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Lawsuit Abandonment Options in Possibly Frivolous Litigation Games

Dr. Peter H. Huang*

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I. INTRODUCTION: AN EXPLOSION OF FRIVOLOUS LITIGATION?

The aggregate quantity of litigation in the United States, both in comparison with other countries and over time, has been and remains the subject of much controversy.¹ But the often heard phrase “litigation explosion” is merely descriptive, being devoid of any particular normative content. A recent, related, and more specific debate concerns the nature or quality of litigation in specific areas, including but not limited to, medical malpractice, product liability, and securities fraud.² In particular, many legal and social commentators feel that America is and has been experiencing an explosion in so-called strike lawsuits, also known as nuisance lawsuits or frivolous litigation.

An explosion in frivolous litigation is not normatively neutral. A perceived rise in frivolous lawsuits alleging securities

1. Legal sociologist Professor Marc Galanter argues that an explosion in litigation is not only foreseeable, but also socially desirable. Marc Galanter, *The Day After the Litigation Explosion*, 46 MD. L. REV. 3, 38 (1986). But Walter Olson, a senior fellow of the Manhattan Institute, argues that an explosion in litigation is both man-made and socially undesirable. WALTER K. OLSON, *THE LITIGATION EXPLOSION: WHAT HAPPENED WHEN AMERICA UNLEASHED THE LAWSUIT* (Penguin Group 1991); WALTER K. OLSON, *THE RULE OF LAWYERS: HOW THE NEW LITIGATION ELITE THREATENS AMERICA’S RULE OF LAW* (2003).

2. See, e.g., *REGULATION THROUGH LITIGATION* (W. Kip Viscusi ed., 2002) (providing selected examples within these areas, including cases dealing with tobacco, firearms, lead-based paint, breast implants, managed care, and insurance).

fraud was a major impetus for the provisions imposing strict pleading requirements contained in the Private Securities Litigation Reform Act of 1995, which Congress enacted over President Clinton's veto.³ The politics of American litigation reform and specific anti-litigation campaigns are an interesting reflection of American culture, history, and society that is beyond the scope of this Article.⁴

Whether there has been such a frivolous litigation explosion is a descriptive and historical question that is empirically challenging to resolve because nearly all lawsuits settle,⁵ with many of the settlements involving confidentiality agreements. Everyone agrees there is a demand for more empirical research and work about civil procedure and litigation,⁶ but unfortunately the supply of it is still rare.⁷ But positive theoretical economics can provide insights into frivolous litigation in the form of implications from analytical, formal, rigorous, and systematic models.⁸ What procedural or

3. Pub. L. No. 104-67, 109 Stat. 737 (1995) (codified at 15 U.S.C. § 78u-4(b)(2) (2000)).

4. See generally THOMAS F. BURKE, *LAWYERS, LAWSUITS, AND LEGAL RIGHTS: THE BATTLE OVER LITIGATION IN AMERICAN SOCIETY* (2002).

5. See, e.g., Judith Resnik, *Trial as Error, Jurisdiction as Injury: Transforming the Meaning of Article III*, 113 HARV. L. REV. 924, 928 nn.10-11 (2000) (providing sources for statistics that about 70% of the civil cases filed in federal court settle; 24% ending in pretrial dismissal, default judgment, summary judgment, or similar disposition; with only 6% proceeding to trial).

6. See, e.g., Robert G. Bone, *Modeling Frivolous Suits*, 145 U. PA. L. REV. 519, 597 (1997) (acknowledging that empirical research has identified several settings likely to encourage frivolous litigation, but "[m]ore work is needed, of course").

7. See, e.g., Catherine Albiston, *The Rule of Law and the Litigation Process: The Paradox of Losing by Winning*, in IN LITIGATION: DO THE HAVES STILL COME OUT AHEAD? 168 (Herbert M. Kritzer & Susan Silbey eds., 2003) (providing an example of empirical research about civil procedure and litigation); Stephen B. Burbank, Amer. Judicature Soc., *Rule 11 in Transition: The Report of the Third Circuit Task Force on Federal Rule of Civil Procedure 11* (1989) (same); Kevin M. Clermont & Theodore Eisenberg, *Litigation Realities*, 88 CORNELL L. REV. 119, 120-21, 125-29 (2002) (advocating the importance of empirical methods on present and future legal issues); Thomas E. Willging, *Past and Potential Uses of Empirical Research in Civil Rulemaking*, 77 NOTRE DAME L. REV. 1121, 1126-41 (2002) (discussing the various types of empirical research that commentators have sought for the rule-making process); see generally Michael Heise, *The Future of Civil Justice Reform and Empirical Legal Scholarship: A Reply*, 51 CASE W. RES. L. REV. 251 (2000).

8. See, e.g., A. Mitchell Polinsky & Daniel L. Rubinfeld, *Sanctioning Frivolous Suits: An Economic Analysis*, 82 GEO. L.J. 397, 426-35 (1993)

substantive reforms would reduce frivolous litigation is a normative question that raises difficult concerns involving procedural fairness, both outcome-based and process-based, in addition to questions regarding the nature and limits of substantive rights. But normative theoretical economics can help answer this question by identifying and comparing the various error and process costs of alternative reforms.⁹

This Article develops a new theory of possibly frivolous litigation by focusing on a plaintiff's options to unilaterally abandon a lawsuit.¹⁰ Federal Rule of Civil Procedure 41(a)(1)(i) and its various state law counterparts permit, under certain circumstances, a plaintiff to voluntarily dismiss her lawsuit without prejudice.¹¹

A. *The Value of Litigation Abandonment Options: A Hypothetical Example*

The following hypothetical example illustrates the value of a plaintiff's option to abandon or drop litigation. Suppose that Portia sues Daphne. In addition, suppose that Portia's *ex ante* or initial expected probability of prevailing at trial is $1/2$. Suppose also that, initially, the monetary judgment that Portia expects to win at trial is \$1,000,000. Under these facts, Portia's actual initial expected judgment at trial is $(1/2)(\$1,000,000)$, or \$500,000. Suppose that Portia's total expected litigation cost of proceeding to a trial is \$550,000. Portia's lawsuit will have a net expected value of $\$500,000 - \$550,000 = -\$50,000 < 0$.

Now divide the lawsuit into two stages, discovery and trial, each of which costs Portia \$275,000. In addition, suppose that

(providing a formal economic model of how optimally to sanction frivolous lawsuits).

9. See, e.g., ROBERT G. BONE, CIVIL PROCEDURE: THE ECONOMICS OF CIVIL PROCEDURE 125-57 (2003) (analyzing error and process costs in determining how to conduct a normative study of procedural rules).

10. This novel theory was originally developed and introduced in Peter H. Huang, Litigation Options in Civil Procedure (1997) (unpublished J.D. thesis, Stanford University) (on file with author) and reproduced in JOSEPH A. GRUNDFEST & PETER H. HUANG, REAL OPTIONS AND THE ECONOMIC ANALYSIS OF LITIGATION: A PRELIMINARY INQUIRY (Stanford Law School Olin Program in Law and Econ., Working Paper No. 131, 1996).

11. FED. R. CIV. P. 41(a)(1)(i); see also Michael E. Solimine & Amy E. Lippert, *Deregulating Voluntary Dismissals*, 36 U. MICH. J.L. REFORM 367, 376-78, 406-18 (2003) (summarizing the state law and District of Columbia counterparts to Rule 41(a)(1)(i) and reproducing the relevant portions of those provisions).

discovery resolves all of the risks of Portia's litigation, so the posterior or *ex post* probability conditional upon discovery of Portia's prevailing in court is either 0 or 1. Portia would only proceed when she has a sure winner, and Portia would abandon a sure loser. Under those facts, the revised initial expected value or initial option value that the lawsuit has for Portia would be $(1/2)(\$1,000,000 - \$275,000) - \$275,000 = (1/2)(\$725,000) - \$275,000 = \$362,500 - 275,000 = \$87,500 > 0$. Notice that, holding fixed the other values of the parameters in this example, this lawsuit has initial positive option value as long as the monetary judgment from Portia's prevailing in court exceeds \$825,000. Portia would initially file this Negative Expected Value ("NEV") lawsuit; however, after discovery, Portia would choose to drop this lawsuit if Portia and Daphne believe that Portia will lose at trial.

In order to illustrate in the simplest possible way the settlement value of this litigation, suppose that Daphne's litigation costs are the same as Portia's costs; that is, that Daphne's total expected litigation costs for proceeding to a trial are \$550,000, with each of discovery and trial expected to cost Daphne \$275,000. Finally, suppose that Daphne and Portia have equal bargaining strength. Then, after discovery, Daphne and Portia either learn that Portia has a sure loser—in which case, Portia abandons the litigation—or Daphne and Portia learn that Portia has a sure winner. If Portia has a sure winner, then Portia should accept any settlement amount that exceeds what she expects to get by proceeding to trial—namely, $\$1,000,000 - \$275,000$. In addition, Daphne should offer any settlement amount that is less than what she expects to lose by proceeding to trial—namely, $\$1,000,000 + \$275,000$. Because Daphne and Portia have equal bargaining power, they agree to settle for \$1,000,000, which is the midpoint of the range between $\$1,000,000 - \$275,000$ and $\$1,000,000 + \$275,000$.

Now that we have figured out what Daphne and Portia would settle for after discovery but before trial if both learn that Portia has a winner, we can proceed to determine what happens before discovery. Upon Portia's commencing the litigation, both Daphne and Portia can reason, as we have above, that if they proceed and incur the costs of discovery—namely, \$275,000 each—then, with an initial probability of 1/2, Portia will have a credible threat to proceed to trial. As a result, Daphne and Portia would settle for \$1,000,000 after discovery. Thus, Portia should accept any settlement amount that exceeds what she initially expects to get by proceeding to discovery—namely, $(1/2)(\$1,000,000) - \$275,000$. In addition, Daphne should offer any settlement amount that is less than what she

initially expects to lose by proceeding to discovery—namely, $(1/2)(\$1,000,000) + \$275,000$. As before, because Daphne and Portia have equal bargaining power, they will settle for $(1/2)(\$1,000,000)$, or \$500,000, which is the midpoint of the range between \$500,000 - \$275,000 and \$500,000 + \$275,000. Recall that when the plaintiff must pay for all her litigation costs up front—that is, when the plaintiff does not have the option to abandon the litigation after discovery—this is a NEV lawsuit. In other words, the plaintiff's threat for pursuing litigation is not credible, and the settlement value is zero.

B. Lawsuit Abandonment Options in Game-Theoretic Litigation Models

Appendix B of this Article presents a multi-period algebraic options game-theoretic model of litigation that generalizes the hypothetical numerical example above by incorporating general bargaining strengths, litigation costs, and probability beliefs on the part of the plaintiff and the defendant. Interested readers should look over the appendices of this Article before going forward. Appendix A provides an accessible, nontechnical, self-contained, and user-friendly primer about options for those unfamiliar with options. Appendix B contains a formal, mathematical game-theoretic analysis of a plaintiff's options to unilaterally abandon a lawsuit. The rest of this Article is organized as follows. Part II of this Article places this Article's options approach to litigation, including quite possibly, frivolous litigation in the context of the literature of economic models about litigation in general and frivolous litigation in particular. This part of the Article explains that possibly frivolous lawsuits will be filed and settled when the values of a plaintiff's options to unilaterally abandon litigation exceed the costs of purchasing those litigation-abandonment options by continuing the litigation. Part III of this Article addresses some of the limitations of this Article's abandonment options game-theoretic model of litigation.¹² In particular, there is reason to believe that people have cognitive limitations in their abilities to reason backwards in sequential interactions.¹³ Empirical and experimental evidence also

12. See also ALEXANDER VOLLERT, A STOCHASTIC CONTROL FRAMEWORK FOR REAL OPTIONS IN STRATEGIC VALUATION 7, 42-44 (2002) (discussing drawbacks to real-options analysis in general).

13. See, e.g., Robert Rosenthal, *Games of Perfect Information, Predatory Pricing and the Chain-Store Paradox*, 25 J. ECON. THEORY 92, 94-97 (1981)

exists that indicates that emotions affect how people make decisions.¹⁴ Finally, recent psychological experiments indicate that decision makers often overvalue options and over-invest in keeping options alive, even if those options present little intrinsic value.¹⁵ Part IV of this Article briefly explains how and why many laws and judicial doctrines effectively preclude specific legal options.

II. AN ECONOMIC ANALYSIS OF LITIGATION

The application of microeconomics to litigation has a distinguished and relatively long history in the field of law and economics.¹⁶ A rich, related literature analyzing civil procedure that utilizes microeconomics also exists.¹⁷ Some legal practitioners utilize the powerful tools of single-person decision theory and risk analysis to help facilitate the settlement of their clients' legal disputes.¹⁸ But multiperson decision-making theory or game theory

(stating possible explanations for non-rational decisions in perfect-information games).

14. See, e.g., Wilco W. Van Dijk et al., *Emotional Reactions to the Outcomes of Decisions: The Role of Counterfactual Thought in the Experience of Regret and Disappointment*, 75 ORG. BEHAV. & HUM. DECISION PROCESSES 117, 136-38 (1998) (showing evidence of how counterfactual thoughts about unfavorable-decision outcomes give rise to qualitatively different emotions, and how anticipation of these emotions results in altered decision-making).

15. Jiwoong Shin & Dan Ariely, *Keeping Doors Open: The Effect of Unavailability on Incentives to Keep Options Viable*, presented at the Society for the Advancement of Behavioral Economics (July 31, 2003) (unpublished manuscript, on file with author).

16. For excellent surveys of this literature, see Robert D. Cooter & Daniel L. Rubinfeld, *Economic Analysis of Legal Disputes and Their Resolution*, 27 J. ECON. LITERATURE 1067 (1989); ROBERT D. COOTER & THOMAS S. ULEN, *LAW AND ECONOMICS* 478-99 (1st ed. 1988); Bruce L. Hay & Kathryn E. Spier, *Settlement of Litigation*, in 3 THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 442 (Peter Newman ed., 1998).

17. See, e.g., Geoffrey P. Miller, *Introduction: Economic Analysis of Civil Procedure*, 23 J. LEGAL STUD. 303, 303-06 (1994) (providing a representative selection of research on the impact of law and economics on civil procedure).

18. See, e.g., David P. Hoffer, *Decision Analysis as a Mediator's Tool*, 1 HARV. NEGOT. L. REV. 113, 113-19 (1996) (stating how decision analysis is used); Marjorie C. Aaron, *The Value of Decision Analysis in Mediation Practice*, 11 NEGOT. J. 123, 123-33 (1995) (discussing the value of decision analysis in mediation practice); Marc B. Victor, *The Proper Use of Decision Analysis to Assist Litigation Strategy*, 40 BUS. LAW. 617, 617-29 (1985) (discussing decision analysis and addressing common misconceptions regarding decision analysis).

describes a lawsuit more accurately than single-person decision-making theory does because of the interactive and strategic nature of litigation. Legal scholars have applied multiperson decision theory or game theory to analyze settlement negotiations in litigation.¹⁹ Game theory's origins date back at least 2500 years and can be found in classic Chinese philosophical texts.²⁰ Multiperson decision theory, as game theory is more accurately and perhaps less frivolously described, is a branch of applied mathematics;²¹ having numerous applications in biology,²² economics,²³ management,²⁴ and politics.²⁵ It has become standard practice to apply game theory

19. See, e.g., ROBERT H. MNOOKIN ET AL., *BEYOND WINNING: NEGOTIATING TO CREATE VALUE IN DEALS AND DISPUTES* 106-26 (2000) (discussing the dynamics involved in dispute resolution).

20. See, e.g., SUN TZU, *THE ART OF WAR* (Oxford University Press 1971) (recognizing different theories on waging war).

21. See, e.g., HAROLD W. KUHN, *LECTURES ON THE THEORY OF GAMES* (2003) (providing mathematical formulations of game theory).

22. See, e.g., JOHN MAYNARD SMITH, *EVOLUTION AND THE THEORY OF GAMES* (1982) (applying game theory to the study of evolution).

23. See, e.g., AVINASH DIXIT & SUSAN SKEATH, *GAMES OF STRATEGY* (1999) (providing a textbook for undergraduate game-theory courses for economics majors); DAVID M. KREPS, *GAME THEORY AND ECONOMIC MODELLING* (1987) (presenting a nontechnical introduction to the strengths and weaknesses of noncooperative (asymmetric information) game theory); ROGER A. MCCAIN, *GAME THEORY: A NON-TECHNICAL INTRODUCTION TO THE ANALYSIS OF STRATEGY* (2004) (providing another textbook for undergraduate game-theory courses for economics majors); MARTIN J. OSBORNE, *AN INTRODUCTION TO GAME THEORY* (2004) (providing a textbook for game-theory courses for economics graduate students); FERNANDO VEGA-REDONDO, *ECONOMICS AND THE THEORY OF GAMES* (2003) (same). But see Robert J. Aumann, *What is Game Theory Trying to Accomplish?*, in *FRONTIERS OF ECONOMICS* 28 (Kenneth J. Arrow & Seppo Honkapohja eds., 1987) (questioning whether the goal of game theory is or should be prediction); ARIEL RUBINSTEIN, *ECONOMICS AND LANGUAGE* 71-88 (2000) (doubting the practical applicability of game theory).

24. See, e.g., DAVID M. KREPS, *MICROECONOMICS FOR MANAGERS* 492-589 (2004) (providing an exposition suitable for MBA students and executive education programs of noncooperative game theory, reciprocity and collusion, and credibility and reputation); JAMES D. MILLER, *GAME THEORY AT WORK: HOW TO USE GAME THEORY TO OUTTHINK AND OUTMANEUVER YOUR COMPETITION* (2003) (presenting case studies of how businesspeople can utilize game theory).

25. See, e.g., SCOTT GATES & BRIAN D. HUMES, *GAMES, INFORMATION, AND POLITICS: APPLYING GAME THEORETIC MODELS TO POLITICAL SCIENCE* (1997) (presenting applications of game-theoretic models to American politics, comparative politics, and international relations).

to analyze legal rules and institutions.²⁶ Proof of the acceptance of game-theoretic reasoning in the legal scholar's toolkit is found in the five peer-refereed journals about law and economics.²⁷ Finally, game theory played a crucial role in designing the Federal Communications Commission (FCC) auctions for assigning licenses to wavelengths for personal communication services, such as cell phones and wireless computer-access services. Professor John McMillan provides an excellent account of this case study, which demonstrates the success of modern game theory, as applied to designing optimal regulatory policy.²⁸ Professor McMillan explains that the features of the auction format the FCC adopted essentially were those proposed by Professors Preston McAfee, Paul R. Milgrom, and Robert Wilson and experimentally tested by Professor Charles Plott.²⁹ As Professor McMillan stated, "When the theorists met the policy-makers, concepts like Bayes-Nash equilibrium, incentive-compatibility constraints, and order-statistic theorems came to be discussed in the corridors of power."³⁰

26. Peter H. Huang, *Strategic Behavior and the Law: A Guide for Legal Scholars to Game Theory and the Law and Other Game Theory Texts*, 36 JURIMETRICS J. 99, 99 (1995) (book review).

27. All five journals have published numerous articles utilizing game theory. See, e.g., Robert Cooter & Josef Drexel, *The Logic of Power in the Emerging European Constitution: Game Theory and the Division of Power*, 14 INT'L REV. L. & ECON. 307 (1994); Peter H. Huang & Ho-Mou Wu, *More Order Without More Law: A Theory of Social Norms and Organizational Cultures*, 10 J.L. ECON. & ORG. 390 (1994); Peter H. Huang, *International Environmental Law and Emotional Rational Choice*, 31 J. LEGAL STUD. 237 (2002); Peter H. Huang & Ho-Mou Wu, *Emotional Responses In Litigation*, 12 INT'L REV. L. & ECON. 31 (1992); Chris William Sanchirico, *Games, Information, and Evidence Production: With Application to English Legal History*, 2 AM. L. & ECON. REV. 342 (2000); James M. Griffin & Weiwen Xiong, *The Incentives to Cheat: An Empirical Analysis of OPEC*, 40 J.L. & ECON. 289 (1997).

