Why Wait to Settle? An Experimental Test of the Asymmetric-Information Hypothesis

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Abstract

The US legal system encourages civil litigants to quickly settle their disputes, yet lengthy and expensive delays often precede private settlements. The causes of these delays are uncertain. This paper describes an economic experiment designed to test one popular hypothesis: that asymmetric information might be a contributing cause of observed settlement delays. Experimental results provide strong evidence that asymmetric information can delay settlements, increasing average time to settlement by as much as 90 percent in some treatments. This causal relationship is robustly observed across different bargaining environments. On the other hand, results do not obviously confirm all aspects of the game-theoretic explanation for this relationship and suggest that asymmetric information may be only one of several contributing causes of settlement delay.

1. Introduction

Why do civil litigants take so long to settle? Though much has been written on the puzzle of trials as evidence of systematic bargaining failure in settlement negotiation, progress on the twin puzzle of settlement delay remains limited. Modern civil litigation is not lacking in opportunities or incentives for litigants to rapidly settle their disputes, but in practice it seems that few lawsuits settle before much time, money, and other scarce resources have been exhausted in protracted legal posturing and negotiation. The salience of the settlement-delay puzzle in civil litigation is not merely the substantial economic waste it entails. The puzzle itself speaks to a broader academic challenge to reconcile game theory and empirical observation of the timing of agreement in negotiations over the outcomes of many kinds of disagreements. This is because settlement bargaining in the

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context of US civil litigation is representative of the essential structure of many dispute-resolution problems.

Holding fixed any deterrence or corrective-justice implications, civil litigation is a negative-sum endeavor. As a first-order approximation, the transfer of wealth or legal rights arising from the litigation process is welfare neutral: the plaintiff gains exactly what the defendant loses. At the same time, the cost of litigation falls on both parties. Complaints, answers, motions, replies, discovery, and trial preparation demand continual contributions of time and capital over the course of a process that can take years to reach the (first) trial on the merits.[1] With no net gains and costs that cumulate over time, the final resolution of a dispute becomes an ever-gloomier affair the longer it takes to get there.

This incentive structure would seem to favor full and rapid settlement of disputes. For example, suppose that litigants are risk neutral and that all aspects of the litigation and settlement negotiation process are common knowledge. Barring something like deontological preferences for resolution by adjudication, a trial outcome is always Pareto dominated by a feasible settlement. Every decree or verdict arising from a trial on the merits could be reproduced (in at least expected value) by a feasible pretrial settlement that would save both plaintiff and defendant the incremental costs of trial practice. Likewise, any pretrial settlement could be more cheaply reproduced by an earlier settlement, assuming that any positive legal costs would be borne in the interim. Modeled as either a cooperative or noncooperative bargaining process, it is difficult to see any way around quick (theoretically immediate) settlement as the most obvious equilibrium in this bargaining game.

But as an empirical matter, full and immediate settlement is a poor description of actual litigation outcomes. This is not to say that civil disputes do not settle. On the contrary, of the subset of disputes that even make it to the formal filing of a complaint, only about 3 percent end in trials (Langton and Cohen 2008). The problem is that settlement is often greatly delayed. Quantifying average delay is complicated by the private and decentralized nature of most settlements, but available data suggest that delays of 2 to 4 years are not uncommon (see, for example, Texas Department of Insurance 2009a).[2] To put this in perspective, despite paying an average of possibly $1,000 a month in pecuniary litigation costs alone,[3] civil litigants rarely settle anywhere near the outset of a dispute. They opt instead to endure the emotional and pecuniary pains of protracted litigation until an almost inevitable settlement is reached years down the road.

This is the disparity between game theory and empirical observation refer-

[1] See Langton and Cohen (2008) for an overview of time to resolution in civil litigation, Farole (2009) for figures specific to contract claims, and Cohen (2009) for figures specific to tort claims.

[2] In Texas Department of Insurance (2009b), for example, the median delay between injury and settlement is about 29.9 months. This figure is based on positive-transfer settlements in which both parties are represented by attorneys. For field definitions, see Texas Department of Insurance (2009b).

[3] This monthly cost is a back-of-the-envelope estimate based on the defendant's allocated loss-adjusted expenditures for the sample defined in note 2.

enced earlier, and it circles back to the fundamental question: why do civil litigants wait to settle? One answer may be that observed behavior frequently represents out-of-equilibrium play, encouraged and enabled by the infrequent and heterogeneous nature of many legal disputes. Without discrediting this possibility, the observation of systematic settlement delay—even in disputes involving experienced litigants, such as liability-insurance companies—demands a more robust explanation. Given the strong shared incentives of the parties to curtail litigation costs, the onus is to explain lengthy and systematic settlement delay as an equilibrium property of settlement negotiation. Two such explanations have been explored in the literature to date: the divergent-expectations hypothesis and the asymmetric-information hypothesis. Though often treated as competing theories of bargaining inefficiencies, these hypotheses are better understood as complementary frictions that may both act to disrupt and delay the resolution of disputes.

The divergent-expectations hypothesis posits that settlement failures result from the incompatible expectations of litigants about the likely value of a trial outcome (see, for example, Gould 1973; Shavell 1982; Priest and Klein 1984). As an explanation of bargaining failure, a behavioral-economics interpretation of the divergent-expectations hypothesis based on the influence of self-serving bias has shown promise in laboratory study (Loewenstein et al. 1993; Babcock et al. 1995; Babcock and Loewenstein 1997) and available field data (compare Farmer, Pecorino, and Stango 2004). There are also some empirical indications that self-serving bias might contribute to settlement delay (see Babcock, Loewenstein, and Issacharoff 1997), but more work is required in this area (compare Yildiz 2004; Ortner 2013).

This paper addresses a different hypothesis, and one less well explored in previous experimental research. Borrowed from an extensive literature on the economic theory of disagreement outcomes in bargaining games (see generally Kennan and Wilson 1993), the asymmetric-information hypothesis contemplates that outcome-relevant private information, held by one or more of the litigants, may support strategies in which settlement delay and even complete bargaining failure are rational outcomes of equilibrium play. For example, P'ng (1983), Hylton (1993), Bebchuk (1984), Reinganum and Wilde (1986), and Nalebuff (1987) all demonstrate, under various models and assumptions, that asymmetric information can motivate rational failures to settle civil disputes. There is modest empirical support for this conclusion in data from the field (Sieg 2000; Fournier and Zuehlke 1989) and the lab (Babcock and Landeo 2004; Inglis et al. 2005) as well as in experimental studies of more general bargaining problems (see, for example, Roth 1995).

The asymmetric-information hypothesis also responds to the settlement-delay puzzle by rationalizing the possibility of systematically delayed settlement in equilibrium (see Spier 1994). For example, a model of settlement bargaining under one-sided information due to Spier (1989, 1992) admits equilibrium strategies in which settlement is always delayed for a duration proportionate to the value of the informed party's private information. Though frequently cited in legal scholarship, Spier's application of the asymmetric-information hypothesis to address the settlement-delay puzzle has not been adequately tested in the empirical literature to date. Survival analyses conducted on available field data lend collateral support to some predictions of the model (see, for example, Fournier and Zuehlke 1996; Kessler 1996; Fenn and Rickman 1999, 2001), but no experimental study has explored the causal prediction of the hypothesis directly. At present, academic confidence in the settlement-delay version of the asymmetric-information hypothesis owes more to the familiarity of economists with asymmetric-information models than to any rigorous empirical validation of the hypothesis itself.

