/2\}(C_{d2} - C_{p2}) \). This expression also increases as the plaintiff’s litigation costs decreases, ceteris paribus. Finally, the discontinuity in \( S^* \) as a function of A occurs at \( \max\{(1/p)[ \mu - (1-p)C_{p2}], C_{p2}, (1/p)C_p - \frac{1}{2}(C_{d2} - C_{p2})\} \), which also increases as the plaintiff’s litigation costs decreases, ceteris paribus.

To this stage we have not analyzed the effects of “front-loading” or “back-ending” litigation costs. As the following proposition suggests, the percentage of total litigation costs that must be borne in Stage 1 can have a significant effect both on a lawsuit’s credibility and on its settlement value. Because the credibility conditions are also existence conditions, it follows that even if one holds fixed the total costs of litigating, the rules allocating litigation costs between the two stages can alone be sufficient to cause litigants either to institute proceedings or never to file an action.

Proposition 15: As first period litigation costs increase relative to second period litigation costs, holding fixed total litigation costs and all other variables,
(a) there is a larger interval of A values over which the option settlement value coincides with
the divisibility settlement value.
(b) the plaintiff is more likely to have a credible threat to proceed at stage 2.
(c) the plaintiff is less likely to have a credible threat to proceed at stage 1.
(d) there is a smaller range of A values over which the option settlement value is a monotonically
increasing affine function.

Proof: As $C_{p1}$ increases, $C_{p2}$ decreases (to keep total plaintiff litigation costs $C_p$ constant), and as
$C_{d1}$ increases, $C_{d2}$ decreases (to keep total defendant litigation costs $C_d$ constant), which means:
(a) it takes longer to reach the critical value of 
$$A = \max\{\frac{1}{p}\left[ \mu - (1 - p)C_{p2} \right], C_{p2}, \left(\frac{1}{p}\right)C_p - \frac{1}{2}(C_{d2} - C_{p2})\}$$
(b) the stage 2 credibility constraint $A > C_{p2}$ is more likely to hold
(c) the stage 1 credibility constraint $S_2 = p[A + \frac{1}{2}(C_{d2} - C_{p2})] > C_{p1}$ is less likely to hold because
even though on the left hand side, $C_{p2}$ decreases by an amount equal to the increase in $C_{p1}$ on the
right hand side of this inequality, only $(1/2)C_{p2}$ is being subtracted on the left hand side and $C_{d2}$
decreases because $C_{d1}$ increases.
(d) the minimum value of A for which $S_2 = p[A + \frac{1}{2}(C_{d2} - C_{p2})] > C_{p1}$, namely $A = (1/p)C_{p1} +$
$[C_{p2}/2] - [C_{d2}/2]$ increases because $(1/p) > 1$ as $p < 1$ so the increase in $C_{p1}$ trumps the decrease in
$C_{p2}$ trumps and the increase in $C_{d1}$ means a decrease in $C_{d2}$, which is being subtracted.

We next examine the consequences of changing relative litigation costs, having explored
the consequences of just changing the plaintiff’s litigation costs (Proposition 14) and the
consequences of changing only the timing, while holding fixed the total amounts, of both parties
litigation costs (Proposition 15).

Proposition 16: As the defendant’s litigation costs increase relative to the plaintiff’s litigation
costs,
(a) The range of credible NEV lawsuits increases, i.e., some NEV lawsuits are only credible
because of asymmetric litigation costs.
(b) The settlement option value increases.
Proof: As the differences \((C_{d2} - C_{p2})\) and \((C_{d1} - C_{p1})\) increase,
(a) the stage 1 credibility constraint \(S_2 = p[A + \frac{1}{2}(C_{d2} - C_{p2})] > C_{p1}\) is more likely to hold or equivalently, the minimum value of \(A\) for which \(S_2 = p[A + \frac{1}{2}(C_{d2} - C_{p2})] > C_{p1}\), namely \(A = (1/p)C_{p1} + \frac{C_{p2}}{2} - \frac{C_{d2}}{2}\) decreases and so, the range of \(A\) values over which the option settlement value is affine is larger.
(b) the option settlement value, when it is an affine function of \(A\), \(S^* = [pA + (p/2)(C_{d2} - C_{p2}) + \frac{1}{2}(C_{d1} - C_{p1})]\) increases. Also, the divisibility settlement value, \(\mu + \frac{1}{2}(C_d - C_p)\) increases.

Changes in the parties’ relative bargaining power can also have dramatic and disproportionate effects on the credibility of litigation and on its option settlement value. Again, just as occurs as a consequence of front-loading or back-ending litigation expenses, changes in the litigants’ relative bargaining power can cause cases to be brought or to be dropped, and can cause significant changes in equilibrium settlement values.

Proposition 17: As the plaintiff’s bargaining power increases, more NEV lawsuits are credible, option settlement values increase, and the effect of the increase in bargaining power is more than proportional (i.e., a 10% increase in bargaining power can lead to a much greater than 10% increase in the option settlement value because it can create lawsuit credibility where there otherwise would be none) when the lawsuit is NEV or the plaintiff’s litigation cost in stage 1 is sufficiently large.