28. See John McMillan, *Selling Spectrum Rights*, J. ECON. PERSP., Summer 1994, at 145, 146 (discussing application of game theory to FCC assignment of wavelength licenses) [hereinafter McMillan, *Spectrum Rights*]. See also John McMillan, *Market Design: The Policy Uses of Theory*, 93 AM. ECON. REV. 139, 139-42 (2003) (discussing other successful applications of modern sophisticated game theory to the optimal design of economic policy).

29. McMillan, *Spectrum Rights*, *supra* note 28, at 146; Paul R. Milgrom, *Game Theory and the Spectrum Auctions*, 42 EUR. ECON. REV. 771 (1998); PAUL R. MILGROM, PUTTING AUCTION THEORY TO WORK (2003).

30. McMillan, *Spectrum Rights*, *supra* note 28, at 146.

A. *A General Comparison of the Expected-Value and Options Models of Litigation*

Three path-breaking models set the standard for the formal economic analysis of the settlement of litigation.³¹ First, Professor William Landes explained why most criminal cases involve negotiated sentences instead of trial.³² Second, Professor Richard Posner explained why the FTC and other administrative agencies settle most regulatory disputes via out-of-court settlements.³³ Third, Professor John Gould explained why most civil cases settle before trial.³⁴ The Landes-Posner-Gould (LPG) single-person decision theory expected-value approach to settlement of litigation culminated in Professor Steven Shavell's model comparing the incentives to sue and settle under alternative rules for allocating legal costs.³⁵

The standard approach in law and economics models to how people deal with risk involves assuming that legal decision-makers maximize their expected utilities of wealth. This general assumption often then is reduced to assuming that legal decision-makers maximize the net present discounted values of their expected-wealth levels. In other words, neoclassical models assume that legal decision-makers have as their utility function over wealth, the net present discounted value of wealth. This can be more accurately termed an expected-value-of-wealth approach to risk.

An expected-value approach to the risks in litigation would be appropriate if legal decision-makers in litigation were locked into their initial decisions. What an expected-value approach to risks ignores, however, are the opportunities to make future choices after learning more concerning the payoff-relevant risks. In the lawsuit context, an expected-value approach neither incorporates nor reflects

31. See THOMAS J. MICELI, *ECONOMICS OF THE LAW: TORTS, CONTRACTS, PROPERTY, LITIGATION* 156-80 (1997) (providing an excellent mathematical exposition of the economics of litigation and settlement); see also COOTER & ULEN, *supra* note 16, at 413-17 (providing a less technical exposition of an economic theory of settlement bargaining).

32. William M. Landes, *An Economic Analysis of the Courts*, 14 J.L. & ECON. 61, 66 (1971).

33. Richard A. Posner, *An Economic Approach to Legal Procedure and Judicial Administration*, 2 J. LEGAL STUD. 399, 416 (1973).

34. John P. Gould, *The Economics of Legal Conflicts*, 2 J. LEGAL STUD. 279, 285-86 (1973).

35. Steven Shavell, *Suit, Settlement, and Trial: A Theoretical Analysis Under Alternative Methods for the Allocation of Legal Costs*, 11 J. LEGAL STUD. 55, 58-61, 63-67 (1982).

the value of the flexibility provided by a plaintiff's option to unilaterally abandon litigation.³⁶ The values of a plaintiff's options to abandon litigation lead to qualitatively different implications concerning the incentives to sue, settle, or go to trial than under the usual expected-value approach to lawsuits, and these option values can be quite large quantitatively.

Professor Bradford Cornell was the first scholar to develop some of the implications of the observation that plaintiffs have unilateral options to drop a lawsuit before incurring the cost of a full-blown trial.³⁷ Professor Cornell showed that the option to drop a lawsuit increases a lawsuit's expected payoff, and, hence, the incentive to file a lawsuit. Professor Cornell's analysis extends the LPG model in which litigation decisions were based solely on the present discounted value of a lawsuit's costs and expected benefits by introducing an explicit options approach to litigation.³⁸ William J. Blanton applied Cornell's insights to evaluate the impact of changes in evidentiary rules on a plaintiff's incentive to file a lawsuit.³⁹ In particular, Blanton focuses on changes in the admissibility of expert scientific testimony resulting from the Supreme Court's decision in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*⁴⁰ Blanton identified four principal ways in which any evidentiary, procedural, or substantive rule (or change in such a rule) can reduce the value of a plaintiff's option to unilaterally drop litigation by: (1) increasing the plaintiff's litigation costs, (2) front-loading the plaintiff's litigation costs, (3) enhancing trial precision, and (4) obfuscating the plaintiff's ability to predict a trial outcome.⁴¹ Frederick Dunbar and his colleagues provided options-based approaches to nuisance lawsuits, plaintiffs' attorneys' behavior under contingent fee arrangements in securities litigation, securities litigation reform, and settlements in shareholder class actions.⁴²

36. FED. R. CIV. P. 41(a)(1)(i) (allowing voluntary dismissal by plaintiff under certain circumstances).

37. Bradford Cornell, *The Incentive to Sue: An Option-Pricing Approach*, 19 J. LEGAL STUD. 173 (1990).

38. *Id.* at 176-82.

39. William J. Blanton, *Reducing the Value of Plaintiff's Litigation Option in Federal Court: Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 2 GEO. MASON L. REV. 159, 160 (1995).

40. 509 U.S. 579 (1993).

41. Blanton, *supra* note 39, at 160-61, 182-90.

42. Frederick C. Dunbar et al., *Shareholder Litigation: Deterrent Value, Merits and Litigants' Options* (Washington University John M. Olin School of Business, Working Paper 95-07-a 26-30, 1995).

I introduced an options model of contingency multipliers for attorney's fees in public interest and civil rights litigation.⁴³ Professor Steven Shavell raised a set of related concerns in his affidavit for a civil rights case where attorney's fees were hotly contested.⁴⁴ Professor Shavell, however, did not frame his argument explicitly in terms of the language of an options approach to litigation. Also related are my proposals to incorporate options in teaching corporate law⁴⁵ and to use an options approach toward an understanding of why a firm could rationally choose to engage in predatory pricing.⁴⁶

Professor Lucian Bebchuk provided a theory of NEV lawsuits where threats to go to trial are credible due to divisibility over time of plaintiffs' litigation costs.⁴⁷ The options model of litigation in this Article differs from Professor Bebchuk's model because in his model litigants face certainty over expected trial outcomes and legal fees, while litigants in this Article's model face uncertainty over expected judgments, litigation costs, or both. The plaintiffs in the model of this Article have opportunities not only to learn about expected judgments and litigation costs during the litigation process, but also to drop litigation, conditional upon information they learn during the course of that litigation. The divisibility of legal costs also forms the basis for Professor William Landes's model of unitary versus sequential trials.⁴⁸ Professor

43. See Peter H. Huang, *A New Options Theory for Risk Multipliers of Attorney's Fees in Federal Civil Rights Litigation*, 73 N.Y.U. L. REV. 1943 (1998) (developing a new options-based theory of calculating attorney's fees that allows an attorney to assess the plaintiff's probability of prevailing at trial during different stages of the lawsuit).

44. Affidavit of Steven M. Shavell at 2-3, *In re Burlington Northern, Inc., Employment Practices Litig.*, Nos. MDL 374 & 78 C269, 1985 WL 1808 (N.D. Ill. May 31, 1985).

45. Peter H. Huang, *Teaching Corporate Law From an Option Perspective*, 34 GA. L. REV. 571, 593-96 (2000).

46. Peter H. Huang, *Still Preying on Strategic Reputation Models of Predation, A Review of John R. Lott, Jr., Are Predatory Commitments Credible? Who Should Courts Believe?*, 3 GREEN BAG 2D 437 (2000).

47. See Lucian Arye Bebchuk, *A New Theory Concerning the Credibility and Success of Threats to Sue*, 25 J. LEGAL STUD. 1 (1996) (identifying conditions under which a plaintiff with an NEV suit will have a credible threat and succeed in extracting a settlement).

48. William M. Landes, *Sequential Versus Unitary Trials: An Economic Analysis*, 22 J. LEGAL STUD. 99 (1993) [hereinafter Landes, *Sequential Versus Unitary Trials*]; see also, DOUGLAS G. BAIRD, *GAME THEORY AND THE LAW* 251-60 (1994) (extending Landes's model to cases in which litigants possess unverifiable information); William M. Landes, *Sequential and Bifurcated Trials*, in

Landes demonstrated that bifurcating liability and damages reduces expected litigation costs because no need to litigate damages arises if no liability exists.⁴⁹ In turn, such bifurcation increases the incentives to sue, increases the minimum acceptable settlement, and decreases the maximum settlement offer.⁵⁰

B. Comparing the Expected Value and Options Models of Frivolous Litigation

1. Defining “Frivolous Litigation”

Both the positive and normative analyses of frivolous litigation depend upon one’s definition of “frivolous litigation.” As Professor Bone details, defining a frivolous lawsuit proves more complicated than one might initially think.⁵¹

An obvious definition of a frivolous lawsuit is a case in which the plaintiff does not expect initially to prevail at trial. In other words, the plaintiff in a frivolous lawsuit is one who has suffered no legally recoverable damages because she either (1) suffered no harm, or (2) if she did suffer harm, she cannot recover it from the defendant under existing legal precedent. Her case lacks any legal merit because her expected judgment from proceeding to a trial is zero. Another, more inclusive definition of frivolous litigation also includes negative-expected-value lawsuits—in other words, litigation in which the expected judgment is greater than zero but still remains less than the plaintiff’s costs of proceeding to trial. Such negative-expected-value (“NEV”) litigation appears to be irrational for plaintiffs to file and for defendants to settle.

A problem with both of the above definitions of frivolous litigation is that they include cases in which litigants are seeking to establish new legal theories that differ from existing legal precedent. Many people, including the author of this Article, believe that novel test cases in such legal areas as civil rights actions, e.g., actions regarding subconscious gender discrimination and unconscious racial discrimination, should not be considered frivolous litigation.

3 THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 438 (Peter Newman ed., 1998) (discussing the sequential nature of litigation) [hereinafter Landes, *Sequential and Bifurcated Trials*].

49. Landes, *Sequential Versus Unitary Trials*, *supra* note 48, at 113.

50. Landes, *Sequential Versus Unitary Trials*, *supra* note 48, at 115.

51. BONE, *supra* note 9, at 41-43; *see also* Bone, *supra* note 6, at 529-33 (discussing the problems inherent in defining frivolous litigation).

Professor Bone defines a frivolous lawsuit as one in which a plaintiff either (1) actually knows that the case completely, or virtually completely, lacks any merit under the legal theories being alleged; or (2) would have known that the case lacked merit under the legal theories being alleged, had the plaintiff conducted a reasonable investigation before filing.⁵² This definition of frivolous litigation clearly differs from negative-expected-value-litigation definitions in three ways. First, Bone's definition makes no comparison of expected judgments and litigation costs. Second, his definition does not include as frivolous those lawsuits described in the observation mentioned in the previous paragraph. Third, this definition includes a second component that has no analogues in the negative expected value definitions. In addition, as Professor Bone details, positive net-expected-value litigation explanations of frivolous litigation are unconvincing.⁵³ This is because positive net-expected-value litigation examples of frivolous litigation are due to either a plaintiff expecting substantial nonlegal benefits or courts making enough mistakes to imply that even a meritless lawsuit has a high likelihood of success at trial. While both of these scenarios are possible, neither is a sufficiently serious problem to warrant costly regulatory intervention.

2. Using Options Games to Develop a Definition of "Frivolous Litigation"

A number of law and economics models address the dual questions of why plaintiffs file frivolous lawsuits and why defendants agree to settle frivolous lawsuits.⁵⁴ Existing models demonstrate that litigation deemed frivolous according to the definitions discussed above can still be worthwhile for the litigants to pursue if any of the following situations applies: the litigants possess different probability estimates of the plaintiff prevailing at trial;⁵⁵ a

52. BONE, *supra* note 9, at 43; Bone, *supra* note 6, at 533.

53. BONE, *supra* note 9, at 44-45; Bone, *supra* note 6, at 534-37.

54. See Lucian Arye Bebchuk, *Suits with Negative Expected Value*, in 3 THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 551 (Peter Newman ed., 1998) (providing excellent summaries of economic analyses of frivolous lawsuits); BONE, *supra* note 9, at 20-68; Bone, *supra* note 6, at 534-77; MICELI, *supra* note 31, at 181-200; Eric B. Rasmusen, *Nuisance Suits*, in 2 THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 690-93 (Peter Newman ed., 1998).

55. Cooter & Rubinfeld, *supra* note 16, at 1083-84.

court makes a legal error;⁵⁶ the parties' litigation costs are incurred sequentially;⁵⁷ asymmetries exist between the litigants with respect to the size or timing of litigation costs;⁵⁸ plaintiffs have private information concerning their cases;⁵⁹ or plaintiffs have the ability to commit or pre-commit to litigation.⁶⁰

The questions of why a plaintiff would choose to file a frivolous lawsuit and why a defendant would agree to settle a frivolous lawsuit are intellectually and practically troublesome. Asymmetric information game-theoretic models answer both questions; however, as the phrase "asymmetric information" suggests, these models assume that just one side of the litigation—in other words, either the plaintiff or the defendant—realizes that the litigation is frivolous.⁶¹ In other words, no mechanism exists for communication between the parties as to the truthful revelation of this private information besides litigation. The 2001 Nobel Prize in Economics recognized the pioneering research of Professors George Akerlof, Andrew Michael Spence, and Joseph E. Stiglitz, each of whom developed seminal concepts in the economics of symmetric information.⁶² Such concepts as lemons, pooling, separation, and

56. Keith N. Hylton, *Costly Litigation and Legal Error Under Negligence*, 6 J.L. ECON. & ORG. 433, 441 (1990) (reasoning that even when all "potentially negligent actors" are exercising due care, plaintiffs may still bring suit in hope that damages may be awarded as a result of court error).

57. See Bebchuk, *supra* note 47, at 10-12 (positing a situation where litigants' costs are not incurred all at once but rather spread out over all stages of the litigation).

58. David Rosenberg & Steven Shavell, *A Model in Which Suits Are Brought for Their Nuisance Value*, 5 INT'L REV. L. & ECON. 3, 9-10 (1985) (explaining how nuisance suits arise when plaintiffs have a relatively low initial cost to sue and defendants have a greater cost to defend themselves).

59. See Avery Katz, *The Effect of Frivolous Litigation on the Settlement of Legal Disputes*, 10 INT'L REV. L. & ECON. 3, 5 (1990) (discussing the worthwhile nature of frivolous lawsuits in situations where plaintiffs have more information concerning their cases than do defendants).

60. Plaintiffs can (pre-)commit to litigation by having lawyers on retainer and paying for legal services in advance, whether or not plaintiffs undertake litigation to trial. HERBERT GINTIS, *GAME THEORY EVOLVING: A PROBLEM-CENTERED INTRODUCTION TO MODELING STRATEGIC INTERACTION* 100-02 (2000).

61. BONE, *supra* note 9, at 54; Bone, *supra* note 6, at 542, 598-99.

62. See generally George Akerlof, *The Market for Lemons: Qualitative Uncertainty and the Market Mechanism*, 84 Q.J. ECON. 488 (1970) (providing a pioneering model of the economic effects of dishonesty); A. Michael Spence, *Job Market Signaling*, 87 Q.J. ECON. 355 (1973) (introducing a model in which market signaling is defined); Michael Rothschild & Joseph E. Stiglitz, *Equilibrium in Competitive Insurance Markets: An Essay in the Economics of Imperfect Information*, 90 Q.J. ECON. 629, 643-48 (1976) (providing asymmetric information

signaling games play crucial roles in asymmetric information game-theoretic models of frivolous litigation.⁶³

This Article allows for the realistic possibilities that (1) initially, neither side of the litigation knows whether he or she is a participant in a frivolous lawsuit, and (2) perhaps more importantly, initially, neither side of the litigation knows for certain whether a court will hold that the lawsuit is frivolous. For example, medical-malpractice plaintiffs may file lawsuits, in part, from a motivation to find out what really happened during a medical procedure that went awry. Even if a doctor seems not to be legally negligent, an empathetic jury might nonetheless find in favor of a sympathetic plaintiff.

The model in Appendix B of this Article discusses litigation that might possibly be frivolous. The adverb “possibly” reflects a realistic feature of litigation in the sense that, during its course or process, litigants and their attorneys will revise their expected costs and benefits of proceeding to a trial. In other words, parties and their lawyers will learn that a lawsuit is frivolous only after the lawsuit commences. Frivolous litigation is not rational for plaintiffs to file or for defendants to settle, if the litigation costs are incurred all-at-once up front or if the expected value of litigation does not change over the course of litigation. But litigation that later turns out to be frivolous can be initially rational for plaintiffs to file and for defendants to settle if litigation costs are incurred sequentially and if the expected value of litigation changes over the course of litigation.

The model in Appendix B of this Article develops a new theory regarding frivolous litigation that provides conditions under which litigation that may later turn out to be frivolous is initially credible for plaintiffs to file and for defendants to settle.⁶⁴ This novel theory of possibly frivolous litigation is based upon two central features of litigation. The first aspect of litigation to note is that, once a plaintiff makes the initial decision to file a lawsuit, Federal Rule of Civil Procedure 41(a)(1)(i) and its state counterparts

competitive market equilibrium models and properties of those equilibria). For an exposition designed for undergraduates, see IAN MOLHO, *THE ECONOMICS OF INFORMATION: LYING AND CHEATING IN MARKETS AND ORGANIZATIONS* 13-14 (1997) (providing an exposition of the role of information in situations that potentially give rise to dishonesty and breach of promise, and analyzing the consequences for people involved). For a survey, see Joseph E. Stiglitz, *The Contributions of the Economics of Information to Twentieth Century Economics*, 115 Q.J. ECON. 1441 *passim* (2000).

63. BONE, *supra* note 9, at 59-64; Bone, *supra* note 6, at 552-66.

64. See *infra* Appendix B, Proposition 1.

provide the plaintiff with unilateral options to abandon that lawsuit under certain circumstances.⁶⁵ The second notable feature of litigation is that parties and their attorneys learn information concerning their litigation over the course of that litigation.

In the particular model presented in Appendix B, no asymmetric information exists. Therefore, one party is not learning things that the other party already knows. Instead, both parties in this Article's model learn information that both parties do not know, namely the judgment at trial or the costs of litigation. In Appendix B's model, the parties to litigation share common initial beliefs regarding the judgment at trial and the costs of litigation. Although the model does not restrict how parties revise their beliefs over time, the model does assume that both sides of the litigation modify those shared initial beliefs in the same manner, and hence, share the same beliefs in each period of litigation. In other words, litigants do not have to necessarily update their probability beliefs via Bayes's rule, but they do have to utilize a common rule for how they adjust probability beliefs over time.⁶⁶

For a decision-maker, an important benefit of learning information is the opportunity to make choices based on that additional information. Such potentially valuable opportunities are precisely what decision-makers gain from having options.⁶⁷ This central and fundamental insight underlies Professors C. Frederick Beckner's and Steven Salop's multistage decision model of sequential legal procedure, which computes the optimal standards of summary disposition (those minimizing the sum of information and error costs) and the optimal sequence of legal and factual issues that a court should address.⁶⁸ That insight also underlies Professor Landes's model regarding whether a court should hold separate trials for liability and damages, as opposed to a unified trial that considers

65. See FED. R. CIV. P. 41(a)(1)(i) (allowing voluntary dismissal by plaintiff); Solimine & Lippert, *supra* note 11, at 406-18 (cataloging the various state analogues to the federal rule).