This lack of validation is problematic, as there are good reasons to question the settlement-delay version of the asymmetric-information hypothesis. For one thing, models of delayed agreement often require a heavy dose of rationality and strategic coordination, as equilibrium strategies typically involve consistency of beliefs across many iterations of backward-inductive reasoning. Even assuming that such rationality requirements are met, many models of bargaining under incomplete information have further been found sensitive to parameterization choices such as the frequency of interaction (see Gul and Sonnenschein 1988), the aspects of the game for which information is incomplete (see Schweinzer 2010; Ortner 2013), and the set of moves afforded to each player (see Wang, Kim, and Yi 1994). At a minimum, latent sensitivities in related models counsel for empirical scrutiny before a prediction can be considered robust. Finally, experimental study of various bargaining problems has yielded what would charitably be described as mixed results on whether incomplete information causes delayed agreement (see, for example, Forsythe, Kennan, and Sopher 1991; Rapoport, Erev, and Zwick 1995; Roth 1995, pp. 312–22), with further confusion introduced by the reverse observation of delayed agreement in games with ostensibly no asymmetric information (see Güth, Levati, and Maciejovsky 2005). Given the significance of settlement delay in civil litigation, a stronger empirical foundation for the asymmetric-information hypothesis is needed.

Using a novel experimental framework for studying settlement bargaining in the lab, this paper asks whether asymmetric information is an empirically plausible source of equilibrium settlement delay. The answer is yes—though asymmetric information may not be the whole story. Testing the asymmetric-information hypothesis by comparing data collected when information is asymmetric to that collected when it is symmetric, the following conclusions are reached. First, asymmetric information does cause settlement delay: in some treatments of the experiment, introducing asymmetric information increases average settlement delay by as much as 90 percent. Second, this causal relationship is apparently quite robust, persisting across significant perturbations to the bargaining environment. Third, the game-theoretic equilibrium is a better predictor of settlement delay than it is of settlement offers, acceptance decisions, and other aspects of negotiation. Finally, controlled information asymmetries are not the only apparent source of settlement delay.

The remainder of this paper provides context and justification for these conclusions. Section 2 briefly describes the model of the asymmetric-information hypothesis explored in this paper. Details of the experimental design and procedure are introduced in Section 3. Collected data are analyzed in Section 4. A brief conclusion offers additional discussion and comments on the broader implications of these findings.

2. Theory

The experiment conducted in this paper closely implements the structural model of settlement bargaining due to Spier (1992). Summary description of the model is provided to clarify the structure of the experiment and associated theoretic predictions. Proofs and fuller treatment of results are left to Spier (1989, 1992) and Bebchuk (1984).

The model contemplates bilateral settlement negotiation between a plaintiff (p) and defendant (d). The game picks up at the point where a civil dispute has already arisen and the exogenous date of a future trial to adjudicate the dispute has been set. Absent settlement, the parties will invest fixed litigation costs $k_\mathrm{p}, k_\mathrm{d} \in \boldsymbol{R}_+$ litigating a trial in which the plaintiff wins damages $x \in X = \left[\underline{x}, \overline{x}\right] \subseteq \boldsymbol{R}_+$ with exogenous probability $\pi \in (0, 1]$.

But before a verdict is rendered, the parties have an opportunity to contractually settle their dispute. Let the span of time from the start of the game to trial be represented by T discrete periods, with the above-described trial scheduled to take place in period $T + 1$. Each bargaining period starts with the parties investing fixed costs $c_\mathrm{p}, c_\mathrm{d} \in \boldsymbol{R}_+$ in litigation expenses. The defendant then proposes settlement at a wealth-transfer $s^t \in \boldsymbol{R}_+$, which the plaintiff may either accept, $a^t(s^t) = 1$, ending the game that period with a binding contract, or reject, $a^t(s^t) = 0$, advancing play to the next period or to trial if in period T.

Assume the parties maintain von Neumann–Morgenstern utility over fully transferable wealth and discount future wealth at rate $\delta \in [0, 1]$ per period. Equations (1) and (2) summarize period t utility, given settlement at arbitrary proposal s^t in period $t \leq T$ and given nonsettlement with a plaintiff of type x in period $T + 1$:[4]

$$U_\mathrm{p}^t(s^t;\, x) = \begin{cases} (\delta)^{t-1} s^t - c_\mathrm{p} \sum_{i=1}^{t} (\delta)^{i-1} & t \in 1, \ldots, T \\ (\delta)^T (\pi x - k_\mathrm{p}) - c_\mathrm{p} \sum_{i=1}^{T} (\delta)^{i-1} & t = T + 1 \end{cases} \tag{1}$$

and

$$U_\mathrm{d}^t(s^t;\, x) = \begin{cases} -(\delta)^{t-1} s^t - c_\mathrm{d} \sum_{i=1}^{t} (\delta)^{i-1} & t \in 1, \ldots, T \\ -(\delta)^T (\pi x + k_\mathrm{d}) - c_\mathrm{d} \sum_{i=1}^{T} (\delta)^{i-1} & t = T + 1 \end{cases}. \tag{2}$$

[4] To avoid confusion, exponentiated terms are enclosed in parentheses, like $(\delta)^{t-1}$, whereas terms with superscripted indexes, like s^t, are not.

Note that both litigants' utility functions depend on only the proposed and accepted settlement transfer s^t in periods $t \in 1, \ldots, T$ and on only potential damages x in period $T + 1$.

Two versions of the settlement-bargaining game are implemented in the experiment studied in this paper. Each corresponds to a different information structure.

In the symmetric-information version of the game, the value of potential damages x is common knowledge throughout negotiations. This models, for example, a situation in which liability is uncertain but damages are not—perhaps representing a stipulated, liquidated, or statutory remedy. With few additional assumptions, the symmetric-information model could alternatively be interpreted as a situation in which damages are uncertain but the parties have the same access to all relevant information.

In the asymmetric-information version of the game, the value of x is the private information of the plaintiff: in conventional terminology, x constitutes the plaintiff's type. Intuitively, the asymmetric-information game models a situation in which damages are uncertain and one party has relatively better access to information that is indicative of the likely damages award, not discoverable, and not credibly disclosable to the less informed party. This disparity in information is common knowledge. As a simplifying assumption for modeling purposes, suppose the parties agree that the set of potential awards X is distributed uniformly on continuous support in the population.

Equilibria in either version of the game consist of sequences of proposals, acceptance decisions, and (possibly trivial) beliefs. For every history of play $h^t \in H^t$, the defendant's strategy is a sequence of proposal functions $s \in S = \{(s^t)_{t=1}^T \,|\, s^t : H^t \to \boldsymbol{R}_+ \ \forall t\}$. The plaintiff's strategy is a sequence of acceptance criteria $a \in A = \{(a^t)_{t=1}^T \,|\, a^t : H^t \times S^t \to \{0, 1\} \ \forall t\}$. And the defendant's beliefs, $g \in G = \{(g^t)_{t=1}^T \,|\, g^t : H^t \to \Delta(X) \ \forall t\}$, specify a sequence of distributions in the set of possible probability distributions on potential damages $\Delta(X)$.