Proof: If the parties differ in their bargaining strength, suppose that at each stage, the plaintiff makes the take-it-or-leave-it offer with probability \(\alpha\) and the defendant makes the take-it-or-leave-it offer with probability \(1 - \alpha\). Because the ability to make a take-it-or-leave-it offer conveys a bargaining advantage, \(\alpha > \frac{1}{2}\) means that the plaintiff has greater bargaining power and \(\alpha < \frac{1}{2}\) means that the defendant has greater bargaining power (and \(\alpha = \frac{1}{2}\) means the plaintiff and defendant have equal bargaining power). When the plaintiff makes the settlement offer, she will offer the highest amount that the defendant will be willing to accept and when the defendant makes the settlement offer, he will offer the lowest amount that the plaintiff will be willing to accept. Thus, at the beginning of stage 2,
\[S_2 = \alpha(\text{Max Offer}_2) + (1 - \alpha)(\text{Min Demand}_2),\] where
Max Offer\(_2\) = p(A + C_{d2})\text{Inv}[A > C_{p2}] + (1 - p)(B + C_{d2})\text{Inv}[B > C_{p2}]

Min Demand\(_2\) = p[\max(0, A - C_{p2})] + (1 - p)[\max(0, B - C_{p2})]

Similarly at the beginning of stage 1,

\[ S^* = \alpha(\text{Max Offer}_1) + (1 - \alpha)(\text{Min Demand}_1), \]

\[ \text{Max Offer}_1 = (S_2 + C_{d1})\text{Inv}[S_2 > C_{p1}] \]

\[ \text{Min Demand}_1 = \max(0, S_2 - C_{p1}) \]

Suppose that both \(A > C_{p2}\) and \(B > C_{p2}\). Then,

\[ S_2 = \alpha(\text{Max Offer}_2) + (1 - \alpha)(\text{Min Demand}_2) = \alpha[p(A + C_{d2}) + (1 - p)(B + C_{d2})] + (1 - \alpha)[p(A - C_{p2}) + (1 - p)(B - C_{p2})] = pA + (1 - p)B + \alpha C_{d2} - (1 - \alpha)C_{p2} = \mu + \alpha C_{d2} - (1 - \alpha)C_{p2} \]

Thus, the stage 1 credibility condition \(S_2 > C_{p1}\) is more likely to be satisfied as \(\alpha\) increases.

Suppose that \(A > C_{p2}\), but \(B < C_{p2}\). Then,

\[ S_2 = \alpha(\text{Max Offer}_1) + (1 - \alpha)(\text{Min Demand}_1) = \alpha[p(A + C_{d2})] + (1 - \alpha)[p(A - C_{p2})] = pA + \alpha pC_{d2} - (1 - \alpha)C_{p2} = p[A + \alpha C_{d2} - (1 - \alpha)C_{p2}] \]

Again, the stage 1 credibility condition \(S_2 > C_{p1}\) is more likely to be satisfied as \(\alpha\) increases.

Similarly if \(B > C_{p2}\), but \(A < C_{p2}\); then,

\[ S_2 = \alpha(\text{Max Offer}_1) + (1 - \alpha)(\text{Min Demand}_1) = \alpha[(1 - p)(B + C_{d2})] + (1 - \alpha)[p(B - C_{p2})] = (1 - p)B + \alpha (1 - p)C_{d2} - (1 - \alpha)(1 - p)C_{p2} = (1 - p)B + \alpha C_{d2} - (1 - \alpha)C_{p2} \]

Again, the stage 1 credibility condition \(S_2 > C_{p1}\) is more likely to be satisfied as \(\alpha\) increases.

As for the option settlement values, for the case of a credible lawsuit,

\[ S^* = \alpha(S_2 + C_{d1}) + (1 - \alpha)(S_2 - C_{p1}) = S_2 + \alpha C_{d1} - (1 - \alpha)C_{p1} \]

If both \(A > C_{p2}\) and \(B > C_{p2}\), recall from the above this means \(S_2 = \mu + \alpha C_{d2} - (1 - \alpha)C_{p2}\), and so

\[ S^* = \mu + \alpha C_{d2} - (1 - \alpha)C_{p2} + \alpha C_{d1} - (1 - \alpha)C_{p1} = \mu + \alpha C_{d} - (1 - \alpha)C_{p} \]
This expression increases as $\alpha$ increases.

If $A > C_{p2}$, but $B < C_{p2}$; recall from the above this means $S_2 = p[A + \alpha C_{d2} - (1 - \alpha)C_{p2}]$, and so,

$$S^* = p[A + \alpha C_{d2} - (1 - \alpha)C_{p2}] + \alpha C_{d1} - (1 - \alpha)C_{p1}$$

Again, this expression increases as $\alpha$ increases.

If $B > C_{p2}$, but $A < C_{p2}$; recall from the above this means $S_2 = (1 - p)[B + \alpha C_{d2} - (1 - \alpha)C_{p2}]$, and

$$S^* = (1 - p)[B + \alpha C_{d2} - (1 - \alpha)C_{p2}] + \alpha C_{d1} - (1 - \alpha)C_{p1}$$

Again, this expression increases as $\alpha$ increases.

If there is zero variance, by Proposition 9, the option settlement value coincides with the divisibility settlement value, namely $\mu + \alpha C_d - (1 - \alpha)C_p$, an expression that increases as $\alpha$ increases.

Finally, the question of whether the effect of an increase in the plaintiff’s bargaining strength on the option settlement value can be more than proportional is equivalent to asking if the elasticity of the option settlement value with respect to the plaintiff’s bargaining strength, $(?S^*/?\alpha)(\alpha/S^*)$ is greater than one.

Notice that if both $A > C_{p2}$ and $B > C_{p2}$, or if there is zero variance that

$$?S^*/?\alpha = C_d + C_p$$

so that

$$(?S^*/?\alpha)(\alpha/S^*) = \alpha(C_d + C_p)/S^* = \alpha(C_d + C_p)/[\mu + \alpha C_d - (1 - \alpha)C_p]$$

$(?S^*/?\alpha)(\alpha/S^*) > 1$ if $C_p > \mu$, i.e. the lawsuit is NEV.