66. See, e.g., Peter H. Huang, *Asymptotic Stability of Bayesian Updating for Spencian Examples*, 17 ECON. LETTERS 47 (1985) (modeling Bayesian learning of market signaling equilibria). Bayes's rule provides a theoretical method for making appropriate inferences in light of the information contained in statistical observations.

67. Ronald A. Howard, *Options*, in WISE CHOICES: DECISIONS, GAMES, AND NEGOTIATIONS 81 (Richard J. Zeckhauser et al. eds., 1996).

68. C. Frederick Beckner, III & Steven C. Salop, *Decision Theory and Antitrust Rules*, 67 ANTITRUST L.J. 41, 54 (1999).

both issues.⁶⁹ Professor Warren F. Schwartz also recognizes the value of options when he demonstrates that separating determinations of damages from determinations of liability could reduce litigation costs.⁷⁰

This Article fills a niche in the literature about possibly frivolous litigation.⁷¹ This Article demonstrates how to harmoniously blend an options approach to lawsuits with a strategic approach to pretrial settlement bargaining. The analytical model in Appendix B of this Article both builds upon and combines two major literatures. The first literature is research about options, both in law in particular and, more generally, in strategic management. The second literature consists of game-theoretic models of litigation. The model in Appendix B of this Article integrates these distinct literatures into a unified game-theoretic options model of litigation. Strategic-options models have only recently begun to appear in the financial and management literatures.⁷² These models can become quite mathematically complicated rather quickly.⁷³

The model in Appendix B of this Article clarifies how and why options analysis explains when possibly frivolous litigation can be nonetheless credible for plaintiffs to threaten to file and for

69. Landes, *Sequential and Bifurcated Trials*, *supra* note 48, at 438-40.

70. See generally Warren F. Schwartz, *Severance—A Means of Minimizing the Role of Burden and Expense in Determining the Outcome of Litigation*, 20 VAND. L. REV. 1197 (1967).

71. See Bone, *supra* note 6, at 542 n.81 (noting that the existing options approach to litigation fails to incorporate theories regarding the strategic interactions between litigants).

72. See generally MARION A. BRACH, REAL OPTIONS IN PRACTICE 33-74 (2003) (providing an introduction to games involving shared real options); Han T.J. Smit & L.A. Ankum, *A Real Options and Game-Theoretic Approach to Corporate Investment Strategy Under Competition*, FIN. MGMT., Autumn 1993, at 241 (applying option theory to evaluate investment strategies in research-and-development and pilot programs).

73. See generally GAME CHOICES: THE INTERSECTION OF REAL OPTIONS AND GAME THEORY (Steven Grenadier ed., 2000) (presenting selected papers that provide theoretical foundations for and practical, state-of-the-art applications of strategic real-options models). See also Steven R. Grenadier, *Option Exercise Games: The Intersection of Real Options and Game Theory*, J. APPLIED CORP. FIN., Summer 2000, at 99, 100 (illustrating how the use of real options in conjunction with game theory leads to greater insights “into the behavior of economic agents under uncertainty”); Steven R. Grenadier, *The Strategic Exercise of Options: Development Cascades and Overbuilding in Real Estate Markets*, 51 J. FIN. 1653, 1653 (1996) (discussing the untapped nature of the area of research surrounding strategic-option-exercise frameworks and their application in real-asset markets); VOLLERT, *supra* note 12, at 7-8 (giving an overview of the basic ideas of the real-options approach to capital-budgeting firms).

defendants to settle. Of course, not all threatened potentially frivolous lawsuits are going to be credible for plaintiffs to threaten to file and for defendants to settle. In fact, Appendix B of this Article proves that only lawsuits, including possibly frivolous ones, with positive-net-abandonment-option values as to their expected costs, are credible for plaintiffs to threaten to file and for defendants to settle.⁷⁴ In other words, the gross-abandonment-option values for each stage of litigation must exceed the cost of that stage of litigation. The model in Appendix B of this Article demonstrates that lawsuits that have positive-net-expected values will also have positive-net-option values. Thus, any lawsuit with a positive expected value ("PEV") will be credible for a plaintiff to threaten to file (and actually to file) and for a defendant to settle.⁷⁵

All lawsuits, including NEV lawsuits, must have positive gross-abandonment-option value, because any random variable's abandonment-option value is larger than or equal to its expected value. That conclusion logically follows from the notion that the abandonment-option value of a random variable equals that random variable's expected value when all of the negative value realizations of that random variable are replaced by zero. Such a conceptualization of the abandonment-option value of a random variable insightfully captures a pragmatic and valuable feature of abandonment options: namely, the flexibility to avoid negative outcome realizations of the underlying random variable. Thus, the abandonment-option value of any random variable, including that of a plaintiff's expected judgment at litigation must be, non-negative by definition.

Several economists have developed the related concept of an option value or quasi-option value, both in the particular context of environmental preservation and in the more general setting of decision-making under conditions of risk.⁷⁶ The relationship between these option values has caused some confusion in the

74. See *infra* Appendix B, Proposition 1.

75. See *infra* Appendix B, Proposition 2.

76. See, e.g., Kenneth J. Arrow & Anthony C. Fisher, *Environmental Preservation, Uncertainty, and Irreversibility*, 88 Q.J. ECON. 312, 315 (1974) (relating the concept of a quasi-option value to the choice between preservation and development of a natural environment); W. Michael Hanemann, *Information and the Concept of Option Value*, 16 J. ENVTL. ECON. & MGMT. 23, 27 (1989); Claude Henry, *Investment Decisions Under Uncertainty: The "Irreversibility Effect,"* 64 AM. ECON. REV. 1006, 1007 (1974) (examining the tendency of a decision-maker to adopt an irreversible decision).

literature.⁷⁷ By the phrase “the option value of a random variable,” this Article simply means the expected value of that random variable, but with all of its negative-value realizations replaced by zero. From this definition, it follows that, at every date, the option value of any random variable exceeds the expected value of any random variable.

The model in Appendix B of this Article provides four principal ways in which any evidentiary, procedural, or substantive rule (or change in such a rule) can increase the value of a plaintiff’s litigation-abandonment option, namely: (1) increasing the variance of trial judgment awards,⁷⁸ (2) increasing the divisibility of plaintiff’s legal costs,⁷⁹ (3) back-loading plaintiff’s litigation costs,⁸⁰ and (4) decreasing plaintiff’s total litigation costs.⁸¹

However, the game-theoretic options model of litigation in Appendix B of this Article differs from game-theoretic expected-value models of litigation in terms of its predictions. For example, in expected-value game-theoretic models of litigation involving risk-neutral parties, a mean-preserving increase or decrease in the variance of judgment at trial has no impact on the incentives to file, nor does it affect the Nash-equilibrium settlement amounts. But in the game-theoretic options model of litigation involving risk-neutral parties, a mean-preserving increase or decrease in the variance of judgment at trial increases or, respectively, decreases both the incentives to file and the Nash-equilibrium settlement amounts.⁸²

The reason for this difference in the predictions of the game-theoretic expected-value and options models of litigation is that risk-neutral litigants only care about expected values, and not variance, in the game-theoretic expected-value model of litigation. In contrast, in a game-theoretic options model of litigation, the option values of the settlement amounts from litigation depend not only upon expected

77. Anthony C. Fisher, *Investment under Uncertainty and Option Value in Environmental Economics*, 22 RESOURCE & ENERGY ECON. 197, 202-03 (2000) (offering a unifying framework for different option theories by showing equivalence); PAUL G.C. MENSINK & TILL REQUATE, *THE DIXIT-PINDYCK AND THE ARROW-FISHER-HANEMANN-HENRY OPTION VALUES ARE NOT EQUIVALENT* (Univ. of Kiel Dep’t of Econ., Working Paper No. 2003-09, 2003) (clarifying the precise relationship between these different senses of option values).

78. See *infra* Appendix B, Proposition 6.

79. See *infra* Appendix B, Proposition 11.

80. See *infra* Appendix B, Proposition 13.

81. See *infra* Appendix B, Proposition 15.

82. See *infra* Appendix B, Proposition 6.

values, but also upon the variances of random variables even with risk-neutral litigants.

A comparison of the English rule, which requires the losing party to pay the legal fees of both sides, and the American rule, which requires each side to pay for its own legal fees, also illustrates the difference between the predictions of the game-theoretic expected-value and options models of litigation. A large body of theoretical and empirical literature exists regarding the incentives to file a lawsuit under the American and English rules for allocating legal costs.⁸³ Almost all of this literature focuses exclusively on the average values or expected judgments of trials because risk-neutral parties care only about means and not about variances, higher-order moments, or any other characteristics of the distributions of trial outcomes. Professor Shavell proved that a plaintiff is more likely to file a lawsuit under the American rule than under the English rule if the plaintiff does not expect to prevail because the plaintiff expects to pay only for the plaintiff's litigation costs rather than both sides' litigation costs.⁸⁴ Appendix B of this Article proves that, under certain hypotheses, the filing of possibly frivolous litigation is more likely under the English rule than under the American rule if the probability of the plaintiff prevailing at trial is sufficiently large or if the plaintiff's expected aggregate litigation costs sufficiently exceed the defendant's expected aggregate litigation costs.⁸⁵

83. See, e.g., BONE, *supra* note 9, at 158-86 (examining the costs and benefits of switching to the British rule); James W. Hughes & Edward A. Snyder, *Litigation and Settlement Under the English and American Rules: Theory and Evidence*, 38 J.L. & ECON. 225, 248 (1995) (finding that fewer plaintiffs pursue claims under the English rule because litigation is more costly); James W. Hughes & Edward A. Snyder, *Allocation of Litigation Costs: American and English Rules*, in 1 THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 51 (Peter Newman ed., 1998) (noting that the English rule requires unsuccessful litigants to pay the winner's legal costs, while the American system typically does not); MICELI, *supra* note 31, at 167-70 (discussing the cost-allocation differences between the American and English rules); Shavell, *supra* note 35, at 58-61, 63-67 (discussing four methods for allocating legal costs: each side bears its own costs, losing side bears all costs, plaintiff pays only his own costs if he loses, and defendant pays only his own costs if he loses); Edward A. Snyder & James W. Hughes, *The English Rule for Allocating Legal Costs: Evidence Confronts Theory*, 6 J.L. ECON. & ORG. 345 (1990) ("An extensive theoretical literature has analyzed how the allocation of legal costs may affect the litigation process . . .").

84. Shavell, *supra* note 35, at 59, 75, Fig. 2.

85. See Appendix B, Proposition 7.

3. Applying These Models to the Discovery Context and Beyond

While Appendix B of this Article develops a multi-period options model of lawsuits, this general approach to litigation can be illustrated by making the simplifying assumption that litigation consists only of two stages, namely discovery and trial. Because modern liberal rules of pleading allow the survival of a fairly broad class of claims, a plaintiff's lawyers can engage in discovery if a plaintiff files a lawsuit and survives a defendant's motion to dismiss for failure to state a claim.⁸⁶ Before discovery, the plaintiff's attorney has only filed suit and initial motions; therefore, legal fees up to then are usually small in comparison to the sizable amounts charged during discovery. In fact, an empirical survey of attorneys found that about 50% of the aggregate costs of litigation are discovery costs.⁸⁷ A plaintiff can avoid incurring those significant discovery costs by dropping the litigation.

But, even if a plaintiff decides to have her attorney engage in discovery, a plaintiff is not locked into proceeding to a trial. In fact, discovery provides information and opportunities to update beliefs as to the probability of the plaintiff's winning at trial. Federal and state rules governing discovery confer upon parties the legal rights to obtain information from other parties before trial via document requests, interrogatories, and the deposition of witnesses.⁸⁸ But both the attorney-client privilege and the work-product doctrine limit the information another party can discover.⁸⁹ The discovery process provides a plaintiff's attorney with the opportunity to conduct research into a case; the attorney can develop it further if it looks promising in terms of an expected judgment or a settlement, or he can recommend that a plaintiff drop the case if it does not look promising. For simplicity, assume that discovery completely resolves the uncertainty over the actual merits of a case. Then, after

86. FED. R. CIV. P. 12(b)(6) (outlining the motion to dismiss for failure to state a claim upon which relief can be granted).

87. THOMAS E. WILLGING ET AL., *DISCOVERY AND DISCLOSURE PRACTICE, PROBLEMS, AND PROPOSALS FOR CHANGE 15* (Federal Judicial Center 1997).

88. *See, e.g.*, FED. R. CIV. P. 34 (calling for production of documents); FED. R. CIV. P. 33 (allowing interrogatories to parties); FED. R. CIV. P. 30 (providing for oral depositions); FED. R. CIV. P. 31 (describing written depositions).

89. *See, e.g.*, Ronald J. Allen et al., *A Positive Theory of the Attorney-Client Privilege and the Work Product Doctrine*, 19 J. LEGAL STUD. 359 (1990) (offering an economic model of the procedural limits on discovery based upon their incentive effects).

discovery, both sides of the case will know the probability of the plaintiff's prevailing at trial is either zero or one. Therefore, in the second period, a plaintiff will be willing to incur the sizable and irreversible costs of trial if she learns that she has a sure winner, while a plaintiff will drop the case unilaterally if she learns that she has a sure loser.

Many sophisticated game-theoretic models of discovery,⁹⁰ discovery rules,⁹¹ and efficient discovery exist.⁹² Discovery generates benefits and costs that differ significantly between plaintiffs and defendants.⁹³ A defendant's cost of complying with a plaintiff's discovery requests for non-privileged, relevant documents can be quite substantial, whether the defendant is a corporation, doctor, or even just another individual.⁹⁴ A clear potential for discovery abuse exists because of the externality involved where plaintiffs receive the informational benefits of discovery but defendants bear its costs.⁹⁵ So, even if the discovery request will likely produce benefits that exceed its costs, one party receives the benefits from, while another party bears the costs of, discovery.⁹⁶ Thus, even if a discovery request is socially desirable, in the sense

90. See, e.g., Robert D. Cooter & Daniel L. Rubinfeld, *An Economic Model of Legal Discovery*, 23 J. LEGAL STUD. 435, 438 (1994) (providing a general strategic analysis of discovery); see also Bruce L. Hay, *Civil Discovery: Its Effects and Optimal Scope*, 23 J. LEGAL STUD. 481, 484-500 (1994) (extending Cooter & Rubinfeld's analysis).

91. See generally Joel Sobel, *An Analysis of Discovery Rules*, 52 LAW & CONTEMP. PROB. 133 (1989) (discussing specific game-theoretic models).

92. Robert Mnookin & Robert Wilson, *A Model of Efficient Discovery*, 25 GAMES & ECON. BEHAV. 219, 220 (1998).

93. FED. R. CIV. P. 26(b)(2)(iii) limits discovery to requests for which compliance does not impose a burden that is likely to outweigh the benefits. FED. R. CIV. P. 26(g)(3) allows courts to impose appropriate sanctions for violations.

94. FED. R. CIV. P. 26(b)(1) provides a broad scope for discovery, including information that need not be admissible at trial so long as the information requested "appears reasonably calculated to lead to the discovery of admissible evidence."

95. See Frank H. Easterbrook, *Discovery as Abuse*, 69 B.U. L. REV. 635, 636 (1989) (expressing judicial concern over discovery abuse). But see Linda S. Mullenix, *Discovery in Disarray: The Pervasive Myth of Pervasive Discovery Abuse and the Consequences for Unfounded Rulemaking*, 46 STAN. L. REV. 1393, 1432-42 (1994) (noting the anecdotal and survey nature of evidence about discovery abuse).

96. John K. Setear, *The Barrister and the Bomb: The Dynamics of Cooperation, Nuclear Deterrence, and Discovery Abuse*, 69 B.U. L. REV. 569, 581 (1989) (differentiating between informational benefits and impositional benefits of discovery requests).

that its benefits exceed its costs, it can provide a small plaintiff an advantage over a large defendant, as Professors David Rosenberg and Steven Shavell demonstrate in their analysis of NEV lawsuits.⁹⁷ Although both sides to a lawsuit can make discovery requests, a plaintiff does not incur much cost in complying with discovery requests when she lacks “truckloads of documents.”⁹⁸ The cost of complying with discovery requests illustrates how litigation-abandonment options may create problems akin to a strategy of raising rival’s costs in the context of business competition and the game-theoretic industrial-organization literature.⁹⁹

More generally, a lawsuit consists not just of discovery and trial stages. Several other stages exist, as well. The plaintiff’s lawyer files a complaint; the defendant’s lawyer files a pre-answer motion to dismiss the plaintiff’s complaint, e.g., under the Federal Rules of Civil Procedure, a motion to dismiss “for failure to state a claim upon which relief can be granted;”¹⁰⁰ the defendant’s lawyer answers the complaint by making admissions,¹⁰¹ making denials,¹⁰² raising affirmative defenses,¹⁰³ or filing counterclaims or cross claims;¹⁰⁴ the lawyers file third-party complaints;¹⁰⁵ the lawyers amend or supplement their pleadings;¹⁰⁶ the lawyers make any required automatic disclosures;¹⁰⁷ the lawyers conduct, object to, and respond to discovery requests for the production of documents;¹⁰⁸ the lawyers send and the parties must sign answers to interrogatories;¹⁰⁹ the lawyers take oral depositions;¹¹⁰ the lawyers

97. Rosenberg & Shavell, *supra* note 58, at 3.

98. See also COOTER & ULEN, *supra* note 16, at 412 (illustrating how “[e]xternalizing compliance costs provides an incentive for discovery abuse”). But see CLASS ACTION (20th Century Fox 1991) (depicting how a defendant’s lawyer can bury a plaintiff’s attorney with literally truckloads of documents in complying with a discovery request).

99. See, e.g., William P. Rogerson, *A Note on the Incentive for a Monopolist to Increase Fixed Costs as a Barrier to Entry*, 99 Q.J. ECON. 399 *passim* (1984) (demonstrating why raising fixed costs benefits a dominant firm).

100. FED. R. CIV. P. 12(b)(6).

101. FED. R. CIV. P. 8(b).

102. *Id.*

103. FED. R. CIV. P. 8(c).

104. FED. R. CIV. P. 13.

105. FED. R. CIV. P. 14.

106. FED. R. CIV. P. 15.

107. FED. R. CIV. P. 26(a).

108. FED. R. CIV. P. 34.

109. FED. R. CIV. P. 33.

110. FED. R. CIV. P. 30.

request and comply with court orders for independent physical or mental medical examinations;¹¹¹ the lawyers promulgate and respond to requests for admissions;¹¹² the lawyers file and respond to motions for directed verdict;¹¹³ the lawyers proceed to trial by, among other things, conducting opening arguments, examining and cross-examining witnesses,¹¹⁴ presenting non-testimonial evidence, and making closing arguments; the lawyers file and respond to motions for judgment as a matter of law before a verdict (also known under some state rules of civil procedure as motions for summary judgment);¹¹⁵ the lawyers file and respond to motions for judgment as a matter of law after the verdict (also known under some state rules of civil procedure as motions for j.n.o.v., which stands for judgment *non obstante veredicto*);¹¹⁶ the lawyers file and respond to motions for a new trial;¹¹⁷ and, finally, the lawyers file and respond to motions to alter or amend a judgment.¹¹⁸ Thus, litigation is a multistage process that provides plaintiffs not just a single option but instead, a sequence of abandonment options analogous to those found in sequential investment.