2.1. *Equilibrium with Symmetric Information*

With symmetric information, there exists a unique subgame perfect equilibrium in which the defendant immediately offers the plaintiff the expected net present value of trial and the plaintiff immediately accepts the offer. This result is analogous to subgame perfect reasoning in the familiar alternating-offers bargaining game (Rubinstein 1982). Spier (1992) provides a model-specific proof.

The intuition behind the proof is that the final period of bargaining is an ultimatum game in which the plaintiff's minimax value is the discounted expected value of trial. Predicting the plaintiff to behave rationally when given the move, the defendant proposes settlement at the plaintiff's minimax value, which the plaintiff accepts. The same argument can then be applied iteratively in each prior period. Equations (3) and (4) represent formal equilibrium strategies, omitting $\hat{g}$, which is trivially the degenerate distribution at $X = x$:

$$\hat{s}^t = (\delta)^{T-t+1}(\pi x - k_{\mathrm{p}}) - c_{\mathrm{p}} \sum_{i=1}^{T-t} (\delta)^i \quad t \in 1, \ldots, T \tag{3}$$

and

$$\hat{a}^t(s) = \begin{cases} 1 & \text{if } s \geq \hat{s}^t \\ 0 & \text{otherwise} \end{cases} \quad t \in 1, \ldots, T. \tag{4}$$

Although this type of solution is canonical in basic courses on game theory, it is worth noting several well-known respects in which it is questionable as both a descriptive and prescriptive account of play. On the theoretic side, uniqueness of the solution is lost without the restrictive assumption that future play will always be rational. There is a continuum of Nash equilibria, for example, in which settlement may occur at proposals different from the subgame perfect contract and with a delay of as much as T rounds before settlement. To the extent that the bargaining game admits multiple equilibria, it is not obvious that rapid settlement would necessarily be a focal equilibrium, nor is it obvious what distribution of wealth the litigants should expect.[5] On the empirical side, subgame perfect equilibria are not robustly observed in studies of bargaining games with perfect information (see, for example, Binmore 2007; Roth 1995; Güth, Levati, and Maciejovsky 2005) or in other perfect-information games for that matter.[6] As a prediction of play in the settlement-bargaining experiment, the zero-delay subgame perfect equilibrium thus stands on shaky ground.

2.2. Equilibrium with Asymmetric Information

With asymmetric information, there exists a perfect Bayesian equilibrium in pure strategies in which the defendant offers the plaintiff a settlement contract with the same net present value each period, the plaintiff delays acceptance of the settlement in proportion to the value of the private information, and some types of plaintiff reject all equilibrium proposals. Spier (1992) provides a proof of this result and its uniqueness under modest regularity assumptions.

The intuition behind the proof is similar in spirit to an equilibrium in randomized strategies. In the period T continuation game just before trial, the defendant responds to uncertainty about the plaintiff's type by making a middling offer that balances the marginal benefit of avoiding trial against the marginal cost of paying more than necessary to reach settlement (Bebchuk 1984). Privately aware of potential damages x, the plaintiff rejects this offer if and only if the discounted expected value of trial exceeds the offer. In every continuation game beginning

[5] The term "focal equilibria" is used in the flexible sense introduced by Schelling (1980). See Myerson (1997) for additional discussion.

[6] The familiar centipede game (Rosenthal 1981) poses a particular challenge to this solution concept (see, for example, Binmore 1996; McKelvey and Palfrey 1992).

in period $t < T$, the forward-looking defendant is then constrained to propose a settlement that would give the plaintiff the same utility as the above final-period settlement. This follows from the identity of preferences by plaintiff type until period $T + 1$: any other sequence of offers is necessarily subject to profitable deviation, as there will always be some period in which no type of plaintiff would settle. Finally, the plaintiff delays settlement in positive proportion to the value of potential damages. This type-dependent delay is not motivated by any intrinsic preference of the plaintiff but is needed to make the above-defined sequence of settlement offers sequentially rational for the defendant. Equations (5)–(7) represent formal equilibrium strategies with $\tilde{g}^t$ uniform on $[\underline{\tilde{x}}^t, \overline{x}]$:[7]

$$(5) \quad \tilde{s}^t = (\delta)^{T-t+1}(\pi\underline{x} + k_\mathrm{d}) + c_\mathrm{d}\sum_{i=1}^{T-1}(\delta)^{i-t+1} + c_\mathrm{p}\sum_{i=1}^{t-1}(\delta)^{i-1}, \qquad (5)$$

$$(6) \quad \underline{\tilde{x}}^t = \begin{cases} \underline{x} + (\pi)^{-1}(c_\mathrm{p} + c_\mathrm{d})\sum_{i=1}^{t-1}(\delta)^{i-T} & t \in 1, \ldots, T \\ \underline{\tilde{x}}^{t-1} + \pi^{-1}(k_\mathrm{p} + k_\mathrm{d}) & t = T+1 \end{cases}, \qquad (6)$$

and

$$(7) \quad \tilde{a}_x^t(s^t) = \begin{cases} 1 & \text{if } s^t > \tilde{s}^t \text{ and } U_\mathrm{p}^t(s^t) \geq U_\mathrm{p}^{T+1}(x) \\ 1 & \text{if } s^t = \tilde{s}^t \text{ and } x < \underline{\tilde{x}}^{t+1} \\ 0 & \text{otherwise} \end{cases}. \qquad (7)$$

As before, there are several senses in which this solution is questionable. On the theoretic side, despite being technically an equilibrium in pure strategies, settlement delay is motivated only by analogy to the unintuitive logic and sensitivity of a randomization equilibrium. Uniqueness and stability concerns also arise from the apparent sensitivity of many extensive-form incomplete-information games to seemingly unimportant changes in game structure, such as the nesting of moves in a choice space, the introduction of slight doubts about other players, and the introduction of low-probability events at the start of a game (see, for example, Fudenberg, Kreps, and Levine 1988; Myerson 1997, secs. 4.8, 5.1). More generally, relaxing maintained and refinement assumptions leads to a multiplicity of equilibria without any obvious focal points. On the empirical side, widespread difficulty with Bayesian updating (compare Ouwersloot, Nijkamp, and Rietveld 1998; Grether 1992) presents a potential obstacle to the predictive capacity of the solution.[8] And as noted previously, equilibrium refinements for bargaining games with incomplete information have fared uninspiringly in experimental studies to date (see, for example, Roth 1995).

[7] Summations with nonpositive upper bound have zero value.

[8] Kahneman (2011, pp. 146–84) provides an interesting summary of this literature. Myerson (1997, sec. 1.7) discusses application to game-theoretic models.