If $A > C_{p2}$, but $B < C_{p2}$, then

$?S^*/?\alpha = p(C_{d2} + C_{p2}) + C_{d1} + C_{p1}$, so that

$$(?S^*/?\alpha)(\alpha/S^*) = \alpha[p(C_{d2} + C_{p2}) + C_{d1} + C_{p1}]/ p[A + \alpha C_{d2} - (1 - \alpha)C_{p2}] + \alpha C_{d1} - (1 - \alpha)C_{p1}$$

$(?S^*/?\alpha)(\alpha/S^*) > 1$ if $pC_{p2} + C_{p1} > pA$. But, as we assumed that $A > C_{p2}$, $pA > pC_{p2}$, so that

$pC_{p2} + C_{p1} > pA$ can only hold if $C_{p1}$ is sufficiently large.

If $B > C_{p2}$, but $A < C_{p2}$, then

$?S^*/?\alpha = (1 - p)(C_{d2} + C_{p2}) + C_{d1} + C_{p1}$, so that

$$(?S^*/?\alpha)(\alpha/S^*) = \alpha[(1-p)(C_{d2} + C_{p2}) + C_{d1} + C_{p1}]/(1-p)[B + \alpha C_{d2} - (1-\alpha)C_{p2}] + \alpha C_{d1} - (1-\alpha)C_{p1}$$

$(?S^*/?\alpha)(\alpha/S^*) > 1$ if $(1-p)C_{p2} + C_{p1} > (1-p)B$. But, as we assumed $B > C_{p2}$, $(1-p)B > (1-p)C_{p2}$, so that $(1-p)C_{p2} + C_{p1} > (1-p)B$ can only hold if $C_{p1}$ is sufficiently large.

V. Discussion
The results generated by our analysis differ significantly from the results generated by the dominant one-stage expected value analysis of precisely the same lawsuit. In this section we first explore the relationship of our model to the prior literature. We then summarize the model’s major findings and contrast them with the results generated by one-stage expected value approaches. We subsequently discuss the implications of our model’s findings for the analysis of litigation, emphasizing the potential benefits of a real-options based approach to litigation analysis, and suggest that a real-options approach has potentially broad implications for our understanding of the role that litigation plays in society. We conclude this section with some broader observations regarding the potential implications of an options-based approach to a wider set of topics in law and economics.

A. Prior Literature

A large and sophisticated literature explores the economics of litigation. The overwhelming majority of the analysis, however, relies on a one-stage litigation process in which there is no learning and in which the parties must pre-commit their litigation expenditures at the inception of the process. These models do not allow the litigants to adapt their litigation strategies in response to information by, for example, abandoning the lawsuit, committing


38 Id.
additional resources to the litigation, reducing the resources committed to the litigation, or re-allocating a fixed set of resources that are brought to bear. As summarized by Cornell, “[i]n deciding whether to sue or to settle, the litigants consider the costs and benefits under the assumption that they must either settle promptly or go to trial. There are no intermediate decisions to be made along the way. Under these conditions, the discounted cash flow model can be used to analyze litigation investments.”  

A relatively small number of analyses consider the implications of divisibility or optionality in litigation. Of these works, Bebchuk 40 and Cornell 41 are closest in spirit and form to the model presented herein. Bebchuk presents a model with divisible litigation expenses and demonstrates that the simple fact of divisibility is sufficient to cause some NEV lawsuits that would be non-credible in a single stage process to become credible if litigation costs are sufficiently divisible. Bebchuk’s analysis also indicates that greater divisibility can only bolster a lawsuit’s credibility.  

Bebchuk’s analysis, however, does not consider the possibility that litigants learn information during the course of the lawsuit. Nor does it provide a contextually meaningful reason for the existence of divisibility at any particular point in the litigation process, or describe how divisibility might rationally be related to information revelation. In contrast, the model presented in this paper expressly allows for learning with subsequent abandonment occurring as a function of information disclosure. Divisibility arises in this context as a necessary precondition for the existence of the abandonment option. Bebchuk’s pure divisibility model thus reduces to a special case of the model presented in this analysis which arises when the information disclosed during the litigation process has no value because no litigant changes her actions in response to disclosure of that information.  

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40 Bebchuk, supra note 8.
41 Id.
42 Id. at 15.
43 See supra Proposition 8.
Cornell\textsuperscript{44} introduces a multistage litigation process in which the plaintiff has the option to abandon the claim if it appears that further litigation will be unprofitable. Cornell explains that the “option pricing approach highlights the fact that whenever a suit is filed, the defendant is forced to write litigation options that give the plaintiff the right to pursue the case in promising situations and the right to drop the case in unfavorable conditions.”\textsuperscript{45} Cornell’s analysis also indicates that “the value of litigation options rises as the uncertainty of the payoff increases,”\textsuperscript{46} even though the litigants are risk neutral, just as occurs in our model. The intuition behind this conclusion in Cornell’s model is the same as in ours: variance acts as a proxy for the value of the option represented by the opportunity to drop a lawsuit if it appears to be unprofitable but to continue to pursue it if it appears ready to generate a significant payoff. Further, as Cornell cogently observes, “if the social value of a case is equated with the expected outcome of a trial, then the options pricing approach implies that too many suits will be filed and that resources will be unfairly transferred from defendants to plaintiffs.”\textsuperscript{47} We expand on this observation in Section D below.