4. Properties of Litigation Abandonment Options

Litigation abandonment options have several interesting features. First, plaintiffs do not pay litigation abandonment option premiums to defendants but instead, to plaintiffs' attorneys. If plaintiffs are not paying clients, but instead are suing under contingency fee arrangements or attorney fee award statutes, then plaintiffs' attorneys incur litigation-abandonment-option premiums up front. Second, defendants provide these litigation abandonment options to plaintiffs by virtue of their activity choices and the relevant substantive and procedural laws. Thus, changes in either procedural or substantive law can alter the value of litigation abandonment options. Third, plaintiffs' litigation abandonment options are similar to the options that a natural resources company, oil refinery, pharmaceutical company, petrochemical firm, or, in fact,

111. FED. R. CIV. P. 35.

112. FED. R. CIV. P. 36.

113. FED. R. CIV. P. 56.

114. FED. R. CIV. P. 43(a).

115. FED. R. CIV. P. 50(a).

116. FED. R. CIV. P. 50(b).

117. FED. R. CIV. P. 59(a).

118. FED. R. CIV. P. 59(e).

any business that is engaged in research and development (“R&D”) has to abandon product or process innovation.¹¹⁹ But there is a very important difference between a plaintiff’s litigation abandonment options and those in R&D. On the one hand, lawsuits are wasteful from the joint perspective of plaintiffs, defendants, and perhaps, society as a whole if the costs imposed upon a court, a judge, and jury (if any) exceed the precedent and process values from adjudication of the litigation. In litigation, the plaintiff and the defendant will both lose if they make investments in a lawsuit, as opposed to resolving their differences via some alternative dispute resolution method. On the other hand, a corporation engaging in R&D, as well as its employees, its equity owners, its debt holders, its current and future customers, the surrounding community, and possibly other third parties, all stand to gain from the development and sale of a new product. Thus, even though litigation abandonment options are similar to other familiar examples of options, litigation abandonment options differ from other existing options in several important ways.

III. LIMITATIONS OF STRATEGIC LITIGATION OPTION ANALYSIS

This part of the Article appraises limitations of an options game-theoretic approach to litigation. Some of these limitations in the particular context of litigation are the result of general behavioral limitations on game-theoretic analysis.¹²⁰ First, there are cognitive limitations as to how people conceptualize, frame, make, process, and understand choices over time.¹²¹ Second, traditional, or non-

119. See, e.g., Terrence W. Faulkner, *Applying “Options Thinking” to R&D Valuation*, 39 RES. TECH. MGMT., May-June 1996, at 50 (discussing the implications of using an options approach for the formulation of R&D strategies); Graham R. Mitchell & William F. Hamilton, *Managing R&D as a Strategic Option*, RES. TECH. MGMT., May-June 1988, at 15 (explaining why companies might have to abandon such innovation).

120. See generally COLIN F. CAMERER, *BEHAVIORAL GAME THEORY: EXPERIMENTS IN STRATEGIC INTERACTION* (2003) (providing an excellent overview of experimental research about how people actually play games).

121. See generally *TIME AND DECISION: ECONOMIC AND PSYCHOLOGICAL PERSPECTIVES ON INTERTEMPORAL CHOICE* (George Loewenstein et al. eds., 2003) (presenting a fascinating interdisciplinary collection of articles about the philosophical, evolutionary, and neurobiological underpinnings; theoretical perspectives; and practical applications of the psychology and economics of time

psychological, game-theoretic models assume that people do not experience any emotions or feelings. Both of these limitations are particularly serious in litigation settings because most litigation is quite time-consuming and emotionally draining, if not protracted and contentious. It is possible that, even if litigants themselves are myopic and overly emotional, their lawyers might be more farsighted and less emotional. Unfortunately, however, lawyers may exacerbate cognitive and emotional issues, due to conflicts of interest and repeat-play considerations, such as those involving developing a reputation for being tough or playing hardball in pretrial settlement negotiations.¹²² This part of the Article considers these limitations in turn and explores possible responses to such limitations.

A. Cognitive Limitations of Strategic Options Analysis

The standard procedure for solving dynamic games of complete information utilizes a technique known as “backward induction.”¹²³ This method for calculating an equilibrium solution to an extensive form game of perfect information starts by determining the optimal choice for the player who moves last. It continues by then determining the optimal course of action for the player who moves penultimately, and so forth, until determining the optimal decision for the player who moves first. An alternative way to understand backward induction focuses on the sequential rationality of players’ strategies. The requirement of sequential rationality relates to another intuitive notion: that of credibility of threats. Professor Bebchuk systematically applied the credibility constraint in his approach to NEV lawsuits.¹²⁴

preference); CHOICE OVER TIME (George Loewenstein & Jon Elster eds., 1992) (presenting articles about how people actually make choices over time).

122. See, e.g., Ronald J. Gilson & Robert H. Mnookin, *Disputing Through Agents: Cooperation and Conflict Between Lawyers in Litigation*, 94 COLUM. L. REV. 509, 514-15 (1994) (illustrating the possibility of a prisoner’s dilemma situation in which both litigants withhold information from each other, and their lawyers file motions to compel disclosure). But see, e.g., A. Mitchell Polinsky & Daniel L. Rubinfeld, *Aligning the Interests of Lawyers and Clients*, 5 AM. L. & ECON. REV. 165, 167 (2003) (proposing a variation of the standard contingent-fee system for compensating lawyers that would overcome the conflict of interest between clients and their lawyers).

123. Robert Gibbons, *An Introduction to Applicable Game Theory*, J. ECON. PERSP., Winter 1997, at 127, 145.

124. Bebchuk, *supra* note 47, at 1-2, 4-5, 7-8, 14-15, 23-24 (analyzing how a plaintiff involved in a high-cost lawsuit with little chance of success can threaten the defendant into settlement).

As Professor Bebchuk noted, backward-induction arguments have become standard in studying multi-period strategic environments.¹²⁵ The history of backward-induction arguments dates back at least to Zermelo's demonstration that in chess, either white or black can ensure itself a draw regardless of how the other side plays.¹²⁶ Later, the philosopher Kierkegaard said, "It is quite true what Philosophy says: that Life must be understood backwards. But that makes one forget the other saying: that it must be lived-forwards."¹²⁷ Similarly, backward-induction arguments presume that decision-makers have the computational ability to, and in fact do, correctly forecast all of the future choices that are to be made in a game. The longer or more complex a game, the more descriptively problematic is the assumption of rational expectations about strategic decisions.¹²⁸

Numerous experiments demonstrate that people are quite limited in their abilities to perform backwards induction for even relatively simple game situations.¹²⁹ The inconsistency between empirical experimental-play results and backward-induction-based solutions for a famous game called "the centipede game" illustrates the predictive limitations of using backward induction arguments for sufficiently lengthy games.¹³⁰ Even in only two-stage or three-stage sequential-bargaining experimental games, subjects actually play very differently from backward-induction-based equilibrium solutions for those games.¹³¹ One way to resolve these and related backward-induction paradoxes is to posit a small degree of uncertainty into the players' knowledge of what motivates other players.¹³²

125. Bebchuk, *supra* note 47, at 6 n.7.

126. E. Zermelo, *Über eine Anwendung der Mengenlehre auf die Theorie des Schachspiels*, 2 PROC. FIFTH INT'L CONG. MATHEMATICIANS 501 (1913).

127. THE DIARY OF SØREN KIERKEGAARD Pt. 5, sec. 4, no. 136, 1843 entry (Peter Rohde ed., 1960).

128. See generally DAVID M. KREPS, GAME THEORY AND ECONOMIC MODELLING 77-82, 147-48 (1990).

129. See, e.g., THEODORE C. BERGSTROM & JOHN H. MILLER, EXPERIMENTS WITH ECONOMIC PRINCIPLES 395 (1997) (evaluating the results of a sequential-bargaining experiment based on the hypothetical sale of a bicycle).

130. The technical term for backward-induction-based solutions to an extensive form game of perfect information is that of subgame perfect (Nash) equilibria.

131. BERGSTROM & MILLER, *supra* note 129, at 374-76, 394-96.

132. See, e.g., JAMES D. MORROW, GAME THEORY FOR POLITICAL SCIENTISTS 279 (1994) (resolving the chain store paradox).

The game-theoretic analysis of litigation-abandonment options in Appendix B of this Article utilizes backward-induction arguments to analyze lawsuits, despite the fact that the above concerns are disturbing and convincing. Utilizing backward-induction arguments to analyze lawsuits is appropriate because litigants have financial and psychological incentives to be sequentially rational. Indeed, litigants are more likely to be sequentially rational than are experimental subjects, who may face artificial time constraints and might lack the motivations of greed and other emotional responses frequently found in litigation.¹³³ Also, even if the litigants themselves fail to be sequentially rational due to, for example, cognitive difficulties, they hire lawyers who provide not only legal knowledge and expertise, but also negotiating experience and professionalism. Presumably, part of being a professional is being unwilling to make and carry out incredible threats. In a sense, then, litigation involves professionals who have reasons to be sequentially rational. Of course, both defendants' and plaintiffs' attorneys are often repeat players and their behavior might be rational across cases as opposed to within any given case. A final defense is the often made hand-waving argument that market reputation and competition discipline lawyers who fail to be sequentially rational. In other words, lawyers who fail to be sequentially rational by making and carrying out incredible threats will become known for doing so and lose business to lawyers who do not do so. They will lose business because carrying out an incredible threat means by definition that carrying out such a threat hurts the plaintiff.

B. Emotional and Psychological Factors in Strategic Options Analysis

Almost all formal economic models of litigation focus primarily on the monetary incentives to sue, settle, or proceed to a trial. Professors Huang's & Wu's psychological game-theoretic models of litigation provide an exception. Their models demonstrate how emotions such as anger, outrage, and shock can prevent or delay settlement in litigation by changing the incentives of parties to sue, to settle, or to go to trial.¹³⁴ In addition, the United States Supreme

133. Peter H. Huang & Ho-Mou Wu, *Emotional Responses in Litigation*, 12 INT'L REV. L. & ECON. 31, 32 (1992).

134. *Id.* at 32. See also William G. Morrison, *Instincts as Reflex Choice: Does Loss of Temper Have Strategic Value?*, 31 J. ECON. BEHAV. & ORG. 335,

Court described and endorsed the wide-ranging rights of parties to control and participate in their litigation based upon a psychological theory of process-based value to precluding feelings of unjust treatment.¹³⁵ Empirical and experimental psychological research demonstrates that people are more likely to accept an adverse outcome and to believe that an adjudicatory process is fair if they have the opportunity to personally participate in that process, that is, have the adjudicator hear their stories.¹³⁶ Emotional considerations usually predominate in particular legal areas, including, but not necessarily limited to battery, child custody, criminal offenses, defamation, divorce, false imprisonment, intentional infliction of emotional distress, invasion of privacy, medical malpractice, products liability (especially involving bodily injury), and worker's compensation. These areas often involve hot emotions because they involve physical or emotional harms or invasions.

Whether a lawsuit has a positive or negative expected value to a plaintiff, a lawsuit always has net negative expected value to a defendant (ignoring the filing of counterclaims) because of a defendant's litigation costs. Indeed, avoiding such costs is often the rationale for settlement. In reality, it is not just legal costs, but also the opportunity costs, such as the prospective harm to a defendant's reputation, that might lead a defendant to settle a lawsuit by effectively purchasing the plaintiff's litigation continuation options. An often used pejorative term is that of "vexatious litigation." In a well-known quotation from a securities-fraud lawsuit, the Chief Justice of the Supreme Court, William Rhenquist, spoke of the danger of "vexatious litigation" that could result from the prosecution of "a complaint which by objective standards may have

354 (1996) (demonstrating that, in games based upon biological-conflict models, subordinate players can benefit from losing their tempers in asymmetric contests with dominant opponents, and such an instinctual reaction can be robust against evolutionary pressures and persist over time); Glenn Feltham & William G. Morrison, *Civil Disputes, the Allocation of Legal Costs and Emotional Litigation* (1995) (unpublished manuscript on file with author) (modeling the possibility of a plaintiff reacting emotionally to a defendant's low pretrial settlement offer by becoming insulted, losing her temper, and making a reflex choice to proceed to trial instead of settle, regardless of the monetary consequences of her doing so).

135. See *Carey v. Piphus*, 435 U.S. 247, 260-61 (1978) (stating that "a purpose of procedural due process is to convey to the individual a feeling that the government has dealt with him fairly").

136. See, e.g., E. ALLAN LIND & TOM R. TYLER, *THE SOCIAL PSYCHOLOGY OF PROCEDURAL JUSTICE* 26-40, 61-83, 93-127 (1988) (presenting research that examines how procedural factors affect people's perceptions of fairness of dispute resolutions).

very little chance of success at trial” because, among other reasons, “the very pendency of the lawsuit may frustrate or delay normal business activity of the defendant which is totally unrelated to the lawsuit.”¹³⁷ Exactly what constitutes a vexatious lawsuit is debatable in the same manner as precisely what constitutes a frivolous lawsuit. But, certainly, the heated emotional considerations that motivate a plaintiff to use a lawsuit to harass a defendant provide an example of a nonmonetary aspect of vexatious litigation.

A recent set of psychological experiments indicates that decision-makers generally overvalue their options and exhibit a willingness to invest greater effort and larger sums of money to keep options viable, even when such options have little intrinsic value.¹³⁸ The tendencies uncovered experimentally were robust with regard to decision-makers’ experiences, information about outcomes, and saliency about option costs.¹³⁹ In other words, options may offer subjective values exceeding their decision-theoretic value for two psychological reasons. First, people sometimes derive pleasure from merely having the right to choose.¹⁴⁰ This phenomenon is perhaps related to a desire for or illusion of control.¹⁴¹ Second, people sometimes experience loss aversion and a type of endowment effect for options.¹⁴² This phenomenon relates to the phenomenon of litigants experiencing framing effects as described by prospect theory, causing frivolous litigation and lack of settlement during pretrial bargaining.¹⁴³

137. *Blue Chip Stamps v. Manor Drug Stores*, 421 U.S. 723, 740 (1975).

138. Shin & Ariely, *supra* note 15, at 1.

139. Shin & Ariely, *supra* note 15, at 4.

140. *But see* Ziv Carmon et al., *Option Attachment: When Deliberating Makes Choosing Feel Like Losing*, 30 J. CONSUMER RES. 15, 19-20 (2003) (presenting experimental evidence that considering options more closely may induce consumers to become attached to choice options and feel discomfort after choice); Sheena S. Iyengar & Mark R. Lepper, *When Choice is Demotivating: Can One Desire Too Much of a Good Thing*, 79 J. PERSONALITY & SOC. PSYCHOL. 995, 996-1001 (2000) (providing both field and laboratory experimental evidence of participants reporting higher satisfaction when their options were limited).

141. Ellen J. Langer, *Experiment 2: Effects of Choice on the Illusion of Control*, 32 J. PERSONALITY & SOC. PSYCHOL. 311, 315-17 (1975).

142. *Id.* at 312.

143. *See, e.g.*, Chris Guthrie, *Framing Frivolous Litigation: A Psychological Theory*, 67 U. CHI. L. REV. 163, 168 (2000) (proposing that the decision frame in frivolous litigation induces risk-averse behavior in defendants and risk-seeking behavior in plaintiffs); Jeffrey J. Rachlinski, *Gains, Losses, and the Psychology of Litigation*, 70 S. CAL. L. REV. 113, 176 (1996) (suggesting that the utility model of

Finally, the emotional and psychological costs of exercising options in general may prevent people from exercising options that are monetarily inexpensive. For example, most prospective law students probably undervalue the value of beginning a legal education because they ignore their options to drop out. In other words, a student can decide to abandon legal education after the first class, day, week, semester, or year of law school (or in fact anytime before graduation). However, many law students refuse to become legal drop-outs because doing so is too embarrassing or costly in terms of their psyche or ego. As with most options to abandon some course of action, people may feel a compulsion to not be quitters in their own eyes or in those of certain observers, such as family members, friends, or even political constituencies, in the case of politicians who do not want a reputation for being inconsistent. The option to modify a course of action might be less emotionally or psychologically costly than the option to abandon or discontinue a course of action (even though abandonment is a particular form of modification). Thus, a student might not drop out of law school, but might instead choose to change her course of study or legal career path.

In conclusion, litigants experience both cognitive limitations as well as emotional and psychological factors that are not present in strategic options analysis of litigation. There are some reasons to believe that lawyers might experience less of those cognitive limitations and emotional and psychological factors in their decision-making, as compared to their clients. But clearly it would be helpful to conduct further empirical research concerning how lawyers actually behave and theoretical research about how to incorporate cognitive limitations as well as emotional and psychological factors into strategic options analysis of litigation.

IV. OTHER LEGAL APPLICATIONS OF OPTIONS ANALYSIS

This part of the Article focuses on applying options analysis to regulate other litigation options in civil procedure, preclusion law, constitutional law, and family law. Constraints of space and time permit only a brief glimpse of the full potential of these legal applications. Although all the possible applications below only

litigation is less useful in describing the finer details of litigation than behavioral-decision theory).

pertain to civil actions, numerous legal options in the areas of criminal law and procedure, such as options provided by prosecutorial discretion and plea bargaining also exist.

A. Other Litigation Options: An Overview

Thus far, this Article has analyzed lawsuits from the perspective of the options that a plaintiff has to unilaterally abandon or drop litigation. Other litigation options also arise naturally in litigation and civil procedure. For example, some states allow for the practice of additur,¹⁴⁴ in which a court denies a plaintiff's motion for a new trial, conditional on a defendant accepting more liability than a jury awarded. From an options perspective, additur involves a court presenting a defendant with an option to accept more liability than a jury award in exchange for a plaintiff not being permitted to exercise her option to file and to later abandon a new trial.

In the medical malpractice area, Professor Jeffrey O'Connell, along with several co-authors, has proposed a reform plan under which a physician has the option to make a plaintiff an early offer to pay for economic losses in the form of medical expenses and lost wages.¹⁴⁵ In exchange for accepting such an offer, a plaintiff relinquishes her option to file and later to abandon litigation for damages to compensate for non-economic harms, unless that plaintiff can prove that the physician was guilty of gross criminal negligence. Applying options theory provides a qualitative, if not quantitative, analysis of both a physician's option to make such early offers and the forgone value of a patient's option to abandon litigation seeking damages for pain and suffering.

144. Note that the Supreme Court prohibited additur in federal practice as violative of the Seventh Amendment in *Dmick v. Schiedt*, 293 U.S. 474, 478 (1935).

145. See, e.g., Jeffrey O'Connell & Andrew S. Boutros, *Treating Medical Malpractice Claims Under a Variant of the Business Judgment Rule*, 77 NOTRE DAME L. REV. 373 (2002) (comparing the liability of corporate officers with the liability of physicians); Jeffrey O'Connell & Patrick B. Bryan, *More Hippocrates, Less Hypocrisy: "Early Offers" as a Means of Implementing the Institute of Medicine's Recommendations on Malpractice Law*, 15 J.L. & HEALTH 23 (2000-01) (proposing that the current tort system does not promote patient safety); Jeffrey O'Connell & Geoffrey Paul Eaton, *Binding Early Offers as a Simple, If Second-Best, Alternative To Tort Law*, 78 NEB. L. REV. 858 (1999) (arguing for a binding "early offers" neo no-fault system); Jeffrey O'Connell & James F. Neale, *HMO's, Cost Containment, and Early Offers: New Malpractice Threats and A Proposed Reform*, 14 J. CONTEMP. HEALTH L. POL'Y. 287 (1998).