3. Experimental Design

In addition to illustrating how the asymmetric-information hypothesis explains settlement delay, the Spier (1992) model of settlement bargaining also structures bargaining in the laboratory experiment reported in this paper. Just like the theoretic model, the experiment involves a defendant making sequential settlement offers, a plaintiff making sequential acceptance or rejection decisions in light of symmetric or asymmetric information about the value of potential damages, and communication restricted to the action space of the bargaining game. The previous presentation of the theoretic model and potential solutions thus obviates the need for a detailed explanation of the rules of experimental interaction and formal hypotheses: the experimental bargaining game and associated predictions are as already described.

There are, however, a few important respects in which the experiment differs in a theory-neutral sense from the theoretic settlement-bargaining game.[9] The following three changes are implemented to help improve translation of the model to an experimental environment.

Interest Rate Substitution. Though convenient as a tool for modeling purposes, an abstract intertemporal discount rate (δ) admits no familiar analog in the experiences of most experimental subjects. It is replaced, in the experiment, by the more familiar device of interest accrual. An interest rate of $r = (1 - \delta)/\delta$, assessed against both costs and wealth, induces theoretically the same relative time preferences as an abstract discount rate of δ.

Painful Injuries. To bring the experiment in line with the type of corrective, distributional, and fairness concerns that permeate civil litigation, plaintiffs in the experiment are forced to suffer actual (monetary) injuries, which in turn define potential damages. Beyond increasing the external validity of results, the extent of loss suffered in a dispute-resolution game may constitute an important focal influence in any equilibrium selection problems that might arise during experimental settlement bargaining.

Wealth Padding. Litigants start the experiment, and each discrete replication of the settlement-bargaining game, with small cash injections calculated to prevent total earnings from ever becoming negative during the experiment.[10] These injections of wealth are the experimental analog of the background incomes of civil litigants and have no bearing on theoretic results except as a control against complications arising from potentially asymmetric preferences on the domains of gains and losses (see Kahneman, Knetsch, and Thaler 1991).

A final property of the experimental adaption of the Spier (1992) settlement-

[9] These changes are theory neutral in the sense that their omission from the theoretic model is without loss of generality under maintained assumptions. The changes are not neutral in the broader sense that they may be theoretically relevant under alternative assumptions and are implemented expressly because they are considered potentially relevant to the decision-making process of experimental subjects.

[10] The necessary size of these cash injections was determined by exploration in pilot studies for the experiment. An initial cash injection of \$50 was provided at the start of the experiment; thereafter, the plaintiff was given \$225 and the defendant was given \$300 each round.

bargaining model is the implementation of continuous-time bargaining in the lab. This design choice is again theory neutral in the sense that, subject to a regularity condition on the domain of parameter values (Spier 1992), all solutions presented in Section 2 persist in the limit as the duration of bargaining periods approaches zero.[11] Continuous-time implementation of the bargaining structure mitigates a potential source of design bias implicated by growing research on the behavioral difference between continuous-time and discrete-time decision environments (see, for example, Güth, Levati, and Maciejovsky 2005; Friedman and Oprea 2012). It also mitigates potential measurement bias arising from the visible collection of information in discrete bargaining periods. Finally, continuous-time bargaining improves the external validity of the experiment by better approximating the potential speed and fluidity of settlement negotiation in the field.

A new online bargaining interface was programmed to accommodate this implementation of settlement bargaining in the lab. Exploiting asynchronous JavaScript and XML and other Web 2.0 functionalities, this interface allows experimental subjects to negotiate flexibly in real time while still preserving strong experimental control over information availability, communication, and the structure of the bargaining process. The interface also serves as a cognitive aid for subjects, providing visual reminders of model parameters, summarizing previous experiences, and performing real-time calculations of income growth and other time-sensitive information relevant to experimental decision making.

3.1. Experimental Treatments

As the primary purpose of the experiment is to provide a low-level test of the asymmetric-information hypothesis, the treatment effect of principal interest is the difference in observed delay when litigants are exposed to asymmetric information as opposed to symmetric information. With all other variables controlled experimentally, the observed difference in settlement delay between these treatments identifies the causal effect of asymmetric information on the timing of dispute resolution.

Measurement of the asymmetric-information treatment effect is implemented in a crossover design that exposes all subjects to two settlement-bargaining games differing only in information structure. In one treatment, only the plaintiff is told the exact value of potential damages; in the other treatment, the value of the potential damages is provided to both the plaintiff and defendant. The purpose of exposing all subjects to both information environments is to create the necessary variation to control for low-level unobserved heterogeneity in econometric analysis of observed effects (see Jones and Kenward 2003).

The experiment also includes several alternative bargaining environments that act as robustness checks for observed treatment effects in the control environment. In addition to the control setting, the experiment estimates the effect of

[11] Parameters in the experiment were selected to satisfy a model-specific regularity condition (Sullivan 2011, pp. 76–77).

asymmetric information on settlement delay under the following four environmental perturbations:

Reversed Costs. Cost terms for plaintiff and defendant are swapped to verify that the arbitrary choice of control parameters does not overly influence the observed treatment effect.[12]

Reduced Costs. Similar to the previous environment, the negotiation costs of both plaintiff and defendant are halved as a means of testing treatment-effect dependence on control terms.

Low Asymmetry. The range and variance of potential damages are substantially reduced as a test of treatment-effect dependence on the presence of large informational asymmetries.

Law Students. The control bargaining environment is replicated using a law student subject pool as a robustness check against the use of undergraduate subjects elsewhere in the design.[13] Parameter values for the control environment and each of these perturbations are consolidated in Table 1. (Theoretic predictions relating to each perturbation are discussed in the online appendix.)

3.2. Experimental Procedure

The size and complexity of the experiment required that it be conducted in a number of smaller constituent sessions spanning several months. Each session consisted of two information treatments (asymmetric and symmetric information) and one bargaining environment (control, reversed costs, and so on), with four sessions assigned to each of the five bargaining environments for a total of 20 sessions, excluding pilot tests.

Sessions began with the random assignment of 12 subjects to permanent roles as plaintiff or defendant. Subjects were then randomly matched into six pairs of litigants at the start of each of 14 rounds of settlement bargaining per session. Information structures were assigned orthogonally in this design, so within the four sessions of a given bargaining environment, two sessions exposed subjects to seven rounds of the symmetric-information treatment followed by seven rounds of the asymmetric-information treatment, and the other two sessions reversed this order. The change in information treatment was not announced until all negotiation in the first seven rounds had been completed. Orthogonal assignment of information structures provides an experimental control against possible design bias arising from the order of exposure to information treatments in the experiment.

Subjects in the experiment were recruited from the student population of the University of Virginia. In total, 240 unique subjects participated in the exper-

[12] The control bargaining environment assigns the plaintiff and defendant unequal costs as a means of reducing the artificial symmetry of bargaining in a laboratory context. For context regarding this concern, see Cherry, Frykblom, and Shogren (2002) and Hoffman et al. (1994).

[13] Subjects included first-, second-, and third-year law students. As these sessions were conducted at the close of an academic school year, the substantive differences between first-year and upper-class law students are believed to have been minimal (no offense intended).