Cornell’s model, however, is limited to a decision tree analysis in which the plaintiff has the option to “prune” the set of outcomes whenever it appears that further litigation will be unprofitable to the plaintiff viewed solely from the perspective of the plaintiff’s own expected litigation costs. There is no bargaining between the litigants. This approach overlooks the fact that abandoning or settling a lawsuit benefits a defendant because of avoided litigation costs, and that bargaining can occur over the allocation of the surplus created from those avoided litigation costs. Cornell’s approach only implicitly considers the credibility of the plaintiff’s claims because the plaintiff is assumed to exercise “the option to terminate litigation if things look bleak.”\textsuperscript{48} Cornell’s analysis does not derive a game-theoretic equilibrium settlement value for a lawsuit with learning and abandonment options.

\textsuperscript{44} Cornell, \textit{supra} note 39.
\textsuperscript{45} \textit{Id.} at 182.
\textsuperscript{46} \textit{Id.} at 179.
\textsuperscript{47} \textit{Id.}
\textsuperscript{48} \textit{Id.} at 178.
Cornell’s approach thus constitutes a useful but incomplete application of a real option approach to litigation. Indeed, the absence of an explicit game-theoretic bargaining element causes Cornell’s results to diverge from the results that one would expect if the parties engaged in rational strategic bargaining model. Alternatively, Cornell’s model can also be viewed as a special case of our model in which the defendant either incurs no defense costs (an unrealistic assumption) or makes a credible commitment that she will not make any settlement payment to the plaintiff that reflects the benefits of avoided litigation costs.

Several articles have appeared that contain formal models applying options analysis to study legal rules and institutions.49 Most notably in the area of litigation analysis, Dunbar et al. present an options approach to nuisance suits, plaintiffs’ attorneys’ behavior under contingent fee arrangements in securities litigation, securities litigation reform, and testable hypotheses about observed settlements in shareholder class actions.50 Blanton evaluates the consequences of changes in evidentiary rules on plaintiffs’ incentives to file lawsuits.51 Landes presents a sequential model that addresses the question of when a court should hold separate trials for liability versus damages as opposed to just one unified trial that considers both issues.52 Beckner and Salop present a multi-stage decision model of sequential legal procedure, which solves for the optimal standards of summary disposition (those which minimize the sum of information and


50 Dunbar et al., supra note 49, at 26-30.


error costs) and the optimal sequence of legal and factual issues which a court should take up.\(^\text{53}\) Huang offers a real options analysis of litigation abandonment options that is partially related to the analysis presented herein,\(^\text{54}\) and also offers an option-based theory for calculating risk multipliers of attorney’s fees in federal civil rights litigation.\(^\text{55}\) All these models are, however, readily distinguishable from ours on the basis of the issues they study, their treatment of information revelation, and their analysis of the strategic interactions between litigants.

In summary, both Cornell’s analysis and Bebchuk’s model involve divisibility of litigation costs. Cornell’s analysis extended the standard law and economics literature in which litigation decisions were based solely on the present discounted value of a lawsuit’s costs and (expected) benefits to introduce an options approach to litigation.\(^\text{56}\) But, there is no explicit game-theoretic settlement bargaining in Cornell’s analysis. Bebchuk’s model of the credibility and success of threats to bring negative expected value suits presents an explicit game-theoretic analysis of settlement bargaining, but does not explicitly consider plaintiffs’ options to learn information and abandon litigation.\(^\text{57}\) Our analysis in this paper explicitly analyzes plaintiffs’ options to learn information and then abandon litigation and contains an explicit game-theoretic analysis of settlement bargaining. The model thus contains the Bebchuk and Cornell models as special cases, and the approach is consistent with recent research integrating game-theoretic and real options analyses.\(^\text{58}\)

B. The Model’s Results in the Context of Prior Literature

As documented in Section IV, a lawsuit’s option settlement value generally does not


\(^{57}\) Bebchuk, supra note 8.

\(^{58}\) See, e.g., SMIT & TRIGEORGIS, supra note 9 and *GAME CHOICES: THE INTERSECTION OF REAL OPTIONS AND GAME THEORY* (Steven Grenadier ed., 2000).
equal its expected judgment value and equals its pure divisibility value only when information has no value. Economically valuable information can cause a lawsuit to settle for an amount either greater or less than the same lawsuit’s divisibility value. A lawsuit’s option settlement value is a function of the variance of the information to be revealed, even if the litigants are risk neutral, and changes in variance can yield discontinuities in option settlement value.

The options based analysis establishes that PEV lawsuits are always credible, defines conditions under which NEV lawsuits are credible, and further demonstrates that every NEV lawsuit can become credible if the variance of the information to be revealed is sufficiently high. If variance is not sufficiently high, then NEV lawsuits can be entirely non-credible, or they can display critical zones of variance over which they lose credibility despite the fact that they are credible for values of variance below and above the critical zone.

Because increased variance will, beyond a certain point, uniformly increase a lawsuit’s option settlement value, whether it is PEV or NEV, plaintiffs can act as though they are risk seeking and defendants can act as though they are risk averse, even though they are risk neutral. A lawsuit’s option settlement value and credibility can also depend on the allocation of costs between the model’s two periods. Changes in relative bargaining power can also cause lawsuits suddenly to gain or lose credibility and drive disproportionate changes in equilibrium settlement values.

These results cannot be replicated by a one-stage model with an equivalent expected value when the litigants are risk neutral and have complete information. Nor have any of the many extensions of the expected value model of litigation generated results that are equivalent to those in our model. It follows that the one-stage model contains within it a set of strong assumptions about the non-divisibility of the litigation process and about litigants’ inability to respond to information once the lawsuit has begun.