Finally, an options perspective to litigation can provide not only descriptive or positive analysis, but also prescriptive or normative analysis of litigation-related behavior. For example, options theory suggests that a rational and far-sighted manufacturer should factor into the price of her product a per-unit amount for covering the option values of products liability cases, which are larger than merely expected litigation costs or damage awards from defending or settling products liability cases.¹⁴⁶ But if only a single manufacturer in a reasonably competitive market raises her prices to cover the option values, instead of expected values of product liability, then it might price itself out of business relative to its competitors in the short run. Another example of prescriptive or normative analysis comes from realizing that, all other things equal, the deterrence impact of settlements or trials based upon the option values of litigation exceeds the deterrence impact of settlements or trials based upon their expected monetary damage awards.¹⁴⁷ This relative comparison applies equally forcefully to the deterrence of harms from accidents, contract breaches, governmental takings of private property, and nuisances.¹⁴⁸ A final example is to analyze how litigation abandonment options affect Professors George Priest's and Benjamin Klein's selective-litigation hypothesis that a nonrandom sample of cases filed will result in trial.¹⁴⁹

146. See also Blanton, *supra* note 39, at 185 n.135, 186 n.137 (comparing litigation costs to stock options); COOTER & ULEN, *supra* note 16, at 345-46 (noting "the cost of liability will be captured in the price"); MICELI, *supra* note 31, at 29-32 (discussing the accident risk factors involved in product liability cases); A. MITCHELL POLINSKY, AN INTRODUCTION TO LAW AND ECONOMICS, 97-98, 98 tbl. 11 (3d ed. 2003) (providing a hypothetical numerical example of the price of a product including expected accident losses).

147. See, e.g., A. Mitchell Polinsky & Daniel L. Rubinfeld, *The Deterrent Effects of Settlements and Trials*, 8 INT'L REV. L. & ECON. 109, 110-12 (1988) (discussing the social desirability of deterrence provided by trials).

148. Robert D. Cooter, *Unity in Tort, Contract, and Property: The Model of Precaution*, 73 CAL. L. REV. 1, 3-5 (1985).

149. George L. Priest & Benjamin Klein, *The Selection of Disputes for Litigation*, 13 J. LEGAL STUD. 1 (1984). See also Theodore Eisenberg, *Testing the Selection Effect: A New Theoretical Framework with Empirical Tests*, 19 J. LEGAL STUD. 337 *passim* (1990) (presenting a theory for testing major litigation models); Keith N. Hylton, *Asymmetric Information and the Selection of Disputes for Trial*, 22 J. LEGAL STUD. 187 *passim* (1993) (presenting a selection of disputes theory that does not require information on the identity of the litigants); MICELI, *supra* note 31, at 158-59 (discussing the 50% rule for selection of disputes); George L. Priest, *Reexamining the Selection Hypothesis: Learning from Wittman's Mistakes*, 14 J. LEGAL STUD. 215 *passim* (1985) (restating the selection hypothesis for predicting which suits will be settled); L. Stanley & Don Coursey, *Empirical*

B. *Precluding Legal Options*

This Article demonstrates that many procedural and substantive legal rules provide options that are valuable because they provide flexibility. It is well known, conversely, that inflexibility can be advantageous in strategic bargaining.¹⁵⁰ Economists and game theorists often speak of people utilizing (pre)commitment devices to improve their bargaining position; for example, automobile salespeople, one member of a couple, and employers often claim their hands are tied. An options perspective about law also reveals that numerous legal doctrines and rules increase the price of, if not preclude, certain other legal options. For example, both the Model Code of Professional Responsibility and the Model Rules of Professional Conduct preclude certain behavior that would otherwise be available to lawyers as options. For another example, both state and federal sovereigns have developed a number of self-limitation doctrines and statutes that prevent them from exercising their full adjudicatory, constitutional authority over non-local cases.¹⁵¹ Most prominent among these subconstitutional restrictions

Evidence on the Selection Hypothesis and the Decision to Litigate or Settle, 19 J. LEGAL STUD. 145 *passim* (1990) (using experimental methods to test the Priest and Klein hypothesis and other hypotheses on the private choice to litigate or settle); Robert F. Thomas, *The Trial Selection Hypothesis without the 50 Percent Rule: Some Experimental Evidence*, 24 J. LEGAL STUD. 209 *passim* (1995) (testing the Priest-Klein selection effect); Joel Waldfogel, *The Selection Hypothesis and the Relationship Between Trial and Plaintiff Victory*, 103 J. POL. ECON. 229 *passim* (1995) (developing implications of the selection hypothesis of Priest and Klein for the relationship between trial rates and plaintiff win rates); Joel Waldfogel, *Selection of Cases for Trial*, in 3 THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 419 (Peter Newman ed., 1998) (comparing Priest and Klein's selective litigation hypothesis with the alternative asymmetric information ("AI") theory); Donald Wittman, *Is the Selection of Cases for Trial Biased?*, 14 J. LEGAL STUD. 185 *passim* (1985) (proposing an alternative model to Priest and Klein's hypothesis that reaches contrary conclusions about the litigation process); Donald Wittman, *Dispute Resolution, Bargaining, and the Selection of Cases for Trial: A Study of the Generation of Biased and Unbiased Data*, 17 J. LEGAL STUD. 313 *passim* (1988) (identifying case characteristics that influence the selection of cases for trial).

150. See generally JOHN McMILLAN, GAMES, STRATEGIES, AND MANAGERS 53-57 (1992) (outlining the benefits of "commitment strategy" and different methods: staking your reputation, hiring agents required to follow narrow procedures, burning bridges, etc.).

151. See generally KEVIN M. CLERMONT, CIVIL PROCEDURE: TERRITORIAL JURISDICTION AND VENUE 27 (1999) (discussing the law of venue as an example of state and federal self-limitation on authority to adjudicate).

on geographic forum selection are the laws of venue and forum non conveniens.¹⁵²

1. Applying Options Theory to Res Judicata and Collateral Estoppel

Another example of this concept is found in the judicially-created doctrines of collateral estoppel and res judicata. Collateral estoppel, also known as issue preclusion, prevents the same issues from being relitigated in subsequent lawsuits. For the doctrine of collateral estoppel to preclude an issue, that issue must be identical, actually litigated, decided, and necessary for the court's judgment in a prior lawsuit.¹⁵³ The standard first-year law-school civil procedure casebook's explanation of the reasons behind collateral estoppel and res judicata is achieving finality or the repose of judgments.¹⁵⁴ Another traditional rationale for both collateral estoppel and res judicata is judicial economy.¹⁵⁵ Finally, decisional consistency is often cited as an additional benefit of collateral estoppel and res judicata.¹⁵⁶ But collateral estoppel and res judicata both also influence the settlement values of litigation. Professor Bruce L. Hay argues that collateral estoppel and res judicata both function to better align the settlement values of lawsuits with their merits.¹⁵⁷ The few economic analyses of collateral estoppel and res judicata do not specifically analyze these judicial doctrines as explicitly proscribing future litigation options.¹⁵⁸ The perspective of

152. *Id.* at 27-30.

153. RESTATEMENT (SECOND) OF JUDGMENTS § 27 (1982).

154. *See generally* BARBARA ALLEN BABCOCK & TONI M. MASSARO, CIVIL PROCEDURE: CASES AND PROBLEMS 1087 (2d ed. 2001); Bruce L. Hay, *Some Settlement Effects of Preclusion*, 21 U. ILL. L. REV. 21, 23 n.8 (1993); ALLAN IDES & CHRISTOPHER N. MAY, CIVIL PROCEDURE: CASES AND PROBLEMS 1093 (2003); LINDA SILBERMAN & ALAN R. STEIN, CIVIL PROCEDURE: THEORY AND PRACTICE 725 (2001); STEPHEN N. SUBRIN ET AL., CIVIL PROCEDURE: DOCTRINE, PRACTICE, AND CONTEXT 884 (2000); STEPHEN C. YEAZELL, CIVIL PROCEDURE 797 (5th ed. 2000) (stating the reasons for procedural rules).

155. Hay, *supra* note 154, at 23 n.10 (citing ALLAN D. VESTAL, RES JUDICATA/PRECLUSION V-10 to V-11 (1969)).

156. BONE, *supra* note 9, at 233-34.

157. Hay, *supra* note 154, at 31-51.

158. *See* Hay, *supra* note 154 (explaining how preclusion rules encourage settlement); Note, *Exploring the Extortion Gap: An Economic Analysis of the Rules of Collateral Estoppel*, 105 HARV. L. REV. 1940 *passim* (1992) (comparing the effects of three preclusion doctrinal regimes); RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 593-95 (6th ed. 2003) (analyzing incentives of the preclusion

this Article suggests analyzing the preclusion rules of collateral estoppel and res judicata specifically from an options perspective, which is beyond the scope of this Article.

2. Applying Options Theory to the Proposal and Ratification of Constitutional Amendments

The political value of precluding some amendment options also helps to explain the supermajoritarian requirements for the proposal and ratification of constitutional amendments.¹⁵⁹ The United States Constitution requires that at least two-thirds of both houses of Congress vote to propose a constitutional amendment.¹⁶⁰ Alternatively, two-thirds of the state legislatures must petition Congress to call a constitutional convention.¹⁶¹ The second method of proposing a constitutional amendment never has been utilized. In addition, the United States Constitution requires three-quarters of the state legislatures or state conventions to ratify a Constitutional amendment.¹⁶² The only amendment ratified by state conventions was the Twenty-first Amendment, which repealed Prohibition.¹⁶³ Although over eleven thousand constitutional amendments have been introduced in Congress since 1793, only thirty-three of these have received the requisite two-thirds vote of Congress to be submitted to the states for ratification.¹⁶⁴ Of those, six never were ratified, including, most notably, the Equal Rights Amendment

regimes); Stephen J. Spurr, *An Economic Analysis of Collateral Estoppel*, 11 INT'L REV. L. & ECON. 47 *passim* (1991) (analyzing alternative proposed rules of collateral estoppel); Stephen J. Spurr, *Collateral Estoppel*, in 1 THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 289 (Peter Newman ed., 1998) (defining the preclusion doctrine in terms of stability and certainty). *But see* Brainerd Currie, *Mutuality of Collateral Estoppel: Limits of the Bernhard Doctrine*, 9 STAN. L. REV. 281, 285 (1957) (criticizing "the multiple claimant anomaly" that can arise with nonmutual offensive collateral estoppel by utilizing a hypothetical involving 50 potential plaintiffs injured by a train wreck); Jack Ratliff, *Offensive Collateral Estoppel and the Option Effect*, 67 TEX. L. REV. 63, 74, 77-95 (1988) (discussing the unfairness of the litigation options that plaintiffs have under offensive nonmutual collateral estoppel).

159. AVINASH K. DIXIT & ROBERT S. PINDYCK, INVESTMENT UNDER UNCERTAINTY 25 (1994).

160. U.S. CONST. art. V.

161. *Id.*

162. *Id.*

163. U.S. CONST. amend. XXI.

164. LINDA R. MONK, THE WORDS WE LIVE BY: YOUR ANNOTATED GUIDE TO THE CONSTITUTION 116 (2003).

proposed in 1972 and, most recently, the D.C. Voting Rights Amendment proposed in 1978.¹⁶⁵ The constitutional amendment process “guards equally against that extreme facility, which would render the Constitution too mutable; and that extreme difficulty, which might perpetuate its discovered faults.”¹⁶⁶

3. Applying Options Theory to Judicial Decision-Making

A similar concern about precluding judicial and legislative options helps explain why the current United States Supreme Court engages in judicial minimalism.¹⁶⁷ Deciding a particular case not only decides that case on its merits, but it also affects future activity, behavior, and cases via precedent and the resulting effects on incentives. In addition, the principles of analogical reasoning and the demands of logical consistency mean that any judicial decision might constrain or preclude future, related judicial or legislative options to make decisions about related legal issues.

4. Applying Options Theory to Family Law

Finally, as Professors Dixit and Pindyck suggested in their book:

Marriage entails significant costs of courtship, and divorce has its own monetary and emotional costs. Happiness or misery within the marriage can be only imperfectly forecast in advance, and continues to fluctuate stochastically even after the event. Therefore waiting for a better match has an option value.¹⁶⁸

This Article suggests analyzing family law statutes in terms of how they regulate the options to marry or divorce. For example, the family law statutes of many states require couples to wait for a

165. *Id.*

166. THE FEDERALIST NO. 43, at 275 (James Madison) (G. P. Putnam's Sons ed., 1888).

167. See, e.g., CASS R. SUNSTEIN, ONE CASE AT A TIME: JUDICIAL MINIMALISM ON THE SUPREME COURT (1999) (discussing examples and explanations of judicial minimalism).

168. DIXIT & PINDYCK, *supra* note 159, at 24.

specified period of time after the application for a marriage certificate before its issuance.¹⁶⁹ Symmetrically, some of these states also stipulate that a couple may not divorce until after the passage of a mandatory waiting period, which usually exceeds the mandatory prenuptial waiting period.¹⁷⁰ One can understand both types of family law statutes as raising the waiting time or non-monetary price of, if not precluding, certain marriage or divorce options. The debate over whether a state will legally recognize the marriage of gay and lesbian couples effectively concerns whether a state will preclude legal marriage options and the attendant legal rights (themselves options) that follow. In fact, legal rights in general are options their owners may choose not to exercise because of either low payoffs or high costs of exercising them.

V. CONCLUSIONS

This Article introduces a new options game-theoretic model of possibly frivolous litigation. This novel theory is a hybrid approach that combines an options approach to litigation incentives and game-theoretic models of pretrial settlement negotiations. This Article derives a set of necessary and sufficient conditions for the credible threatening and filing of possibly frivolous litigation based on whether the option values from abandoning litigation exceed the cost of those litigation abandonment options. Similarly, defendants only settle those possibly frivolous lawsuits with initial positive net (of the cost of litigation) abandonment-option values. This Article also considers limitations of strategic litigation-options analysis. Finally, this Article very briefly introduces other applications of options analysis to law by pointing out other litigation options and preclusions of legal options in various legal areas.

The technical details of this new options game-theoretic model of possibly frivolous litigation are presented in Appendix B of this Article. But the intuition of this new model is captured by the numerical example presented in the Introduction. The procedural

169. See, e.g., 23 PA. CONS. STAT. ANN. § 1303(a) (West 2001) (“No marriage license shall be issued prior to the third day following the making of application therefor.”).

170. See, e.g., 23 PA. CONS. STAT. ANN. § 3301(d) (West 2001) (stating that a married couple must allege that their marriage is irretrievably broken, file affidavits that each party consents to a divorce, and wait ninety days after commencing such action before the court may grant a divorce).

fact that both Federal Rule of Civil Procedure 41(a)(1)(i) and its state counterparts provide a plaintiff with the option to unilaterally and voluntarily abandon her lawsuit under certain circumstances without prejudice provides plaintiffs litigation abandonment options with value. If those positive option values exceed a plaintiff's expected litigation costs, then a plaintiff will credibly threaten to and will file a lawsuit. This Article develops a formal mathematical theory of how to value a plaintiff's litigation abandonment options.

APPENDIX A: AN OPTIONS PRIMER

What do buying a house, having children, and recalling the governor of California have in common? These three seemingly unrelated experiences all involve not only sequential decision making,¹⁷¹ but also exercising or preserving various options. House hunting may involve looking over many houses that differ along numerous dimensions.¹⁷² These differences mean that it can be difficult for a buyer to compare houses in order to determine an optimal stopping rule for house shopping.¹⁷³ Passing on a particular house preserves options to buy other houses, but risks losing an option to buy that particular house later. Multiple potential buyers might express interest in a particular house and end up bidding against each other. A bidding contest over a house means that a potential buyer has fewer negotiating options because she may feel she has to make her initial bid her best offer, instead of engaging in a series of negotiating rounds. Deciding to bid on, and then possibly losing bids on, houses can become an emotional roller coaster.¹⁷⁴ The purchase of a home is part of the American dream, but for most Americans, their home is their most expensive purchase (at least, until then). Thus, most (at least first-time) home buyers finance part of the price of their purchase by taking out a mortgage. Virtually every home mortgage grants a homeowner the option to pay off the mortgage early without any penalties for prepayment.¹⁷⁵

Whether and when to have children, as well as how many to have, are various options that people face. Before (and even after) a child is conceived, there are numerous options regarding birth

171. See generally ERIC V. DENARDO, *DYNAMIC PROGRAMMING: MODELS AND APPLICATIONS* 2-3 (2d ed. 2003) (describing the ubiquitous nature of sequential decision making).

172. See generally *House Hunters* (HGTV television broadcast) (depicting the actual house-searching experiences of various first-time home buyers).

173. ROBERT H. FRANK, *MICROECONOMICS AND BEHAVIOR* 288 (5th ed. 2003) (explaining that experienced realtors often show their clients two nearly identical houses, one of which is both in better condition and less expensive than the other, in order to provide their clients with the opportunity to make an easy decision).

174. MARY FRANCES LUCE ET AL., *EMOTIONAL DECISIONS: TRADEOFF DIFFICULTY AND COPING IN CONSUMER CHOICE* 2-9 (2001) (detailing the emotional difficulties that consumers face in deciding among consumption alternatives).

175. See 15 U.S.C. § 1639(c)(1)(A) (2000) (prohibiting penalties for prepayment of principal prior to due date).

control. Conception can be assisted by reproductive and genetic technologies.¹⁷⁶ Once a child is conceived, many options exist regarding prenatal care, whether to carry the child to full term, and methods of delivery. But, while a woman is pregnant, she does not have the option to become pregnant again until after her first pregnancy concludes. In addition, numerous adoption options exist.¹⁷⁷ After a child is born, parents have fewer options in terms of alternative joint activities or purchases. Finally, numerous child-rearing options exist. Of course, children have options to have their own children.

California's 2003 gubernatorial recall election was authorized by the California Constitution provision that provides California voters with options to recall their elected officials.¹⁷⁸ Some social observers and political commentators feared that California's recall election set a dangerous precedent because it could lead to voters exercising their options to hold recall elections of any elected officials who make unpopular decisions.¹⁷⁹ As a result, elected officials may come to engage in perpetual campaigning, and elections might degenerate into no more than contests of personality or popularity. But, fifteen states, the District of Columbia, Guam, and the Virgin Islands already have laws that provide their voters with options to recall elected state officials, and thirty-six states have laws that provide their voters with options to recall various local officials.¹⁸⁰ In fact, a Gallup Poll conducted in 1987 found that 67% of a nationwide sample of 1009 people supported amending the United States Constitution to provide for the recall of members of Congress, and 55% of that same sample supported a constitutional amendment providing for the recall of the President.¹⁸¹ Only one-

176. See, e.g., Peter H. Huang, *Herd Behavior in Designer Genes*, 34 WAKE FOREST L. REV. 639 (1999) (applying economic perspectives to understand the ethical, legal, and social issues of rerogenetic technologies for trait-enhancement selection).

177. See, e.g., Elisabeth M. Landes & Richard A. Posner, *The Economics of the Baby Shortage*, 7 J. LEGAL STUD. 323 (1978) (describing the current adoption system and analyzing how the world would look if there were a free market in babies).

178. CAL. CONST. art. II, §§ 13-18.

179. But see Richard Thompson Ford, *Love It: The Recall is Pure Democracy*, SAN JOSE MERCURY NEWS, Aug. 14, 2003, at <http://www.bayarea.com/mld/mercurynews/6529726.htm> (criticizing poor arguments against a recall of California's Governor Gray Davis).

180. THOMAS E. CRONIN, DIRECT DEMOCRACY: THE POLITICS OF INITIATIVE, REFERENDUM, AND RECALL 125, 126-27 tbl. 6.1 (1989).

181. *Id.* at 132 tbl. 6.2.

third of those polled opposed the idea of recalling nationally elected officials.¹⁸²

Another common feature of buying a house, having children, and recalling the governor of California is risk. In fact, virtually every decision involves an element of risk. Attorneys, their clients, elected officials, judges, jurors, legislators, litigants, negotiators, regulators, and voters face various risks, including those arising from appellate, contractual, electoral, financial, judicial, legislative, regulatory, statutory, and technological sources. It is increasingly critical for such decision-makers to respond effectively to such risks. Just as omnipresent as risks are the methods by which individuals, organizations, and institutions cope or deal with risks, including diversifying, hedging, insuring, and learning. In a sense, (payoff-relevant) information can be thought of as the reduction of risk or the negative of risk.