Table 1
Bargaining Environment Parameter Values

Term	Control	Reversed Costs	Reduced Costs	Low Asymmetry
$\underline{x}$ ($)	50.00			
$\overline{x}$ ($)	200.00			150.00
π	.75			
T	120			
δ	.999			
c_p ($)	.14	.32	.07	
c_d ($)	.32	.14	.16	
k_p ($)	11.00	5.00		
k_d ($)	5.00	11.00		

iment: 192 undergraduate students and 48 law students. Subjects volunteered to participate without prior knowledge of the experiment (were uninformed) and participated in at most one session of the experiment (were inexperienced). While it was not possible to prevent subjects from recognizing each other when entering the lab, all interactions in the experiment were fully anonymous.

Subjects were compensated for participating in the experiment with cash payments determined by their negotiation performance. A $6 show-up fee was provided for timely arrival, and subjects were informed that they would be paid a percentage of their total experimental earnings at the end of the experiment. Undergraduate subjects were compensated at .05 percent of their experimental earnings, and law student subjects were compensated at .075 percent of their earnings. Average total payments were around $23.50 for undergraduate subjects and $31.00 for law students. As sessions generally lasted only 60–75 minutes including instructions, this level of compensation is believed to have sufficed in maintaining effort and attention throughout the experiment.

4. Analysis of Results

Data collected in the experiment support the asymmetric-information hypothesis as an explanation of settlement delay. As a corollary, the results also support asymmetric information as a cause of total bargaining impasse. Other aspects of the predicted equilibrium are not so strongly supported by the data. The following discussion presents the observed treatment effects and other information learned from the experiment.

4.1. Treatment Effects of Asymmetric Information

The presentation of treatment effects in this paper requires two brief caveats. First, the concept of settlement delay is poorly defined for disputes ending in trial verdicts. These outcomes are the pinnacle of delay from a total-time-to-resolution perspective. But as trial-disposed disputes never settle, their relationship to delay in settled disputes is necessarily a function of assumptions about the timing of trial. To address this complication, the following analysis reports treatment effects in terms of both delay to resolution (average delay including trial outcomes as a delay of 121 seconds)[14] and delay to settlement (average delay conditional on settlement of a dispute).

Second, treatment effects and all other analyses are computed with a sample that omits observations from the first two rounds of bargaining in an information treatment: rounds 1, 2, 7, and 8 are dropped from the data. Excluding these initial rounds of play provides an experimental control for design bias introduced by rapid learning and strategy adjustment in the early rounds of exposure to a treatment. This is a costly control, as subjects were fully compensated for their participation in the omitted rounds, but seems appropriate given the complexity of the experiment and this paper's focus on equilibrium behavior.

With each session considered as a matched pair of observations on average delay, the treatment effect of exposure to asymmetric information (as oppose`d to symmetric information) is an increase in delay to resolution of about 25.18 seconds, or an increase in delay to settlement of 23.78 seconds. As a reminder, this effect is relative to a total bargaining window of only 2 minutes. To the extent that one believes that session-average differences are identically distributed across different bargaining environments, an exact test rejects the null hypothesis of no treatment effect at a p-value of 1.907×10^{-6} for both measures of delay.[15] Put another way, average delay under asymmetric information exceeded average delay under symmetric information in every session of the experiment.

Exposure to asymmetric information also had the treatment effect of increasing the rate of bargaining impasse. With session-average differences again taken to be identically distributed across bargaining environments, the effect of exposure to asymmetric information is about a 50 percent increase in the percentage of disputes ending in trials: from 23.5 percent with symmetric information to 36.2 percent with asymmetric information. An exact test rejects the null hypothesis of no treatment effect at a p-value of 2.67×10^{-5}. In 19 of 20 experimental sessions, the rate of trial verdicts was higher when subjects were given asymmetric information.

A more detailed view of these treatment effects can be seen in the data on individual dispute outcomes. Figure 1 shows the entire distribution of delay to resolution (A) as predicted by theory for the control environment with asymmetric information, (B) as observed in the pooled subsample of data for the control and law school bargaining environments, and (C) as observed under symmetric information for the same pooled subsample. Pooling data in this manner helps to smooth empirical delay distributions and is justified by the identity of parameter values and similarity of observed behavior in both environments (as discussed

[14] The experimental bargaining model defines trial outcomes as lasting 1 second and occurring immediately at the end of settlement negotiation.

[15] These and the following exact test are paired-sample applications of the Wilcoxon signed-rank test to the vector difference of matched pairs for the two information treatments in each session (see, for example, Miller 1997).

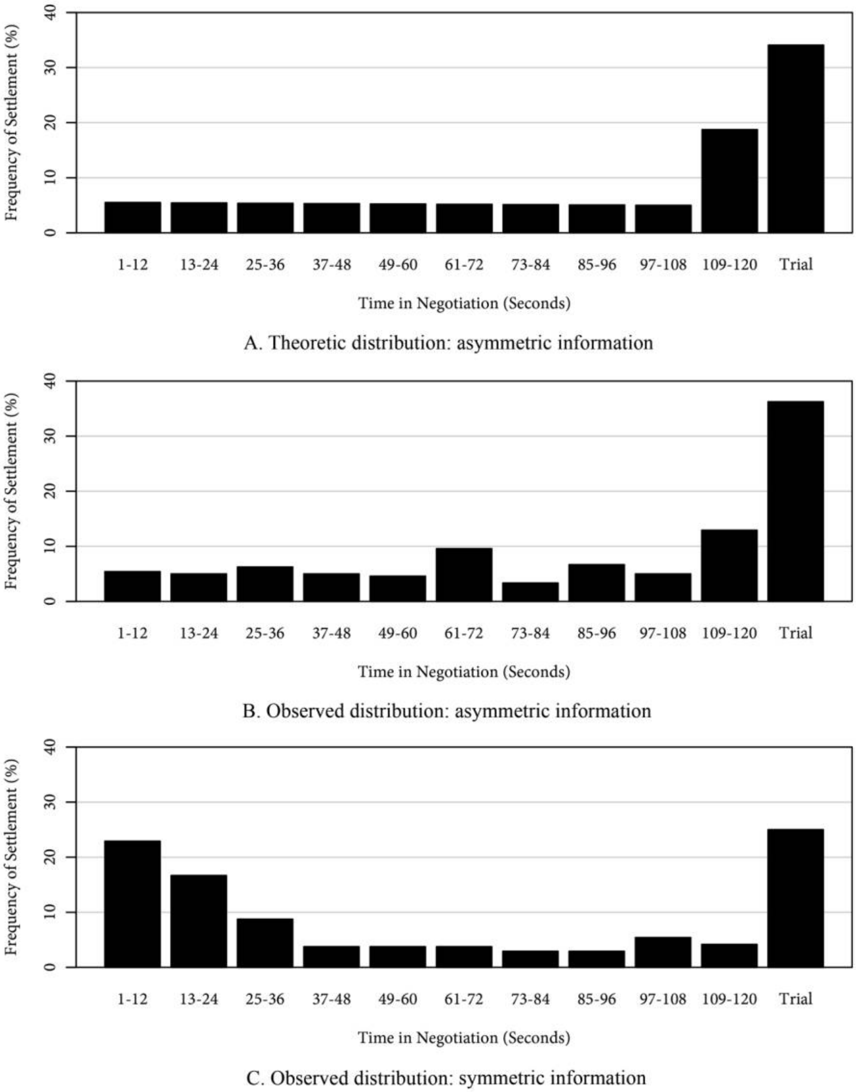


Figure 1. Distribution of delay to resolution

later in this section). The predicted distribution of delay under symmetric information is trivial (full settlement in the first second of bargaining) and omitted for brevity.