C. Implications for Litigation Analysis: A Real Options Perspective

The dramatically different results obtained in our model suggests that further insight into the litigation process is gained by considering litigation as though it is a real option process with dynamic information revelation where litigants have an opportunity to adjust their strategies and
to bargain with each other in response to information. The extension of real option analysis to litigation modeling will, however, require that models be refined in order to capture the realities of the litigation process.

In particular, when a plaintiff files a lawsuit, she forces the defendant to write a series of call options. The plaintiff does not, however, pay the premium for those options to the defendant. Instead, she pays the premium to lawyers, experts, and other third parties whose services are necessary to litigate the matter so as to force the payoff. On the defendant’s side of the ledger, the defendant receives no premium from the plaintiff, and is also forced to pay a fee to third parties, such as lawyers and experts, whose services are necessary in order to prevent the value of the option held by the plaintiff from becoming even higher. Also, unlike many real option models in which the game is played against nature, litigation involves a negotiation process with opportunities for bargaining and deadlock over the division of gains from early resolution of disputes. Real options models will have to be adapted to reflect this reality as well.

The credibility conditions imposed on litigation as a consequence of the backward induction process further suggest that litigation options may have characteristics similar to down and out barrier options that terminate if the price of the underlying ever reaches a pre-specified minimum value at any point during the option’s term. The parallel arises because the credibility condition for litigation requires that the lawsuit be credible at every stage of its existence (i.e., that it never reach a settlement value of zero at any stage) in order for the claim to have a positive settlement value at the lawsuit’s inception.

The real options approach also suggests that variance, whether it is generated as a consequence of uncertainty in the interpretation of the law or as to the underlying facts, can be of great value to plaintiffs even when litigants are risk neutral. This observation may help explain the fact that public concern about the implications of punitive damages and other large awards by some measures exceeds the concern that might be warranted as a consequence of the simple expected value of such judgments. This observation would also help explain a broad-based concern that lawyers have an incentive to file a large number of weak cases in hopes of


extracting a settlement because, from a real options perspective, such strategies are indeed perfectly rational. Put another way, it can make a great deal of financial sense for a plaintiff, or a plaintiffs’ lawyer working on a contingency fee basis, to file a lawsuit that has a low or even negative expected value, because of the claim’s settlement value. Multiply that observation over the hundreds of thousands of new complaints filed every year in the United States, and the potential for broad-based concern becomes apparent.

This observation suggests that it is sensible to consider repeat plaintiff players in the litigation process, particularly plaintiffs class action law firms, as though they are investors who acquire a portfolio of real options and manage individual lawsuits in order to maximize the value of the portfolio as a whole. To such investors, it can make sense to pursue weak individual cases - - even if those cases are not credible if viewed as stand alone options - - if there is sufficient probability that the individual case could yield a precedent that would change the variance of lawsuits in the remaining portfolio. Such an outcome could result even if a case is lost, provided that it is lost in a manner that increased the variance of outcomes of cases held in the remainder of the portfolio.

The value of uncertainty in the hands of plaintiffs can also help explain why the perception of randomness in the legal process has such a strong valence in the policy debate. The classic plaintiff argument is that many claims should be allowed to be brought because the courts will ultimately be able to winnow out the low-quality claims and it is not in a plaintiffs’ best interest to bring lawsuits with low expected values. These arguments are subject to profound critique if the legal process generates significant variance as it struggles to reach the correct result, even if the courts get the answers “right” on average and over time. This perspective suggests that the literature examining “error” and “correction” in the legal process, and the social value of accuracy in judgments, can be expanded by being viewed through a lens that recognizes the volatility cost imposed even by an error that is corrected.61

Put another way, even if the net (of the plaintiff’s total litigation costs) expected value of a lawsuit is zero or negative, sufficient variance in the outcome, or the ability to impose sufficient litigation costs on the defendant, can induce the defendant to pay a material sum to be

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61 For a discussion of issues raised by the accuracy or inaccuracy of the legal process see, e.g., SHAVELL, supra note 1, at 450-456.
rid of the expense and risk inherent in defending against these claims. Rules of procedure that make it increasingly difficult to dismiss actions earlier in the litigation process, or that increase the prospect of error, even if that error is later corrected, can feed into this trend and can dramatically increase the value of a lawsuit in a plaintiff’s hands.

This real options perspective also suggests a different approach to the analysis of class action litigation. To oversimplify, consider a class of 1 million plaintiffs each of whom has a potential claim with an expected value, net of attorneys’ fees, of $100 and a 10 percent chance of prevailing at trial. If the cases could each be separately tried the defendant would, under the expected value calculus, settle the whole lot of them for $10 million. However, because the class mechanism causes these same claims to be aggregated in a manner that makes them worth either $100 million or nothing, if pursued to judgment, it is easy to contemplate how, from an options perspective in which variance drives valuation, the simple ability to aggregate the claims generates variance and hence potential value in the hands of the plaintiffs. This brief discussion does not take into account the effect of class certification on the plaintiffs’ or defendants’ costs of litigating those cases, and thereby clearly oversimplifies the matter. It does, however, suggest some simple intuition that helps describe a broad-based concern over the operation of the class action mechanism.