One particular method of handling risks is by utilizing options. An option provides its holder with a right, as opposed to an obligation, to choose some action in the future. The word option “comes from the medieval French and is derived from the Latin *optio*, *optare*, meaning to choose, to wish, to desire.”¹⁸³ Options are valuable from a decision-theoretic perspective when there are unresolved risks because they provide the flexibility not to be locked into an irreversible course of action. In other words, options have no value if there is no risk and decisions are reversible.¹⁸⁴ After all, risks involve not only dangers, but also opportunities.¹⁸⁵ Options allow those facing risky environments to profit from the upside potential of the risks they face, while truncating losses from the downside possibility. Options thus offer asymmetric, kinked, or non-linear payoffs because options permit actors to make future decisions after learning relevant information concerning the risks they face.

A few legal scholars already have begun to apply options analysis to study legal rules and institutions.¹⁸⁶ But financial

182. *Id.* at 133.

183. BRACH, *supra* note 72, at 1.

184. VOLLERT, *supra* note 12, at 7-8.

185. The Chinese character for crisis is composed of two ideograms: those for “danger” and “opportunity.”

186. See, e.g., Huang, *supra* note 43, at 1945 (developing an options-based theory of calculating attorney’s fees); Huang, *supra* note 45, at 571 (proposing the introduction of the option perspective in teaching corporate law); Mark Klock, *Is It “The Will of the People” or a Broken Arrow? Collective Preferences, Out-of-the-Money Options, Bush v. Gore, and Arguments for Quashing Post-Balloting*

economists and management scholars have been studying options theory and its applications in the practice of financial engineering and management science for over a quarter of a century.¹⁸⁷ Options

Litigation Absent Specific Allegations of Fraud, 57 U. MIAMI L. REV. 1, 4 (2002) (comparing the 2000 presidential election and financial options); Michael S. Knoll, *Put-Call Parity and the Law*, 24 CARDOZO L. REV. 61, 63 (2002) (showing how the put-call parity theorem can be utilized to evade a wide range of rules); Michael S. Knoll, *Products Liability and Legal Leverage: The Perverse Effects of Stiff Penalties*, 45 UCLA L. REV. 99, 100 (1997) (describing cases in which stiffer penalties encourage companies to produce and sell risky products); Paul G. Mahoney, *Contract Remedies and Options Pricing*, 24 J. LEGAL STUD. 139 *passim* (1995) (using options theory to examine the choice between money damages and specific performance); Richard A. Nagareda, *Autonomy, Peace, and Put Options in the Mass Tort Class Action*, 115 HARV. L. REV. 749, 755-58 (2002) (building the case for mass tort settlements structured as a trade of punitive damages for put options); Klaus M. Schmidt, *Contract Renegotiation and Options Contracts*, in 1 THE NEW PALGRAVE DICTIONARY OF ECONOMICS AND THE LAW 432, 432 (Peter Newman ed., 1998) (describing the important properties of option contracts); Alexander J. Triantis & George G. Triantis, *Timing Problems in Contract Breach Decisions*, 41 J. L. & ECON. 163, 165 (1998) (providing a model of the private incentives for the timing of anticipatory repudiation).

187. See generally MARTHA AMRAM, VALUE SWEEP: MAPPING CORPORATE GROWTH OPPORTUNITIES 49-64 (2002) (describing how real options can be used to value potential); Martha Amram & Nalin Kulatilaka, *Disciplined Decisions: Aligning Strategy with the Financial Markets*, HARV. BUS. REV., Jan.-Feb. 1999, at 95-96 (describing how to make disciplined decisions, including using options to mitigate risks); F. Peter Boer, *Valuation of Technology Using Real Options*, RES. TECH. MGMT., July-Aug. 2000, at 27 (describing how real options have been used in the valuation of oil production); BRACH, *supra* note 72, at 67-103 (discussing managerial options); RICHARD A. BREALEY & STEWART C. MYERS, PRINCIPLES OF CORPORATE FINANCE 268-76 (7th ed. 2003) (describing the relationship between the risk associated with an investment and its expected return); RICHARD A. BREALEY & STEWART C. MYERS, CAPITAL INVESTMENT AND VALUATION 429-49 (2003) (describing real options found in investment projects); Michael J. Brennan & Eduardo S. Schwartz, *Evaluating Natural Resource Investments*, 58 J. BUS. 135, 135 (1985) (applying option theory to evaluate the soundness of resource investments); Michael J. Brennan & Lenos Trigeorgis, *Real Options: Development and New Contributions*, in PROJECT FLEXIBILITY, AGENCY, AND COMPETITION 2-3 (Michael J. Brennan & Lenos Trigeorgis eds., 2000) (recognizing that options theory in financial markets has been in use since the 1960s); Andrew H. Chen et al., *Valuing Flexible Manufacturing Facilities as Options*, 38 Q. REV. ECON. & FIN. 651, 651 (1998) (applying option pricing methods to evaluating equipment such as computer-controlled machine tools); Thomas E. Copeland & Philip T. Keenan, *Making Real Options Real*, MCKINSEY Q., June 1998, at 128, 129 (describing the mainstream economic utility of option valuation); TOM COPELAND & VLADIMIR ANTIKAROV, REAL OPTIONS: A PRACTITIONER'S GUIDE 5 (2001) (explaining the definition of real options); Peter Coy, *Exploiting Uncertainty*, BUS. WK., June 7, 1999, at 118 (describing how real options are used in business decision-making); Avinash Dixit, *Investment and Hysteresis*, J. ECON. PERSP.,

Winter 1992, at 107, 108 (observing optimal inertia for dynamic decision-making in an uncertain environment); Avinash Dixit & Robert S. Pindyck, *The Options Approach to Capital Investment*, HARV. BUS. REV., May-June 1995, at 105 (discussing use of options in capital investments); AVINASH K. DIXIT & ROBERT S. PINDYCK, INVESTMENT UNDER UNCERTAINTY (1994) (describing the options approach as a way to optimize investments); Glenn Hubbard, *Investment Under Uncertainty: Keeping One's Options Open*, 32 J. ECON. LITERATURE 1816 (1994) (analyzing the book INVESTMENT UNDER UNCERTAINTY by Avinash Dixit and Robert S. Pindyck, previously referenced in this footnote); Keith J. Leslie & Max P. Michaels, *The Real Power of Real Options*, MCKINSEY Q., June 1997, at 4, 5-6 (noting the applicability of options to other strategic situations); Timothy A. Luehrman, *Investment Opportunities as Real Options: Getting Started on the Numbers*, HARV. BUS. REV., July-Aug. 1998, at 51 ("The analogy between financial options is . . . increasingly well accepted."); Timothy A. Luehrman, *Strategy as a Portfolio of Real Options*, HARV. BUS. REV., Sept.-Oct. 1998, at 90 (exploring how option pricing can be used to improve decision-making about strategic investments); DAVID G. LUENBERGER, INVESTMENT SCIENCE 337-43 (1998) (providing an explanation for evaluating investment opportunities using real options); Scott Mason & Robert C. Merton, *The Role of Contingent Claims in Corporate Finance*, in RECENT ADVANCES IN CORPORATE FINANCE 34 (Edward Altman & Marti G. Subrahmanyam eds., 1985) (applying an options-evaluation framework to the strategic issue of sequencing investment projects); Robert McDonald & Daniel Siegel, *Investment and the Valuation of Firms when There is An Option to Shut Down*, 26 INT'L ECON. REV. 331 (1985) (noting the effects of a shut-down option in a plant when future revenues or costs are uncertain); Nancy A. Nichols, *Scientific Management at Merck: An Interview with CFO Judy Lewent*, HARV. BUS. REV., Jan.-Feb. 1994, at 88, 90-91 (noting that option analysis is a useful tool for valuing pharmaceutical research investments); Robert S. Pindyck, *Irreversibility, Uncertainty, and Investment*, 29 J. ECON. LITERATURE 1110, 1114-15 (1991) (comparing investment opportunities to a call option stock); REAL OPTIONS AND INVESTMENT UNDER UNCERTAINTY: CLASSICAL READINGS AND RECENT CONTRIBUTIONS *passim* (Eduardo S. Schwartz & Lenos Trigeorgis eds., 2001) (covering a variety of topics related to uncertain investments and real options); Alex Triantis & Adam Borison, *Real Options: State of the Practice*, J. APPLIED CORP. FIN., Summer 2001, at 8 *passim* (discussing effectiveness of options analysis due to its recognition that future decisions to maximize value depend on new information); Alexander J. Triantis & James E. Hodder, *Valuing Flexibility as a Complex Option*, 45 J. FIN. 549, 549 (1990) (noting that "[c]ontingent claims pricing techniques have been used to value a project's . . . 'real options'"); Lenos Trigeorgis, *Real Options and Interactions with Financial Flexibility*, FIN. MGMT., Autumn 1993, at 202, 203-16 (1993) (providing overview of real options literature and presenting principles for quantifying the value of various real options); REAL OPTIONS IN CAPITAL INVESTMENT: MODELS, STRATEGIES, AND APPLICATION *passim* (Lenos Trigeorgis ed., 1995) (integrating new contributions to the growing real options literature); LENOS TRIGEORGIS, REAL OPTIONS: MANAGERIAL FLEXIBILITY AND STRATEGY IN RESOURCE ALLOCATION 227-71 (1996) (exploring generally the interactions among multiple real options); W. Carl Kester, *Today's Options for Tomorrow's Growth*, HARV. BUS. REV., Mar.-Apr. 1984, at 153, 154 (describing future investment opportunities as analogous to ordinary call options on securities).

are classified as financial or real.¹⁸⁸ Financial options are contracts that give their holders the right, but not an obligation, to buy (or sell) a particular quantity of some underlying financial asset at a certain price on (or before) a certain date.¹⁸⁹ Examples of underlying financial instruments on which options are written include bonds, stocks, commodities (such as corn, soybeans, wheat, gold, or silver) futures contracts, foreign currencies, or stock indices. A vast literature addresses the financial theory, institutional details, pricing models, regulation, and valuation of various financial options.¹⁹⁰

Because options concepts, ideas, and terminology may not be familiar to some readers, this appendix offers a brief overview about options in general.¹⁹¹ A call option provides its owner with the right, but not an obligation, to buy a specified quantity of some underlying item at some price called the strike or exercise price.¹⁹² A put option provides its owner with the right, but not an obligation, to sell a specified quantity of an underlying item at some price called the strike or exercise price.¹⁹³ An option's price is called its premium in order to avoid confusion with exercise or strike prices.¹⁹⁴ An option is at-the-money if the current price of the item equals the strike price. A call option is out-of-the-money (respectively, in-the-money) if the current price of the underlying item the option is written on is less (respectively, greater) than its exercise price. Similarly, a put option is out-of-the-money (respectively, in-the-money) if the current price of the underlying item the option is written on is greater (respectively, less) than its exercise price.

The intrinsic value of a call (respectively, put) option is the difference between the current price of the underlying item on which the option is written and the strike price (respectively, the difference

188. BRACH, *supra* note 72, at 1.

189. WILLIAM L. MEGGINSON, *CORPORATE FINANCE THEORY* 226 (1997).

190. For institutional details about financial options and their regulation, see generally Peter H. Huang, *A Normative Analysis of New Financially Engineered Derivatives*, 73 S. CAL. L. REV. 471 (2000); Roberta Romano, *A Thumbnail Sketch of Derivative Securities and Their Regulation*, 55 MD. L. REV. 1, 41-47 (1996). For the financial theory of and pricing models for stock options, see generally RICHARD A. BREALEY & STEWART C. MYERS, *FINANCING AND RISK MANAGEMENT* 181-208 (2003) (explaining how to spot and value financial options).

191. See, e.g., Huang, *supra* note 43, at 1943-47 (providing a more detailed introduction to options).

192. BLACK'S LAW DICTIONARY 204-205 (6th ed. 1990).

193. *Id.* at 1094.

194. *Id.*

between the strike price and the current price of the underlying item that the option is written on). Even an option that is currently out-of-the-money has a positive (although possibly, very small) value because of its time value. The time value of an option will be positive (although possibly, very small) as long as the option has not yet expired because, in the remaining time before its expiration, an option may finish in-the-money. It is, of course, true, symmetrically, that an option may finish out-of-the-money. But, because options do not require their owners to buy or sell the underlying items on which the options are written, rational option holders will simply choose not to exercise options that are out-of-the-money. The flexible nature of an option explains why, intuitively, an option always has a value that is nonnegative, gross of the option premium, because the holder of an option can decide not to exercise the option.

Financial options permit decision-makers to hedge financial types of risk such as those arising from fluctuations in stock prices, interest rates, or currency rates.¹⁹⁵ Financial options are a type of state-contingent securities. Professor Kenneth J. Arrow, a recipient of the 1972 Nobel Prize in Economics, introduced the concept and theory of state-contingent securities in a paper that he presented in 1952.¹⁹⁶ Many of today's exotic financial derivatives that Wall Street investment banks create, such as catastrophe bonds (whose payoffs are linked to natural disasters such as earthquakes and hurricanes),¹⁹⁷ utilize Professor Arrow's work.¹⁹⁸ Professor Robert J. Shiller has proposed the creation of even more contingent securities markets to hedge aggregate-income risks, home-price risks, income-distribution-inequality risks, intergenerational risks, international risks, and livelihood risks.¹⁹⁹ Professor Stephen A. Ross proved that, under certain assumptions, trading simple financial call and put options written on a single index of existing securities

195. See generally Peter H. Huang, *Securities Price Risks and Financial Derivative Markets*, 21 NW. J. INT'L L. & BUS. 589 (2001) (discussing how financial options permit decision-makers to hedge financial risks).

196. Kenneth Joseph Arrow, *The Role of Securities in the Optimal Allocation of Risk Bearing*, 31 REV. ECON. STUD. 91 (1964) (providing English translation of original paper).

197. HAL R. VARIAN, *INTERMEDIATE MICROECONOMICS: A MODERN APPROACH* 219-20 (6th ed. 2003).

198. Arrow, *supra* note 196, *passim*.

199. See generally ROBERT J. SHILLER, *MACRO MARKETS: CREATING INSTITUTIONS FOR MANAGING SOCIETY'S LARGEST ECONOMIC RISKS* *passim* (1993) (proposing creation of markets to hedge economic risks); ROBERT J. SHILLER, *THE NEW FINANCIAL ORDER: RISK IN THE 21ST CENTURY* *passim* (2003) (proposing new risk management infrastructure to secure economic gain).

can realize any possible desired pattern of payoffs across contingencies and over time.²⁰⁰

Financial options have revolutionized modern financial markets by facilitating the reallocation of underlying financial market risks. The 1997 Nobel Prize in Economics recognized the path-breaking financial option-pricing models of Professors Fisher Black, Robert C. Merton, and Myron S. Scholes.²⁰¹ Widely publicized, huge losses from trading in financial options by well-known corporations such as Barrings Bank, Dell Computer, Gibson Greetings, and Procter & Gamble;²⁰² municipalities such as Orange County, California;²⁰³ and hedge funds such as Long-Term Capital Management (LTCM)²⁰⁴ illustrated the potential dangers from

200. Stephen A. Ross, *Options and Efficiency*, 90 Q.J. ECON. 75, 84-86 (1976). See also Fred Arditti & Kose John, *Spanning the State Space with Options*, 15 J. FIN. & QUANTITATIVE ANALYSIS 1 *passim* (1980) (strengthening Ross's theorem); Kose John, *Efficient Funds in a Financial Market with Options: A New Irrelevance Proposition*, 36 J. FIN. 685 *passim* (1981) (extending and generalizing Ross's theorem); Rolf W. Banz & Merton H. Miller, *Prices for State-Contingent Claims: Some Estimates and Applications*, 51 J. BUS. 653, 653 (1978) (presenting a method "for making risk adjustments in practical capital budgeting applications"); Douglas T. Breeden & Robert H. Litzenberger, *Prices of State-Contingent Claims Implicit in Option Prices*, 51 J. BUS. 621, 622 (1978) (applying Ross's theorem). See generally Huang, *supra* note 190, at 477 (explaining the financial engineering implications of Ross's theorem).

201. See generally Fischer Black & Myron S. Scholes, *The Pricing of Options and Corporate Liabilities*, 81 J. POL. ECON. 637 (1973) (developing a theoretical valuation formula for call options); Robert C. Merton, *Theory of Rational Option Pricing*, 4 BELL J. ECON. 141, 141 (1973) (discussing "the further extension of the theory to the pricing of corporate liabilities"). See Robert A. Jarrow, *In Honor of the Nobel Laureates Robert C. Merton and Myron S. Scholes: A Partial Differential Equation That Changed the World*, J. ECON. PERSP., Fall 1999, at 229 (explaining the many contributions and ramifications of Black-Merton-Scholes option pricing theory); JOHN SUTTON, MARSHALL'S TENDENCIES: WHAT CAN ECONOMISTS KNOW? 35-47 (2000) (explaining how and why option pricing models are so successful).

202. Brandon Becker & Jennifer Yoon, *Derivative Financial Losses*, 21 J. CORP. L. 215, 216-18 (1995) (listing examples of financial losses that have been described by the press as related to financial derivative instruments).

203. PHILLIPE JORION, BIG BETS GONE BAD: DERIVATIVES AND BANKRUPTCY IN ORANGE COUNTY *passim* (1995).

204. Franklin R. Edwards, *Hedge Funds and the Collapse of Long-Term Capital Management*, J. ECON. PERSP., Spring 1999, at 189, 197-200; ROGER LOWENSTEIN, WHEN GENIUS FAILED: THE RISE AND FALL OF LONG-TERM CAPITAL MANAGEMENT 163 (2000); NICHOLAS DUNBAR, INVENTING MONEY: THE STORY OF LONG-TERM CAPITAL MANAGEMENT AND THE LEGENDS BEHIND IT 197-230 (2000).

speculation in financial options.²⁰⁵ Recently, many commentators have questioned whether incentive compensation in the form of executive stock options contributed to the series of corporate fraud and mismanagement scandals, and whether companies should expense their executive stock options.²⁰⁶

Real options involve decisions concerning activities whose risks have not been completely reduced to financial assets or financial commodities.²⁰⁷ Real options are so named to differentiate them from financial options such as well-known executive stock options.²⁰⁸ The phrase “real options” in corporate finance refers to the options that managers have to add value to an organization by adjusting its production plans;²⁰⁹ alter capacity, output levels, or scale of operations; break up, divide, or partition investment opportunities; defer before (further) investing; switch inputs, outputs, or production methods; and grow from a pilot project.²¹⁰ Indeed, any dynamic investment opportunity presents a sequence of real options.²¹¹ For example, business-deal-making negotiations entail

205. See Peter H. Huang et al., *Derivatives on TV: A Tale of Two Derivatives Debacles in Prime-Time*, 4 GREEN BAG 2D 257 (2001) (comparing alternative depictions of the dangers of derivatives in two television programs).

206. See, e.g., FRANK PARTNOY, *INFECTIOUS GREED: HOW DECEIT AND RISK CORRUPTED THE FINANCIAL MARKETS* 156-60 (2003) (describing how compensating CEOs with stock options led to fraud).

207. See Stewart C. Myers, *Determinants of Corporate Borrowing*, 5 J. FIN. ECON. 147, 163 (1977) (coining the phrase “real options”).

208. See Don M. Chance, *A Derivative Alternative as Executive Compensation*, FIN. ANALYSTS J., Mar.-Apr. 1997, at 6 (questioning the ability of executive stock options, at least as they are typically granted, to align the interests of executives with those of shareholders); RON S. DEMBO & ANDREW FREEMAN, *THE RULES OF RISK: A GUIDE FOR INVESTORS* 207-22 (1998) (discussing the possibly unexpected and perverse incentive effects of utilizing stock options in employee compensation).

209. See Peter Christoffersen & Andrey Pavlov, *Company Flexibility, the Value of Management and Managerial Compensation* (Jan. 20, 2003) (unpublished manuscript, on file with author) (presenting a real-options model explaining the staggering variation in managerial compensation in firms of similar sizes across industries and countries).