The predicted distribution of delay under asymmetric information in Figure 1*A* comes from equations (5)–(7) with arguments set to control parameter values. The almost constant probability of settlement before the final second of bargaining is explained by the perfect Bayesian equilibrium described in Section 2.2. The intuition is similar to that of a randomization equilibrium: every type of plaintiff ultimately settles for the same offer in net present value, but the plaintiff must delay acceptance in proportion to her private damages draw in order to make this sequence of offers sequentially rational for the defendant. The discrete spike in settlement at the end of bargaining reflects the discrete cost of trial, and plaintiffs with large enough damages never settle.

Figure 1*B* and 1*C* shows the main findings of this experiment. Surprisingly, for such a complicated equilibrium, the observed distribution of delay under asymmetric information roughly tracks the theoretic prediction. Delay under symmetric information does not. The observed treatment effects of asymmetric information are reflected in the comparison of empirical delay when subjects are symmetrically and asymmetrically informed: exposure to asymmetric information increases settlement delay by shifting probability mass away from early settlement and into both late settlement and nonsettlement.

Formal analysis of dispute-level data confirms these qualitative observations about the treatment effects of asymmetric information. The outcomes of individual disputes may be dependent within repetitions of a particular matching but are independent and plausibly identically distributed after controlling for potential sources of dependence. Randomized matchings produce an unbalanced panel with 620 pairs and $1 \leq M \leq 4$ repeat observations per pair for an effective sample of 1,200 observations; omitting trial outcomes from the sample (to compute delay to settlement) leaves 532 pairs and 842 observations.

Table 2 contains parameter estimates and associated inferences for several regressions of dispute-level settlement delay on experimental and observational controls. Columns 1 and 3 regress measures of settlement delay on indicators for exposure to asymmetric information interacted with indicators for each of the noncontrol robustness-check environments. Columns 2 and 4 add two lags of the response variable for the plaintiff (D_p) and defendant (D_d) to control for unobserved sources of serial dependence. In every case, fixed-round effects and random-pair effects account for potential correlation within rounds and pairs of subjects, respectively.

For the control environment, the treatment effect of exposure to asymmetric information is easiest to see as the parameter on asymmetric information in columns 1 and 3 of Table 2. The estimated increase in average delay to resolution of 27.7 seconds in column 1 is about a 60 percent increase over delay with symmetric information. The estimated average increase in delay to settlement of 31.8 seconds in column 3 is about a 90 percent increase. In each case, the treatment effect of exposure to asymmetric information is statistically distinguishable from 0 at every interesting level of significance.

Estimates in columns 2 and 4 of Table 2 tell a similar story. Lagged terms indicate significant positive partial correlation between past and present delay, pre-

Table 2
Regression of Settlement Delay on Asymmetric Information

	Delay to Resolution		Delay to Settlement	
Parameter	(1)	(2)	(3)	(4)
Constant	46.876***	10.586+	35.484***	12.164*
	(5.7243)	(6.1978)	(5.1419)	(5.7191)
AI	27.728***	15.467**	31.836***	23.358***
	(5.6439)	(5.2354)	(4.9396)	(4.8077)
Reversed costs	2.079	2.060	9.930+	9.067+
	(6.5875)	(5.7408)	(5.3102)	(4.8697)
Reduced costs	10.854	6.208	18.345**	15.865**
	(6.6874)	(5.8895)	(5.7531)	(5.3255)
Low asymmetry	6.479	4.610	6.020	5.891
	(6.7911)	(5.9048)	(5.4769)	(5.1481)
Law students	7.197	4.085	9.847+	6.719
	(6.4392)	(5.9475)	(5.3682)	(5.1446)
Reversed costs × AI	−6.546	−4.688	−15.397*	−13.062*
	(7.9447)	(7.1764)	(6.6202)	(6.3036)
Reduced costs × AI	−1.176	−.552	−6.974	−8.001
	(7.7787)	(7.0566)	(7.6844)	(7.1361)
Low asymmetry × AI	−9.160	−6.623	−12.435	−11.581
	(8.0635)	(7.4130)	(7.5727)	(7.3887)
Law students × AI	.033	−1.906	−1.435	−2.073
	(7.5962)	(7.0301)	(7.3410)	(7.0941)
Lag(1)D_p		.043		.073**
		(.0285)		(.0270)
Lag(2)D_p		.139***		.103***
		(.0315)		(.0304)
Lag(1)D_d		.159***		.082**
		(.0301)		(.0297)
Lag(2)D_d		.199***		.087**
		(.0297)		(.0282)
σ_η^2	479.44	152.01	531.5	381.84
σ_ε^2	1,269.39	1,255.71	698.74	701.62

Note. Parameter estimates are from random-pair-effects regressions of delay to resolution and delay to settlement on treatment indicators and lagged dependent variables (Swamy and Arora 1972). Values in parentheses are heteroskedasticity and cluster-robust standard errors (Arellano 1987). Parameter estimates for fixed-round effects are omitted. Variances σ_η^2 and σ_ε^2 correspond to pair and idiosyncratic error terms, respectively. AI = asymmetric information.

$^+ p < .10$.
$^* p < .05$.
$^{**} p < .01$.
$^{***} p < .001$.

sumably by acting as a proxy for litigant-specific fixed effects.[16] Controlling for serial correlation does not, however, substantively change results. Most of the ap-

[16] This interpretation is suggested by attenuated lagged terms in unreported regression models with fixed-pair effects; these regressions have been omitted for brevity and are available on request. See Wooldridge (2006, pp. 315–17) for an accessible discussion of lagged dependent variables as a proxy for unobserved heterogeneity.

parent difference in estimates relative to the unlagged estimates is due to a subtle difference in what is being estimated: these are contemporaneous treatment effects as opposed to average treatment effects.[17] And appropriate transformation of the lagged estimates yields implied average treatment effects of 33.6 seconds for delay to resolution and 35.6 seconds for delay to settlement.[18] Controlling for serial dependence thus provides even stronger support for the asymmetric-information hypothesis as a causal explanation of delayed agreement in settlement negotiation.

Similar results are reported in Table 3 for binary-response regressions contrasting early settlement (seconds 1–12 of bargaining) with intermediate settlement (seconds 13–108), late settlement (seconds 109–20) with intermediate settlement, and trial with any settlement. These contrasts correspond to different subsets of the data: 482 pairs and 732 observations for the early settlement contrast, 473 pairs and 679 observations for the late settlement contrast, and (the full sample) 620 pairs and 1,200 observations for the trial contrast. To retain statistical power for the growing number of parameters that must be estimated with each additional contrast, explicit interactions between the information treatment and bargaining environments are omitted in these regressions.[19] Random-pair effects and round effects account for potential correlation within pairs of subjects and rounds of the experiment, respectively.