All of these observations relating to the fact that lawsuits tend to have an option value in excess of their expected value are consistent with Cornell’s observation that “if the social value of a case is equated with the expected outcome of a trial, then the options pricing approach implies that too many suits will be filed and that resources will be unfairly transferred from defendants to plaintiffs.”\(^\text{62}\)

Regardless of the social implications of optionality in litigation, a real options approach can also be used to place a value on procedure qua procedure. To illustrate, consider two identical lawsuits where different procedural rules change the sequence in which information is revealed, the costs of litigating the action, or the variance of the information disclosed at different stages in the process. By comparing settlement values of identical lawsuits litigated under different procedural regimes, it becomes possible to put a specific price tag on the rules of

\(^{62}\) Cornell, supra note 39, at 182.
legal procedure and to quantify the extent to which specific rules are relatively pro-plaintiff or pro-defendant.

D. Implications for Law and Economics Based on One-Stage, Expected Value Logic

The one-stage expected value model is commonly applied to the analysis of many topics in law and economics. The preceding discussion suggests that a real options approach to the economic analysis of law can have implications that reach well beyond the calculation of a lawsuit’s credibility or settlement value. Consider the operation of the Hand Formula, which suggests that a potential injurer is negligent only if the costs of precaution are less than the probability of the harm that is caused multiplied by its magnitude. Consider also the classic deterrence calculus which requires consideration of the probability of detection and of the magnitude of the fine to be imposed conditional on detection. In both cases, it is commonly assumed that if the legal process generates an outcome that replicates the expected value of the harm to be caused, then the social optimum can be attained.

The real option perspective, however, emphasizes that the legal process is highly unlikely to replicate the expected value of the harm to be caused. Instead, the financial value of a lawsuit in a plaintiff’s hands can be far greater than its expected value because of the plaintiff’s ability to learn information, to adapt to information, to sub-divide litigation expenses, and to force the defendant to incur litigation expenses. Thus, all other factors equal, “if the social value of a case is equated with the expected outcome of a trial, then the options pricing approach implies that too many suits will be filed and that resources will be unfairly transferred from defendants to plaintiffs.” An option-based approach also implies that greater variance in the legal process and larger litigation costs, particularly if defense costs increase relative to prosecution costs, will also cause the social value, measured by the expected value, to diverge from its real options value in a direction that favors plaintiffs’ private interests. This effect is not necessarily uniform

63 POSNER, supra note 1, at 167 – 168.
64 COOTER & ULEN supra note 1, at 456-57.
65 Cornell, supra note 39, at 182.
because our model suggests that there can be situations in which PEV cases will settle for amounts less than the lawsuit’s expected value

Thus, operating at a very high level of generality, a real options approach to litigation can lend analytic support to the common concern that we live in an overly-litigious society in which plaintiffs are able too frequently to exert control over the operation of important economic processes. It also lends support to the observation that plaintiffs benefit from uncertainty in the law, from lawsuits that have small probability – high stakes potential payoffs, and from the ability to impose litigation costs on opponents, particularly in situations where the leverage inherent in litigation (i.e., the plaintiffs’ ability to cause the defendant to spend many dollars for each dollar spent by the plaintiff). These observations also support the view that the private benefits of the litigation process can diverge systematically from its social benefits for reasons related to the technology used to calculate both private and social benefits.

It would be inaccurate, however, to suggest that the options perspective influences only half the equation in the classic cost benefit calculus. Precaution costs as measured under the Hand Formula can also be viewed through the lens of real option theory. For example, a manufacturer can be viewed as having the option of adding or deleting safety features at different stages of a product’s development. Just as it would be analytically incorrect to assume that a litigant must pre-commit to strategy and expenditures at a lawsuit’s inception, it would also be analytically incorrect to assume that a manufacturer cannot adapt safety features to the discovery of new information. As a practical matter, however, it is our intuition that plaintiffs have powerful incentives to discover a defendant’s failure efficiently to adapt a product to newly discovered information because such a failure would help support the underlying claim of negligence. Accordingly, even when a real options approach is applied to both sides of the Hand Formula, it is our intuition that there is far more unappreciated optionality on the plaintiffs’ side of the equation than on the defendants’, and that the consequence of this bias is a tilt to over-deterrence, all other factors equal.

VI. Extensions

There are many natural extensions of our real option model of litigation. As presently structured, the model considers only a costless abandonment option. The analysis can be
extended to consider costly abandonment, as well as options to expand or to reduce plaintiffs’ litigation expenditures. Further, our model currently assumes that only the plaintiff has the ability to exercise litigation options. This assumption is not realistic. Defendants can file counterclaims and take other steps that can have the effect of increasing plaintiffs’ litigation costs or of reducing the expected value or variance of the judgment. The recognition that defendant choices can influence the optimal plaintiff expenditure, and vice versa, also suggests a model in which litigation expenditures are endogenous and reflect the presence of options that can be exercised by the plaintiff and defendant alike.

The model, as currently constructed, also contains only two stages. It can, however, be extended to allow a larger number of stages and, in the limit, can be fashioned as a continuous time model. The assumption that the information disclosed in the course of the litigation is binary can also be dropped. In reality, information disclosed during the course of litigation will often, but not always, be better characterized by a continuous probability distribution.

The requirement that the probability distribution describing the relevant uncertainty be part of a family of distributions that are mean-preserving spreads of each other can also be abandoned. Models that allow changes to both mean and variance, and that allow the litigants to engage in trade-offs between the mean and variance of probability distributions are more general and realistic.

The model can be further extended by incorporating the asymmetries that are commonly applied to one-stage expected value models. The litigants can, for example, be modeled as having one or two-sided forms of asymmetric information, heterogeneous beliefs about various model parameters, heterogeneous risk preferences, and various forms of emotional reaction to the litigation process.