210. See generally BRACH, *supra* note 72, at 67-103; BREALEY & MYERS, *supra* note 187, at 616-41; DIXIT & PINDYCK, *supra* note 187, at 6-25; TRIGEORGIS, *supra* note 187, at 1-4, 9-20, 121-50.

211. See, e.g., Frank T. Magiera & Robert A. McLean, *Strategic Options in Capital Budgeting and Program Selection under Fee-For-Service and Managed Care*, HEALTH CARE MGMT. REV., Fall 1996, at 7 (explaining how to apply real options analysis to healthcare management).

numerous real options.²¹² Multinational corporations face numerous real options in making foreign investments.²¹³

In describing a generic decision-making setting, the phrase “real option” implies that options theory is applicable to analyzing the sequential choices that are inherent in such a dynamic and uncertain environment. Real options have a fascinating history.²¹⁴ Familiar (and perhaps, some unfamiliar) examples of real options include the options to: abandon, perhaps temporarily (i.e. mothball) a project;²¹⁵ become delinquent in property-tax payments;²¹⁶ breach a contract and pay liquidated or expectation damages;²¹⁷ build or develop real-estate property versus delaying construction;²¹⁸ continue with education;²¹⁹ declare bankruptcy;²²⁰ delay a

212. See generally RICHARD RAZGAITIS, *DEALMAKING: USING REAL OPTIONS AND MONTE CARLO ANALYSIS* 175 (2003) (introducing a real-options approach to valuing and negotiating business projects).

213. See generally KIRT C. BUTLER, *MULTINATIONAL FINANCE* 461-87 (3d ed. 2004) (providing examples of various real options in cross-border investments).

214. BRACH, *supra* note 72, at 13-15.

215. See, e.g., Brennan & Schwartz, *supra* note 187, at 147-50 (discussing the utility and relative efficiency of temporary or permanent abandonment of a project); Stewart C. Myers & Saman Majd, *Abandonment Value and Project Life*, in 4 *ADVANCES IN FUTURES AND OPTIONS RESEARCH* 1 *passim* (1990) (analyzing the option to abandon for salvage value).

216. See generally Brendan O’Flaherty, *The Option Value of Tax Delinquency: Theory*, 28 J. URBAN ECON. 287 (1990) (applying option theory in measuring the threat of confiscation of property for failure to pay property taxes).

217. See Mahoney, *supra* note 186, at 150 (discussing the application of options theory to remedies in lawsuits arising out of breach of contract).

218. See, e.g., Paul D. Childs et al., *Mixed Uses and the Redevelopment Option*, 24 REAL ESTATE ECON. 317, 319 (1996) (concluding that options provide needed flexibility in determining the proper use of land in redevelopment projects); David Geltner, *On the Use of the Financial Option Price Model to Value and Explain Vacant Urban Land*, 17 AM. REAL ESTATE & URBAN ECON. ASSOC. J. 142 *passim* (1989) (reviewing the financial option model of under-utilization of urban land); Steven R. Grenadier, *The Strategic Exercise of Options: Development Cascades and Overbuilding in Real Estate Markets*, 51 J. FIN. 1653 *passim* (1996) (focusing on the timing of real estate development and how that timing shapes market behavior); Sheridan Titman, *Urban Land Prices Under Uncertainty*, 75 AM. ECON. REV. 505 (1985) (discussing the pricing of vacant lots and when it is rational to postpone building until a later date).

219. Uri Dothan & Joseph Williams, *Education as an Option*, 54 J. BUS. 117 (1981) (explaining a general valuation equation for determining if education is a viable option and stressing the role of education as an option to postpone commitment to a specific career).

project;²²¹ dissolve a business arrangement, marital or corporate union, merger, partnership, or any other form of ongoing or steady relationship;²²² drill, develop, or start production from oil wells;²²³ engage in venture capital start-up investing;²²⁴ exchange one asset for another;²²⁵ heat new construction with electricity, heating oil, or natural gas;²²⁶ lease airplanes, assets, copiers, power plants, real estate, satellites, trucks, or zoo animals;²²⁷ maintain academic employment under faculty tenure;²²⁸ make a movie from a script and follow-up sequels if the original movie is a box office success;²²⁹

220. Douglas G. Baird & Edward R. Morrison, *Bankruptcy Decision Making*, 17 J. L. ECON. & ORG. 356, 358-66 (2001) (exploring the decision of declaring bankruptcy and alternative options that may be available).

221. Jonathan E. Ingersoll, Jr. & Stephen A. Ross, *Waiting to Invest: Investment and Uncertainty*, 65 J. BUS. 1 (1992); Saman Majd & Robert S. Pindyck, *Time to Build, Option Value, and Investment Decisions*, 18 J. FIN. ECON. 7 *passim* (1987) (using contingent claims analysis to derive optimal decision rules and to value investments).

222. Dixit, *supra* note 187, at 105 (describing how any investment can be seen as an option).

223. See, e.g., Jeff Strand, *Taxes and Nonrenewable Resources: The Impact on Exploration and Development* (July 1996) (unpublished manuscript, available at <http://www.ssrn.com>) (analyzing the effects of tax laws on the last three options).

224. Pascal Botteron & Jean-Francois Casanova, *Start-ups Defined as Portfolios of Embedded Options*, International Center for Financial Asset Management and Engineering Research Paper No. 85 (May 2003) (unpublished manuscript, on file with author).

225. See generally William Margrabe, *The Value of an Option to Exchange One Asset for Another*, 33 J. FIN. 177 (1978) (developing an equation for the value of the option to exchange one risky asset for another).

226. BRACH, *supra* note 72, at 7-8. See also Nalin Kulatilaka, *The Value of Flexibility: The Case for a Dual-Fuel Industrial Steam Boiler*, FIN. MGMT., Autumn 1993, at 271 *passim* (explaining the value of an industrial facility which can be fueled by gas or oil).

227. See, e.g., Steven R. Grenadier, *Valuing Lease Contracts: A Real-Options Approach*, 38 J. FIN. ECON. 297 (1995) (developing a unified model for pricing a variety of leasing contracts using a real-options approach to derive the term structure of lease rates); Stephen E. Miller, *Economics of Automobile Leasing: The Call Option Value*, 29 J. CONSUMER AFFAIRS 199 *passim* (1995) (discussing options involved in leasing a car).

228. See generally John G. McDonald, *Faculty Tenure As a Put Option: An Economic Interpretation*, 55 SOC. SCI. Q. 362 (1974).

229. See generally AMRAM, *supra* note 187, at 155-70; Martha Amram, *The Value of Film Studios*, J. APPLIED CORP FIN., Summer 2003, at 24; Laura Martin & Patrick Wang, *Film Studio Reel Options* (May 11, 2001), Credit Suisse First Boston Equity Research, available at http://www.valuesweep.com/csfb_filmoptions5_11_01.pdf; ZIV BODIE & ROBERT C. MERTON, FINANCE 448-50

purchase assets, items, or properties;²³⁰ threaten to employ fewer workers if a firm has a flexible production technology;²³¹ throw away food obtained from an all-you-care-to-eat buffet or freely dispose of items generally; try predatory pricing or to leverage monopoly power in one market into monopoly power in another market;²³² and utilize (export or import) quota licenses.²³³

Real-options theory applies financial option-pricing models to derive qualitative, if not (yet) quantitative, estimates of real-option values.²³⁴ Many quantitative financial and real-option-pricing models assume that the underlying risks evolve over time according to a particular stochastic process, known as geometric Brownian motion with drift.²³⁵ Although there is no reason that such a distributional assumption would accurately describe litigation risks in general, other quantitative option-pricing models, such as the binomial or two-state option-pricing model, may approximately describe a particular lawsuit.²³⁶ More generally, qualitative, as opposed to quantitative, financial- and real-option valuation models apply to litigation-abandonment options because qualitative option-valuation models make no distributional assumptions regarding the stochastic process of underlying risks.²³⁷ Nonetheless, qualitative

(2000).

230. See, e.g., John E. Stonier, *What is an Aircraft Purchase Option Worth? Quantifying Asset Flexibility Created Through Manufacturer Lead-Time Reductions and Product Commonality*, in HANDBOOK OF AIRLINE FINANCE 231 (Gail F. Butler & Martin R. Keller eds., 1997).

231. See Nalin Kulatilaka & Stephen Gary Marks, *The Strategic Value of Flexibility: Reducing the Ability to Compromise*, 78 AM. ECON. REV. 574, 575 (1988) (discussing downsizing in the context of incomplete contracting and the options value of flexibility).

232. Huang, *supra* note 46, at 437, 442-43.

233. James E. Anderson, *Quotas as Options: Optimality and Quota License Pricing under Uncertainty*, 23 J. INT'L ECON. 21 *passim* (1987).

234. MEGGINSON, *supra* note 189, at 292 n.42.

235. See, e.g., J. MICHAEL STEELE, STOCHASTIC CALCULUS AND FINANCIAL APPLICATIONS 29-40 (2001) (outlining the concept of Brownian motion); LARS TYGE NIELSEN, PRICING AND HEDGING OF DERIVATIVE SECURITIES 13 (1999) (providing examples of both geometric Brownian motion and generalized Brownian motion).

236. James Cox et al., *Option Pricing: A Simplified Approach*, 7 J. FIN. ECON. 229 (1979); Richard J. Rendleman & Brit J. Barter, *Two-State Option Pricing*, 34 J. FIN. 1093, 1093-98 (1979) (presenting an elemental two-state option-pricing model that can be used to solve many complex option-pricing problems).

237. See, e.g., John C. Cox & Stephen A. Ross, *A Survey of Some New Results in Financial Option Pricing Theory*, 31 J. FIN. 383, 384-89 (1976)

option-valuation models provide upper and lower bounds for option values.²³⁸

(presenting option-pricing results that are distribution- and preference-free).

238. See Merton, *supra* note 201, at 142-60 (deriving restrictions on option-pricing formulae based upon the assumption that investors prefer more wealth to less wealth); Hal R. Varian, *The Arbitrage Principle in Financial Economics*, J. ECON. PERSP., Fall 1987, at 62-64 (deriving bounds for option prices based upon the no-arbitrage condition).

APPENDIX B: A GAME-THEORETIC OPTIONS MODEL OF LITIGATION

This appendix introduces a game-theoretic options model of possibly frivolous litigation under the assumption that defendants and plaintiffs maximize their expected net wealth and initially have incomplete but common knowledge regarding all information concerning their litigation. This appendix adopts these quite strong assumptions to focus attention on the additional and novel insights provided by viewing litigation from an options-theoretic perspective. This Article demonstrates that options analysis generates different conclusions and implications from those of expected value analysis under an identical set of assumptions. Litigation costs are stochastic processes in the game-theoretic options model in this appendix. More generally, litigants might choose the levels of litigation expenditures as endogenous variables as opposed to facing litigation costs that are exogenously distributed random variables. It is left for another day to model endogenous litigation expenditures in a strategic options analysis of litigation.

A. *Notation*

The following notation is used in the formal model. Denote the plaintiff's total litigation costs by P . Denote the defendant's total litigation costs by D . Divide the number of stages in pretrial bargaining by the index $t = 1, \dots, n$. All money values at periods $t > 1$ are denominated in terms of their present discounted values at $t = 1$ (using a common discount rate or factor). Let I_t represent the plaintiff's litigation costs at stage t . Thus, by definition, $P = \sum_{t=1}^n I_t$. Let C_t represent the defendant's litigation costs at stage t . Then, by definition, $D = \sum_{t=1}^n C_t$. Let P_t denote the plaintiff's remaining litigation costs after stage t . Then, by definition, $P_t = \sum_{k=t+1}^n I_k$. Let $E_1(P_t)$ denote the initial expected present value of plaintiff's remaining litigation costs once stage t is reached. Let D_t denote the defendant's remaining litigation costs once stage t is reached. Then, by definition, $D_t = \sum_{k=t+1}^n C_k$. Let $E_1(D_t)$ denote the initial expected present value of defendant's remaining litigation costs once stage t is reached. Let α denote the relative bargaining strength of the plaintiff; so that, $0 \leq \alpha \leq 1$.

At stage t , the size of the dollar amount of judgment expected at trial is J_t . At stage t , the subjective probability of the plaintiff

prevailing at trial is denoted p_t . At stage t , the expected value of the judgment expected at trial is defined as $x_t = p_t J_t$. Denote the initial net present discounted expected value of the settlement if the litigation settles at stage t by $E_I(s_t)$. Solving recursively via backwards induction, $E_I(s_t) = x_t + \alpha E_I(D_t) - (1-\alpha)E_I(P_t)$. Let $OV_I(s_t)$ be the initial abandonment-option value of the settlement at stage t . Finally, let $E_I(I_t)$ be the initial present-expected value of the plaintiff's litigation cost at stage t .

The following game-theoretic options model of lawsuits assumes that $\{J_t\}$, $\{I_t\}$, and $\{C_t\}$ are stochastic processes, whose distributions are agreed upon and common knowledge among the litigants and their attorneys. Recall that the litigants are assumed to be risk-neutral, to share a common discount rate, and to face no effective wealth constraints. Finally, J_t , I_t , and C_t are assumed to be independent random variables at each t .

B. Necessary and Sufficient Conditions for the Credible Filing of Litigation

This characterization of the incentives to file lawsuits illustrates the power of backwards induction.

Proposition 1: A necessary and sufficient condition for a lawsuit to be filed is that the initial value of all the *abandonment options* exceed the initial value of their expected costs or premiums. In other words, for all $t = 1, \dots, n$; these inequalities hold at date 1:

$$OV_I(s_t) \geq E_I(I_t)$$

Proof: (a) Necessity: If for any $t \leq n$, $OV_I(s_t) < E_I(I_t)$; then both parties expect at stage 1 that the plaintiff will not continue the lawsuit at stage t . Thus, reasoning backwards, both parties expect at stage 1 that the plaintiff's threat at stage t to continue the lawsuit is not credible.

(b) Sufficiency: Conversely, if for all $t \leq n$, $OV_I(s_t) \geq E_I(I_t)$; then both parties expect at stage 1 that the plaintiff will at each stage t be able to credibly threaten to continue the lawsuit for its abandonment option value at that stage.

It is straightforward to show that any Positive-Expected-Value (PEV) lawsuit will always satisfy the above condition.

Proposition 2: If a lawsuit has PEV, then all of the abandonment options will have initial values that exceed their initial expected cost.

Proof: A PEV lawsuit by definition satisfies $x_I \geq E_I(P)$. Because $P = \sum I^n I_t^i$ and $I_t \geq 0$ for all t , it follows that $x_I \geq E_I(I_t) + E_I(P_t)$ for all t . So, $\alpha x_I \geq \alpha E_I(I_t)$ and $(1-\alpha)x_I \geq (1-\alpha)E_I(I_t) + (1-\alpha)E_I(P_t)$ for all t . Adding these last two inequalities together results in the inequality, $x_I - (1-\alpha)E_I(P_t) \geq E_I(I_t)$ for all t . This implies that $x_I + \alpha E_I(D_t) - (1-\alpha)E_I(P_t) \geq E_I(I_t)$ for all t because $\alpha E_I(D_t) \geq 0$. But, $E_I(s_t) = x_I + \alpha E_I(D_t) - (1-\alpha)E_I(P_t)$ by definition. So, for all t ; $E_I(s_t) \geq E_I(I_t)$. Finally, by the definition of abandonment-option value, we conclude that for all t : $OV_I(s_t) \geq E_I(s_t) \geq E_I(I_t)$.

Thus, a lawsuit having PEV is a sufficient, but not necessary condition for a lawsuit to be credibly filed by a plaintiff. The last step in the proof of the above corollary, namely that for all t , $OV_I(s_t) \geq E_I(s_t)$, is merely an instance of the more general proposition that at every date, the abandonment-option value of a random variable is greater than its expected value. This is true because the abandonment-option value of a random variable can be thought of as being equal to its expected value with all of its negative-value realizations replaced by zero.

C. *Litigation-Abandonment Option Values and Equilibrium Settlement Amounts*

In expected-value litigation models, the parties compare their deterministic cash outflows from the costs of litigation with their probability weighted expected monetary payoffs to litigation. If the parties have the same expected values for trial, they will settle rather than go to court, in order to save on trial costs (even if they are risk-neutral) or because they are risk-averse (even if trial costs are zero). Parties only go to trial if they have sufficiently different beliefs about the probability that the plaintiff will prevail at trial or about the size of the judgment if the plaintiff should win at trial. In expected-value litigation models, different expected values for the outcome of trial

are necessary, but not sufficient for trial.²³⁹ Settlement occurs if and only if there is a range of mutually acceptable settlement amounts. This interval will be non-empty if and only if the difference between the plaintiff's expected gain and the defendant's expected loss from going to trial is less than the sum of their litigation costs. The parties will settle immediately at an amount in the range of mutually acceptable settlement amounts. The precise settlement amount in that range is determined by the values of the parties' relative bargaining strengths. A similar immediate settlement result holds true in this game-theoretic options model of lawsuits, the difference being the value of the settlement amount.²⁴⁰

Proposition 3: If the parties to litigation share the same initial common probability beliefs $\{p_t\}$ and have common knowledge over $\{J_t\}$, $\{I_t\}$, and $\{C_t\}$, then both parties will agree to settle the litigation in period 1 for the Nash equilibrium amount $S^* = OV_1(s_1) \geq E_1(s_1)$.

Proof: If the litigants share common prior probability beliefs regarding the distributions of the relevant random variables, then they also will agree on the values of $OV_1(s_t)$ and $E_1(I_t)$ and the inequality conditions in Proposition 1 being satisfied for all $t \leq n$. Thus, they will agree to settle immediately to avoid incurring litigation costs. In other words, the defendant will effectively agree to buy the plaintiff's initial abandonment option for its value $OV_1(s_1)$, which is at least as large as the net present discounted expected value of the lawsuit, $E_1(s_1)$.

In this game-theoretic options model, all lawsuits are settled immediately in the case of homogeneous probability beliefs $\{p_t\}$ between the plaintiff and defendant and common knowledge regarding the distributions of $\{J_t\}$, $\{I_t\}$, and $\{C_t\}$. As with settlement in game-theoretic expected-value models, the settlement amount in this game-theoretic options model is constructed iteratively period by period from the last period backwards. If a lawsuit were to be credibly filed and not settled immediately due to differing beliefs $\{p_t\}$ or lack of common knowledge over the distributions of $\{J_t\}$, $\{I_t\}$, and $\{C_t\}$, it might settle nonetheless at some later period, e.g.,

239. See, e.g., MICELI, *supra* note 31, at 157-58 (explaining the differing-perceptions model).

240. See, e.g., Cornell, *supra* note 37, at 180-81 (giving an example of the options model of a lawsuit).

after discovery, due to convergence of probability beliefs $\{p_t\}$ or common knowledge about $\{J_t\}$, $\{I_t\}$, and $\{C_t\}$. In particular, optimism or self-serving biases can prevent immediate settlement, as is the case in expected-value litigation models.²⁴¹ Finally, notice that higher than expected realized litigation costs may cause a plaintiff unilaterally to drop her lawsuit, because the actual premium of the litigation-abandonment option at that stage exceeds its value.

D. *Qualitative Comparative Statics or Sensitivity Analysis*

A game-theoretic options model of litigation has different implications for how various policies or shifts in the underlying legal random variables change the incentives to file litigation and the size of Nash-equilibrium settlement amounts than those that are predicted by game-theoretic expected value models of litigation. Economists utilize the phrase “comparative-statics analysis” to refer to a comparison of how equilibrium behavior differs for different parameter values.²⁴² Another way to think of a comparative-statics result is that it analyzes how sensitive behavior endogenously determined in equilibrium is to changes in exogenous variables. Thus, comparative-statics results are forms of sensitivity analysis. In this Article’s game-theoretic options model of litigation, many of these comparative-statics results are driven by the fact that the option value of a random variable increases with its variance because of the option to avoid downside risk, while a random variable’s expected value does not necessarily increase with its variance.