In each of the contrasts reported in Table 3, the treatment effect of exposure to asymmetric information in the control environment is statistically different from 0 at every interesting level of significance. Exposure to asymmetric information decreases the probability of early settlement from 34 percent (with symmetric information) to 13 percent (with asymmetric information) contrasted with intermediate settlement. Asymmetric information increases the probability of late settlement from 5 percent to 14 percent contrasted with intermediate settlement. And asymmetric information increases the probability of a trial verdict from 20 percent to 34 percent contrasted with any settlement.

4.2. *Robustness of Observed Treatment Effects*

Confidence in the validity of observed treatment effects is bolstered by the similarity of results across all of the noncontrol bargaining environments included as robustness checks in the experiment. The primary inquiry is whether average settlement delay differs substantially from the control environment in any of these

[17] The parameter on asymmetric information represents an average treatment effect in the unlagged estimates. In the lagged estimates, the same parameter represents the effect of introducing asymmetric information while holding prior experience constant. But since prior experience is itself a function of the information environment, the contemporaneous effect of information asymmetry is not generally the same as its average effect over time.

[18] This assumes that the model is wide-sense stationary. For discussion, see Sullivan (2011, pp. 220–21).

[19] This omission is relaxed by the nonlinearity of the probit link function, which creates functional dependence between environmental shifters and the effect of exposure to asymmetric information at any rate.

Table 3

Regression of Dispute Outcomes on Asymmetric Information

Parameter	Early Settlement	Late Settlement	Trial
Constant	−.412**	−1.612***	−.808***
	(.1534)	(.2415)	(.1385)
Asymmetric information	−.689***	.538***	.392***
	(.1304)	(.1430)	(.0837)
Reversed costs	−.282	.008	−.132
	(.1847)	(.2251)	(.1385)
Reduced costs	−.410*	.511*	.032
	(.1970)	(.2203)	(.1366)
Low asymmetry	−.031	.098	.080
	(.1830)	(.2291)	(.1361)
Law students	−.350+	.255	.070
	(.1908)	(.2226)	(.1359)
σ^2_η	.1663	.2076	.1201
σ^2_ρ	.0478	.0083	.0696

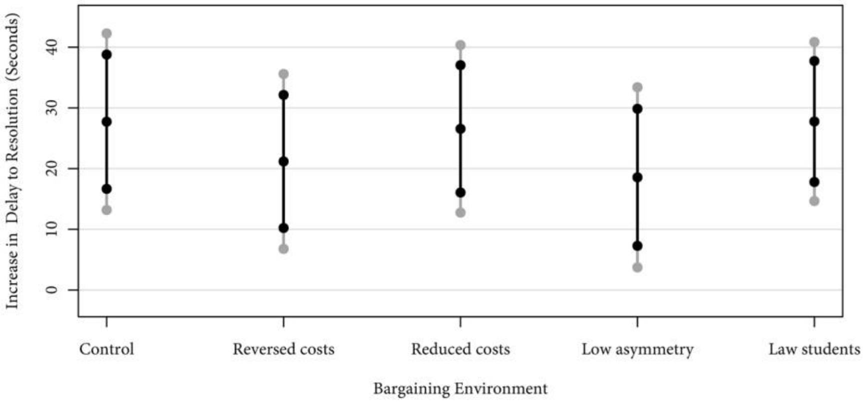
Note. Parameter estimates are from probit regressions contrasting early settlement (seconds 0–12) with intermediate settlement (seconds 13–108), late settlement (seconds 109–20) with intermediate settlement, and trial with any settlement. All regressions include random-pair effects and round effects with estimated variances σ^2_η and σ^2_ρ, respectively.

+ $p < .10$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

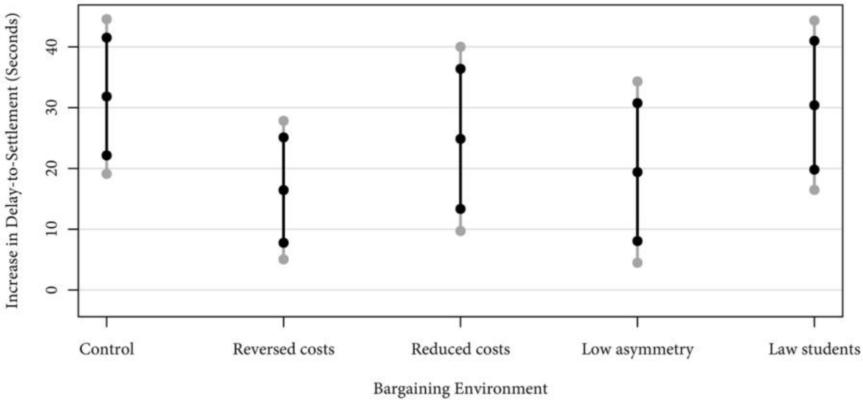
different environments; this comparison of averages roughly reflects lower-level distributional differences as well. Relevant treatment effects are contained in Table 2, but because interaction terms make them a bit difficult to read for the noncontrol environments, estimated effects and associated confidence intervals are shown in Figure 2.

The intervals in Figure 2 reflect the observed treatment effects of asymmetric information on average settlement delay in each environment, as implied by appropriate combinations of parameter estimates for unlagged regressions in Table 2. Dark segments illustrate individual 95 percent confidence intervals, while light segments represent simultaneous 95 percent confidence intervals constructed using Bonferroni correction (see, for example, Miller 1997, pp. 74–74).[20] In every case, and even simultaneously, the increase in settlement delay under asymmetric information is statistically distinguishable from 0 at the 5 percent level of significance. Asymmetric-information treatment effects vary little between the different bargaining environments, with most confidence intervals easily containing the observed treatment effect in the control environment. The greatest differences in treatment effects are observed in delay to settlement for the reversed-costs and low-asymmetry environments. But even these differences are modest, and the di-

[20] Simultaneous 95 percent confidence intervals have the interpretation of being generated by a process that bounds all five expected values at least 95 percent of the time.



A. Average increase in delay to resolution



B. Average increase in delay to settlement

Figure 2. Asymmetric-information treatment effects by environment

rectional effect of asymmetric information on settlement delay remains the same as in the control environment.

For the law student bargaining environment, the strong similarity of observed treatment effects to those of the control environment strengthens experimental results in several respects. First, it lends confidence to the external validity of data gathered from undergraduate subjects—at least in terms of the generality of results in this laboratory experiment. Second, it supports the pooling of undergraduate and law student subjects to obtain greater statistical power in some parts of this analysis, since these subjects exhibited broadly similar behavior when exposed to the same treatments and bargaining parameters.