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The model is also not limited to private civil litigation seeking monetary damages and can be readily extended to address the criminal process, as well as the several different forms of civil or criminal prosecutorial options held by the Department of Justice, the Internal Revenue Service, the Securities and Exchange Commission, and state enforcement agencies. Extensions to the criminal process are, we believe, of particular interest in light of the extreme penalties often imposed by the Federal Sentencing Guidelines. Those extreme sentences, when viewed through a real options model of the sort presented here, create high variance that can dramatically increase the prosecution’s bargaining leverage as has proven to be the case. At the other end of the dispute resolution spectrum, real option analysis can further be applied to the study of arbitration, mediation, and other alternative dispute resolution techniques, whether those techniques are applied as a prelude to litigation or as stand-alone dispute resolution mechanisms.

Indeed, our next extension of the model is to assume a simple form of disagreement between the plaintiff and defendant as to the distribution of the court’s likely decision at the beginning of Stage 2. We demonstrate that even though the litigants agree as to the model’s expected value, differential expectations as to the model’s variance are sufficient to cause the litigants to initiate the lawsuit and then to settle midstream once the difference of opinion as to variance has been eliminated. In light of the fact that well over ninety percent of lawsuits settle prior to judgment, and that the law and economics literature often has trouble generating a straightforward model in which the litigants settle mid-stream, this simple extension suggests that the real option approach to litigation can generate realistic predictions through the application of relatively parsimonious models.

Let us illustrate with a simple numerical example how we can introduce heterogeneous beliefs about variance. Suppose that initially the parties do not know the variance of the random variable X, but in Stage 1, the court announces its ruling on the variance of X before announcing in Stage 2 its ruling on X. Assume that \( p, \mu, \) and litigation costs are common knowledge. In particular, consider these parameter values \( p = \frac{1}{2}, C_{p1} = C_{d1} = 10, C_{p2} = C_{d2} = 80, \mu = 100; \) so that \( C_p = C_d = 90. \) Suppose that the plaintiff believes that \( A_p = 260 \) (and so believes that \( B_p = -60), \) and the defendant believes that \( A_d = 100 \) (and so believes that \( B_d = 100). \) The plaintiff believes that \( S_{p}^* = S_{p2} = 130. \) The defendant believes that \( S_{d}^* = S_{d2} = 100. \) Because \( S_{p}^* > S_{d}^* \), the parties do not settle initially. But, the plaintiff initially believes that by spending \( C_{p1} = 10, \) it will be able to learn the court’s announcement of \( A = 260 \) (and \( B = -60) \) and receive a settlement of
Similarly, the defendant initially believes that by spending $C_{d1} = 10$, it will be able to learn the court’s announcement of $A = 100$ (and $B = 100$) and have only to make a settlement of $S_2 = 100$. So, both parties initially proceed to spend $C_{p1} = C_{d1}$. Once the court announces the variance, both parties know it and proceed to settle for the corresponding value of $S_2$. Ex post, one of the parties is wrong and spent $C_{p1} = C_{d1} = 10$ for naught, because that party ends up with the option settlement value which the other party had expected. Ex post, one of the parties is right and even after spending $C_{p1} = C_{d1} = 10$, that party is better off than had it agreed to settle initially for the option settlement value that the other party had expected.

VII. Conclusion

Litigation is at the core of much of the economic analysis of the law. In addition to the large literature that explores the dynamics of the litigation process itself, many fundamental principles of law and economics rest, directly or indirectly, on the proposition that lawsuits yield verdicts or settlements that rationally approximate the social or individual harm or benefit caused by the activity that generates the lawsuit.

This assumption warrants closer scrutiny. As demonstrated earlier in this paper, the economic analysis of litigation most often relies on the assumption that lawsuits are litigated in a single stage process. The parties pre-commit to a set of expenditures and cannot adapt their strategies in response to information disclosed in the course of the proceedings. This assumption is not realistic. More significantly, it causes models to generate estimates of settlement values that can diverge dramatically from the settlement values that would be reached by rational litigants who are fully informed of the realities of the litigation process.

To illustrate this point, this paper presents a simple two stage model of the litigation process in which risk neutral litigants have an option to acquire one piece of information and in which the plaintiff has the option to abandon her lawsuit midstream conditional on the information revealed, thereby saving some of the lawsuit’s litigation costs. We demonstrate that the settlement value of that lawsuit differs dramatically from its expected value and from its divisibility value. We further demonstrate that the lawsuit’s settlement value can be influenced much more by the variance of the information that is disclosed in the course of the litigation, by the relative size of the parties’ litigation costs, by the sequence in which litigation costs have to
be incurred, and by the litigant’s relative bargaining power, than by the expected value of the judgment that would be awarded at the culmination of the lawsuit. The implication of this finding is straightforward: settlement values can reflect the mechanics of the litigation process itself more than the value of the judgment that ostensibly animates the litigation. Accordingly, the assumption that litigation results in payments that are a reasonable proxy for the social or individual costs or benefits of the activity at issue is suspect.

The model also suggests that the variance of a lawsuit’s outcome can be important in the valuation of settlements because, once variance becomes sufficiently large, it acts as a proxy for the value of the litigants’ ability to learn information and to react to that information. As variance increases in our model, all other factors equal, plaintiffs are able to extract and defendants are willing to pay increasingly large settlements because plaintiffs have to invest proportionally smaller amounts in litigation costs in order to capture potentially larger award. Plaintiffs can therefore appear to behave as though they are risk seeking while defendants can appear to behave as though they are risk averse, even though both are in fact risk neutral. Viewed from a slightly different perspective, the model emphasizes the importance of procedure in the litigation process. By simply changing the amount of uncertainty inherent in relevant precedent, the percentage of litigation costs that must be borne early or late in the process, or the parties’ bargaining power, it is possible to cause dramatic changes in a lawsuit’s settlement value, even if its expected value is held constant. These findings, among others, suggest that closer analysis of “litigation microstructure” as reflected in the rules of civil and criminal procedure can be important to the proper analysis of litigation’s true economic impact.