The first comparative statics result concerns the awarding of punitive damages,²⁴³ a practice in certain areas of the law, such as

241. See Linda Babcock & George Loewenstein, *Explaining Bargaining Impasse: The Role of Self-Serving Biases*, J. ECON. PERSP., Winter 1997, at 109, 111-16 (1997) (using the example of a Texas tort case).

242. See, e.g., ALPHA C. CHIANG, FUNDAMENTAL METHODS OF MATHEMATICAL ECONOMICS 127-28 (3d ed. 1984) (explaining the method of comparative statics); LIONEL W. MCKENZIE, CLASSICAL GENERAL EQUILIBRIUM THEORY 133-64 (2002) (presenting a detailed and rigorous treatment of comparative statics); PAUL A. SAMUELSON, FOUNDATIONS OF ECONOMIC ANALYSIS 20 (enlarged ed. 1983) (defining comparative statics).

243. See generally A. Mitchell Polinsky & Steven Shavell, *Punitive Damages: An Economic Analysis*, 111 HARV. L. REV. 869 (1998) (providing principles of economics to analyze punitive damages question, in light of deterrence and punishment goals); Cass R. Sunstein et al., *Do People Want Optimal Deterrence?*, in PUNITIVE DAMAGES: HOW JURIES DECIDE 132, 132-34 (Cass R. Sunstein et al. ed., 2002) (exploring the economic theory of deterrence

treble damages in antitrust,²⁴⁴ punitive multiples in certain tort actions,²⁴⁵ or willful contract breach. Punitive damages increase the incentive to file lawsuits because such damages increase the amount of expected judgments. But, above and beyond the mean-increasing effect on judgments, punitive damages also increase the variance of judgments, and hence, they not only increase the net present discounted values, but also the option values, of settlement.

Proposition 4: Holding all other variables fixed, punitive damages increase the incentives to file lawsuits and equilibrium settlement amounts more than just a variance-preserving increase in judgments by the same factor as the punitive multiple does.

Proof: All other things being equal, punitive damages increase the variance of x_t for all t and thus increase $OV_I(s_t)$ for all t . Thus, the necessary and sufficient conditions for filing lawsuits are more likely to hold with punitive damages than without punitive damages. In addition, the necessary and sufficient conditions for filing lawsuits are more likely to hold with punitive damages than with merely a variance-preserving increase in judgments by the same factor as the punitive multiple.

The other side of the above result concerns the frequently suggested policy of capping the damages that juries can award. Although these proposals usually lament both the unpredictability and seemingly random nature of jury awards, the argument behind these reforms focuses on the absolute magnitude of the punitive component of jury awards. A game-theoretic options model of

ted to punitive damages). See also John E. Calfee & Richard Craswell, *Some Effects of Uncertainty on Compliance with Legal Standards*, 70 VA. L. REV. 965, 994-97 (1984) (discussing damage multipliers as a sliding scale, decreasing as the probability of getting caught goes up); Richard Craswell, *Damage Multipliers in Market Relationships*, 25 J. LEGAL STUD. 463, 478-87 (1996) (explaining the shortcomings of damage multipliers in market relationships, with reference to cost increases, risk tolerances, and probability of punishment); Richard Craswell, *Deterrence and Damages: The Multiplier Principle and Its Alternatives*, 97 MICH. L. REV. 2185, 2187 (1999) (explaining why the multiplier principle is not necessary for optimal deterrence and discussing alternatives); Richard Craswell & John E. Calfee, *Deterrence and Uncertain Legal Standards*, 2 J.L. ECON. & ORG. 279, 292-97 (1986) (discussing damage multipliers).

244. Clayton Act, ch. 323, §4(a), 38 Stat. 730, 731 (1914).

245. See, e.g., *Milwaukee & St. Paul Ry. Co. v. Arms*, 91 U.S. 489, 492 (1875) (holding that punitive damages were “too well-settled now to be shaken, that exemplary damages may in certain cases be assessed”).

litigation makes clear that not only the size of expected punitive damages, but also the variance of punitive damages affects the incentives to sue and settle. This is because, above and beyond the mean-decreasing effect on judgments, damage caps also decrease the variance of judgments. Hence, they not only decrease the net present values but also the option values of settlement.

Proposition 5: Holding all other variables fixed, damage caps decrease the incentives to file lawsuits and equilibrium settlement amounts more than just a variance-preserving decrease in judgments by the same factor as the damage caps.

Proof: All other things being equal, damage caps decrease the variance of x_t for all t and thus decrease $OV_I(s_t)$ for all t . Therefore, the necessary and sufficient conditions for filing lawsuits are less likely to hold than with damage caps than without damage caps. In addition, the necessary and sufficient conditions for filing lawsuits are less likely to hold with damage caps than with merely a variance-preserving decrease in judgments by the same factor as the damage caps.

The above two results concerning effects on incentives to file lawsuits of substantive or procedural reforms are special cases of the next general comparative-statics result about how the abandonment-option value of a lawsuit changes as the variance of the trial-judgment award changes.

Proposition 6: Holding all other variables fixed, an increase (respectively, decrease) in the variance of the trial judgment award increases (respectively, decreases) the incentives to file lawsuits and equilibrium settlement amounts.

Proof: All other things being equal, higher (respectively, lower) variance in the trial judgment award increases (respectively, decreases) $OV_I(s_t)$ for all t . Thus, the necessary and sufficient conditions for filing a lawsuit are more (respectively, less) likely to hold with changes in the variance of the trial-judgment award than without such changes.

The next result provides a set of conditions under which the English rule for allocating legal costs, under which the party losing at trial is required to also pay for the winning party's legal costs, increases the incentive to file lawsuits and equilibrium settlement

amounts. Professor Cornell observed that even risk-neutral plaintiffs are better off under the English rule for allocating litigation costs than under the American rule for allocating litigation costs, under which each side of litigation pays for its own legal costs. This is due to the increased variance of trial outcomes, when taking into account paying for legal costs under the English rule for allocating litigation costs as compared to the American rule for allocating litigation costs.²⁴⁶ But a lawsuit having an expected judgment of x under the American rule becomes a lawsuit having an expected judgment of $x + p_t P - (1 - p_t) D$ under the English rule. Thus, shifting from the American rule to the English rule not only increases the variance of, but also changes the mean of, trial outcomes. Hence, whether the English rule increases or decreases the likelihood of litigation and settlement amounts compared to the American rule depends respectively on whether the English rule's variance-increasing effect on the plaintiff's abandonment-option value outweighs its mean-decreasing effect on the plaintiff's abandonment option value or vice versa. As the next result makes clear, a sufficient condition for the English rule's variance-increasing effect on the plaintiff's abandonment-option value to outweigh its mean-decreasing effect on the plaintiff's abandonment-option value is that for all t , $p_t E_t(P) \geq (1 - p_t) E_t(D)$.

Proposition 7: If for all t , $p_t E_t(P) \geq (1 - p_t) E_t(D)$, then the English rule increases the likelihood of filing a lawsuit and the settlement amount compared to the American rule.²⁴⁷

Proof: Litigation under the English rule instead of the American rule changes both the mean and variance of the litigation process. At each period t , the expected judgment changes from x_t to $x_t + p_t E_t(P) - (1 - p_t) E_t(D)$, where the conditional expected values $E_t(P)$ and $E_t(D)$ are conditional on the realized values of litigation costs up to stage t for the plaintiff and defendant, respectively. By hypothesis, for all t , $x_t + p_t E_t(P) - (1 - p_t) E_t(D) \geq x_t$. Thus, the English rule does not decrease the expected judgment compared with the American rule. The English rule also increases the variance in expected judgment compared with the American rule. Each of these effects on the mean and variance of judgment increases $OV_1(s_t)$. But the English rule

246. See Cornell, *supra* note 37, at 186 (stating that the English rule would increase incentive to sue because of increased variance in the final award).

247. If it is not true that for all t , $p_t E_t(P) \geq (1 - p_t) E_t(D)$.

does not change the plaintiff's litigation costs at any given stage because they are incurred sequentially. Thus, the necessary and sufficient condition for filing a lawsuit is more likely to hold under the English rule for allocating litigation costs than under the American rule for allocating litigation costs.

The next proposition explains how the option value of a lawsuit changes as the variance of the defendant's litigation costs changes, all other things being equal. More (respectively, less) risk over the defendant's legal costs at any given stage increases (respectively, decreases) a plaintiff's incentive to file a lawsuit because of the increased (respectively, decreased) savings in defendant's avoided legal costs from settling before that stage.

Proposition 8: Holding all other variables fixed, increasing (respectively, decreasing) the variance of defendant's litigation costs at any stage $k \leq n$, increases (respectively, decreases) the incentives to file lawsuits and equilibrium settlement amounts.

Proof: Holding all other variables fixed, more (respectively, less) variance in the defendant's litigation costs at stage $k \leq n$ increases (respectively, decreases) $OV_I(s_t)$ for all $t \leq k$. Thus, the necessary and sufficient conditions for filing a lawsuit are more (respectively, less) likely to hold with changes in the variance of the defendant's litigation costs than without changes in the variance of the defendant's litigation costs.

Because changing the variance of the plaintiff's litigation costs also generally changes the mean of the plaintiff's litigation costs; changing the variance of the plaintiff's litigation costs affects both sides of the inequalities from the necessary and sufficient conditions for the (credible) filing of a lawsuit. To isolate the impact of changing the variance of the plaintiff's litigation costs upon the option value of lawsuit, the next proposition analyzes how the option value of a lawsuit changes as the variance of plaintiff's litigation costs changes in a *mean-preserving* manner.

Proposition 9: Holding all other variables fixed, a mean-preserving increase (respectively, decrease) in the variance of plaintiff's litigation costs at any stage $k \leq n$, increases (respectively, decreases) the incentives to file lawsuits and equilibrium settlement amounts.

Proof: All other things being equal, higher (respectively, lower) variance in the plaintiff's litigation costs at stage k increases (respectively, decreases) $OV_I(s_t)$ for all $t \leq k$. Thus, the necessary and sufficient condition for filing a lawsuit is more likely to hold with mean-preserving changes in the variance of the plaintiff's litigation costs than without mean-preserving changes in the variance of the plaintiff's litigation costs.

The next proposition analytically demonstrates how this appendix's model of initially NEV lawsuits due to non-negative values of litigation-abandonment options generalizes Bebchuk's model of NEV litigation.

Proposition 10: The set of parameter values for which initially NEV lawsuits are brought is larger than in Bebchuk's model of NEV litigation.²⁴⁸ The difference between the set of parameter values for which NEV lawsuits are filed in a game-theoretic options model and Bebchuk's game-theoretic expected-value model of litigation is a function of the difference between $OV_I(s_t)$ and $E_I(s_t)$, which in turn depends on the ability to subdivide the litigation into stages and the opportunities to learn more information.

Proof: Bebchuk's conditions for the filing of a lawsuit can be thought of as t , $E_I(s_t) > I_t$. Bebchuk's model describes the situation of a lawsuit in which the values of all of the variables are known with certainty by the litigants. Under symmetric uncertainty, Bebchuk's conditions become $E_I(s_t) > E_I(I_t)$. Because the lawsuit can be dropped t , $OV_I(s_t) \geq 0$ and moreover $OV_I(s_t) \geq E_I(s_t)$. Thus, whenever $E_I(s_t) > E_I(I_t)$, $OV_I(s_t) > E_I(I_t)$ also holds. But, $OV_I(s_t) > E_I(I_t)$ can hold even though $E_I(I_t) > E_I(s_t)$.

Interpreting a comparison between the relative sizes of the set of parameter values in Bebchuk's non-stochastic model that satisfy the necessary and sufficient conditions for the credible filing of NEV lawsuits with that of the set of parameter values in this appendix's stochastic litigation abandonment options model that satisfy the necessary and sufficient conditions for the credible filing of initially NEV lawsuits requires a bit of care. When any non-stochastic model is embedded in a stochastic model involving the same variables as in the non-stochastic model, the whole parameter space of the non-

248. Bebchuk, *supra* note 47, at 14.

stochastic model is only a single point in the parameter space of the stochastic model. In other words, for most economically and legally relevant choices of topologies and measures, the entire parameter space of the non-stochastic model will only be a small or negligible set in the parameter space of the stochastic model.²⁴⁹ Thus, any proper subset of the parameter space of the non-stochastic model is *a fortiori* a small and negligible proper subset in the parameter space of the stochastic model. It thus comes as no surprise that a stochastic game-theoretic options model of NEV litigation generalizes Bebachuk's non-stochastic game-theoretic expected value model of NEV litigation because any stochastic model generalizes any non-stochastic model involving the same variables in the sense that stochastic random variables generalize non-stochastic random variables.

The next two results analyze the impact of changes in a plaintiff's litigation costs on that plaintiff's incentive to file litigation and the resulting equilibrium settlement amount. Increased or greater divisibility of a plaintiff's legal costs only bolstered the credibility of a plaintiff's threats to continue a lawsuit in Bebachuk's nonstochastic model²⁵⁰ and Cornell's non-game-theoretic model.²⁵¹ A similar proposition holds in this Article's game-theoretic stochastic model.

249. The precise notion of "small" depends on how we measure risk. For example, if risk involves a family of normal distributions, the parameter space of the stochastic model is that of the mean and variance of normally distributed random variables and the non-stochastic model is described by a point, which is a closed set of measure zero in the non-negative quadrant of the Euclidean plane. If the risk involves a family of smooth distributions restricted to have finite variance, then a natural parameter space of the stochastic model is the infinite dimensional function space L_2 and the non-stochastic model is described by a set consisting of a single point, which is a small or negligible set for most economically, legally, and mathematically relevant or appropriate choices of topologies and measures. For technical details, see RALPH ABRAHAM ET AL., *MANIFOLDS: TENSOR ANALYSIS, AND APPLICATIONS* 2, 399, 551 (1983) (defining closed set, L_p spaces, and measure zero).

250. Bebachuk, *supra* note 47, at 15 n.11. See also Lucian A. Bebachuk, *On Divisibility and Credibility: The Effects of the Distribution of Litigation Costs Over Time on the Credibility of Threats to Sue*, John M. Olin Center in Law, Economics, and Business Discussion Paper No. 190, Harvard Law School (August 1996) (unpublished manuscript, on file with The Review of Litigation).

251. Cornell, *supra* note 37, at 184.

Proposition 11: A finer partition of a plaintiff's legal costs can only bolster the credibility of that plaintiff's threats to continue a lawsuit and therefore increase equilibrium settlement amounts.

Proof: Let a finer partition of the plaintiff's legal costs be formed by at least subdividing some stage k into two substages: i and j . By construction, the plaintiff's legal costs in stage k can be decomposed into two component legal costs in stage i and stage j : $I_k = I_i + I_j$. If the plaintiff initially had credible threats for continuing the lawsuit through to trial, then by proposition 1, option values of settlement at each stage are larger than the initial expected premia of those continuation options. In other words, for all $t \leq n$; these inequalities hold at date 1: $OV_1(s_t) \geq E_1(I_t)$. In particular, at stage 1 it is expected that at stage k , $OV_1(s_k) \geq E_1(I_k) = E_1(I_i) + E_1(I_j)$. By definition of the random variables s_t , $s_k = s_i = s_j$ because there is no intermediate bargaining between stages k and $k+1$. Thus, $OV_1(s_i) = OV_1(s_k) \geq E_1(I_k) > E_1(I_i)$ and $OV_1(s_j) = OV_1(s_k) \geq E_1(I_k) > E_1(I_j)$. By proposition 1, this means that all of the plaintiff's threats for continuing the lawsuit through to trial remain credible.

If the plaintiff initially did not have a credible threat at stage k for continuing the lawsuit through to trial, then by proposition 1, $OV_1(s_k) < E_1(I_k) = E_1(I_i) + E_1(I_j)$. As noted above, $s_k = s_i = s_j$ because there is no intermediate bargaining between stages k and $k+1$. It is now possible that both $OV_1(s_k) \geq E_1(I_i)$ and $OV_1(s_k) \geq E_1(I_j)$. Of course, that is not guaranteed because it is also possible that $OV_1(s_k) < E_1(I_i)$ yet $OV_1(s_k) \geq E_1(I_j)$, or $OV_1(s_k) \geq E_1(I_i)$ yet $OV_1(s_k) < E_1(I_j)$, or $OV_1(s_k) < E_1(I_i)$ and $OV_1(s_k) < E_1(I_j)$. If any one of these three possibilities holds, then the plaintiff is initially expected not to have a credible threat at stage i , j , or both for continuing the lawsuit through to trial.

In Cornell's non-game-theoretic model, front-loading a plaintiff's legal costs, meaning increasing that plaintiff's expected litigation costs at earlier stages while preserving the plaintiff's total expected litigation costs, reduced that plaintiff's litigation-abandonment-option value.²⁵² A similar proposition holds in this Article's game-theoretic stochastic model.

252. See Blanton, *supra* note 39, at 161, 186 (explaining that rules enabling the plaintiff to spread the litigation over more steps, while maintaining total litigation costs at a constant, raises the option value of litigation).

Proposition 12: Holding all other variables fixed, front-loading a plaintiff's litigation costs decreases the incentives to file lawsuits and equilibrium settlement amounts.

Proof: All other things being fixed, front-loading a plaintiff's litigation costs increases $E_I(I_t)$ for initial values of $t = 1, 2, \dots$. Thus, the necessary and sufficient conditions for initially filing lawsuits are less likely to hold when a plaintiff's litigation costs are front-loaded than when a plaintiff's litigation costs are not front-loaded.

Conversely, back-loading a plaintiff's legal costs, meaning decreasing that plaintiff's expected litigation costs at earlier stages while preserving the plaintiff's total expected litigation costs, increases that plaintiff's litigation-abandonment-option value.

Proposition 13: Holding all other variables fixed, back-loading a plaintiff's litigation costs increases the incentives to file lawsuits and equilibrium settlement amounts.

Proof: All other things being held equal, back-loading a plaintiff's litigation costs decreases $E_I(I_t)$ for initial values of $t = 1, 2, \dots$. Thus, the necessary and sufficient conditions for initially filing lawsuits are more likely to hold when a plaintiff's litigation costs are back-loaded than when a plaintiff's litigation costs are not back-loaded.

In Cornell's non-game-theoretic model, increasing a plaintiff's total legal costs reduced that plaintiff's litigation-abandonment-option value.²⁵³ A similar proposition holds in this Article's game-theoretic stochastic model.

Proposition 14: Holding all other variables fixed, increasing a plaintiff's total expected litigation costs decreases that plaintiff's incentives to file lawsuits and equilibrium settlement amount.

Proof: All other things being held fixed, increasing a plaintiff's total expected litigation costs increases $E_I(I_t)$ for some

253. See Blanton, *supra* note 39, at 161, 186 (citing Cornell's observation that increasing a plaintiff's initial expenditure to gain information reduces the option value of the litigation).

value(s) of t . Thus, at least one of the necessary and sufficient conditions for initially filing lawsuits is less likely to hold when a plaintiff's total expected litigation costs increase than when a plaintiff's total expected litigation costs stay constant.

Conversely, decreasing a plaintiff's total legal costs increases that plaintiff's litigation-abandonment-option value.

Proposition 15: Holding all other variables fixed, decreasing a plaintiff's total expected litigation costs increases that plaintiff's incentives to file lawsuits and equilibrium settlement amount.

Proof: All other things being equal, decreasing a plaintiff's total expected litigation costs decreases $E_I(I_t)$ for some value(s) of t . Thus, at least one of the necessary and sufficient conditions for initially filing lawsuits is more likely to hold when a plaintiff's total expected litigation costs decrease than when a plaintiff's total expected litigation costs do not change.