The mode of analysis presented in this paper can also be described as an application of real option theory. Indeed, we believe that real option theory holds significant promise for a more refined and realistic form of litigation analysis because it allows both for more accurate representation of the litigation process and for more rigorous analysis of the behavior of litigants who have the ability to learn new information and then to adapt their litigation strategies to the discovery of that information. Although the model presented in this paper is admittedly quite simple, its implications are rich and suggest many additional insights that can be gained from more rigorous and refined extensions of real options analysis to the litigation process.
Figure 1
Plaintiff Cash Flows for
Single-Stage Litigation, Divisible Litigation, and
Litigation With Learning and Abandonment Options

(a) Single-stage Litigation

Filing

Verdict

EV = 100

-140

|______________________________|

|______________________________|

|______________________________|

(b) Divisible Litigation

Filing

Stage 1
Expenditure

Stage 2
Expenditure

Verdict

EV = 100

-70

|______________________________|

|______________________________|

(c) Litigation With Learning and an Abandonment Option that Displays A Mean-Preserving Spread

Filing

Stage 1
Expenditure

Stage 2
Expenditure

Abandonment Option

Information Revelation

Abandonment Option

A

B

-70

|______________________________|

|______________________________|

|______________________________|
Figure 2
The Calculation of the Equilibrium Settlement Value When $\mu = 100$
and $C_{ij} = 70 \ \forall_{ij}$

Payoff A

(130, 0) (140, 0)

(130 - e, 100)

(140 + e, 70 + e/2)
Figure 3
The Calculation of the Equilibrium Settlement Value When $\mu = 100$ and $C_{p1} = C_{d1} = 10$, $C_{p2} = C_{d2} = 80$
Table 1: The Calculation of the Equilibrium Settlement Value When $\mu = 100$ and $C_{ij} = 70 \forall C_{ij}$

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Notes to Table 1:

Columns 1 and 2 describe the values of Outcomes A and B, which are constrained to have an expected value of 100 where $p = 0.5$.

Column 3 is the plaintiffs’ minimum Stage 2 demand conditional on the corresponding value of A, which is calculated as A minus the avoided Stage 2 litigation costs of 70 (Column 1 – 70).

Column 4 is the defendants’ maximum Stage 2 offer conditional on the corresponding value of A, which is calculated as A plus the avoided Stage 2 litigation costs of 70 (Column 2 + 70).

Column 5 is the plaintiffs’ minimum Stage 2 demand conditional on the corresponding value of B, which is calculated as B minus the avoided Stage 2 litigation costs of 70, provided however that if the
net value is non-positive the demand is zero because the claim is then not credible (MAX{0, Column 2 – 70}).

Column 6 is the defendants’ maximum Stage 2 offer conditional on the corresponding value of B, which is calculated as B plus Stage 2 avoided litigation costs of 70, provided however that if the net value is non-positive the demand is zero because the claim is then not credible (MAX{0, Column 2 – 70}).

Column 7 describes the litigation’s settlement value at the beginning of Stage 2, prior to the resolution of the underlying uncertainty, and is calculated as the average of the values in Columns 3, 4, 5, and 6. See text for explanation.

Column 8 describes the plaintiffs’ minimum Stage 1 demand, which is calculated as the lawsuit’s value prior to the resolution of the uncertainty (Column 7) less the avoided Stage 1 litigation costs of 70.

Column 9 describes the defendants’ maximum Stage 1 offer, which is calculated as the lawsuit’s value prior to the resolution of the uncertainty (Column 7) plus the avoided Stage 1 litigation costs of 70.

Column 10 is the lawsuit’s settlement value and is calculated as the midpoint of Columns 8 and 9, because $a = 0.5$. 

70
Table 2
The Calculation of the Equilibrium Settlement Value When \( \mu = 100 \) and \( C_{p1} = C_{d1} = 10, C_{p2} = C_{d2} = 80 \).

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Notes to Table 2:

Columns 1 and 2 describe the values of Outcomes A and B, which are constrained to have an expected value of 100 where \( p = 0.5 \).

Column 3 is the plaintiffs’ minimum Stage 2 demand conditional on the corresponding value of A, which is calculated as A minus the avoided Stage 2 litigation costs of 80 (Column 1 – 80).

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Column 5 is the plaintiffs’ minimum Stage 2 demand conditional on the corresponding value of B, which is calculated as B minus the avoided Stage 2 litigation costs of 80, provided however that if the net value is non-positive the demand is zero because the claim is then not credible (MAX{0, Column 2 – 80}).
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Column 7 describes the litigation’s settlement value at the beginning of Stage 2, prior to the resolution of the underlying uncertainty, and is calculated as the average of the values in Columns 3, 4, 5, and 6. See text for explanation.

Column 8 describes the plaintiffs’ minimum Stage 1 demand, which is calculated as the lawsuit’s value prior to the resolution of the uncertainty (Column 7) less the avoided Stage 1 litigation costs of 10.

Column 9 describes the defendants’ maximum Stage 1 offer, which is calculated as the lawsuit’s value prior to the resolution of the uncertainty (Column 7) plus the avoided Stage 1 litigation costs of 10.

Column 10 is the lawsuit’s settlement value and is calculated as the midpoint of Columns 8 and 9, because a = 0.5.