For the remaining robustness-check environments, the overall similarity of treatment effects to the control environment suggests that the causal effect of asymmetric information on settlement delay is robust. For example, while the treatment effect on delay to settlement is slightly attenuated in the reversed-costs perturbation, results are otherwise similar to the control. This provides confidence that results are not driven by the arbitrary assignment of asymmetric cost terms in the experiment. So too, the similarity of treatment effects in the control and reduced-costs perturbation indicates that the asymmetric-information treatment effect is relatively insensitive to changes in gross costs. And this again provides confidence in the representativeness of control-environment treatment effects. Finally, results from the low-asymmetry perturbation indicate that, at least in the neighborhood of the control parameter values, substantial changes in the size of the informational asymmetry have only a limited effect on the magnitude of resulting delay. Once again, this provides confidence that results are not strongly dependent on the control environment's arbitrary choice of informational disparity.

4.3. *Comparison of Observed and Predicted Play*

Having validated the asymmetric-information hypothesis, a collateral inquiry is whether lower-level details of the Spier (1992) model of settlement bargaining accurately predict other aspects of behavior in the lab. To be clear, a rigorous test of equilibrium strategies is not on the table: game-theoretic solution concepts are notoriously difficult to test in all but the simplest of cases,[21] and this experiment is designed to measure and test treatment effects, not equilibria. But measurements taken during the experiment can still be helpfully compared with the theoretic model to provide at least illustrative evidence of the model's descriptive plausibility. In this respect, some aspects of the Spier model fit the collected data remarkably well; others do not.

For example, average observed settlement proposals are surprisingly close to theoretic predictions. Figure 3 shows the average sequence of settlement offers in the experiment and the corresponding predictions for the pooled subsample of disputes in the control and law student bargaining environments. To be precise, the conditional average settlement offer measures the average settlement offer observed in the experiment at each point in time; worst-case-scenario bounds on the unconditional average settlement offer represent a set estimate of the average offer accounting for nonobservation of settlement offers following settlement of a dispute.[22] After the first 25 seconds of play, conditional average and predicted set-

[21] Challenges include the elicitation of beliefs and strategies off the path of play.

[22] Unlike the game-theoretic model, in which strategies define settlement offers at every possible information set regardless of the path of play, settlement offers in the experiment are measured only along the path of play and only prior to settlement of a dispute. Worst-case-scenario bounds enclose the unconditional average offer under the agnostic assumption that all postsettlement offers would, on average, fall within the 10 percent and 90 percent empirical quantiles of observed offers (see Manski 1989). The conditional average is estimated as a fourth-degree polynomial in time. Nonparametric worst-case-scenario bounds (Manski 1989) are constructed from the 10 percent and 90 percent empirical quantiles of observed offers with a Loess model of the likelihood of settlement over time.

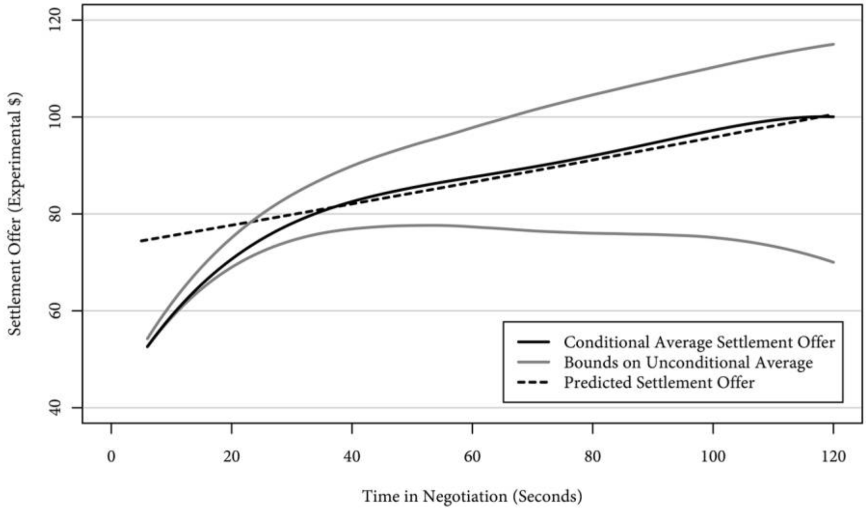
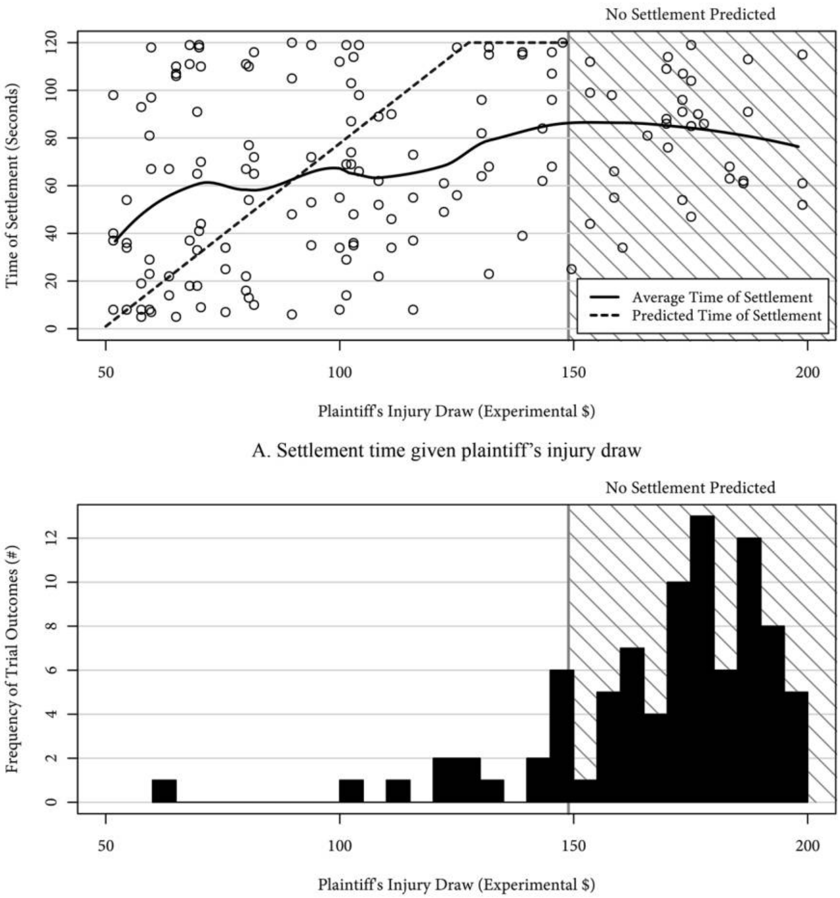


Figure 3. Comparison of observed and predicted settlement offers

tlement sequences are nearly identical. And while bounds on the unconditional average are imprecise, they are not inconsistent with the theoretic model.

But this similarity of predicted and observed settlement proposals is not well reflected at the more disaggregated level of individual disputes. In some cases, individual proposal sequences do correspond closely with the theoretic prediction. But in the majority of cases, the sequences of proposals differ from prediction. Common observations are sequences of settlement proposals that everywhere exceed prediction or that increase too quickly over time. Proposal sequences that decrease over time are not uncommon and tend to end in trial verdicts. Nonmonotonic sequences are also observed, sometimes varying rapidly between high- and low-value proposals. Video replays illustrating observed play in a subsample of experimental bargaining games are provided with the online appendix. In sum, while average settlement proposals closely track theoretic predictions, it is hard to draw the more demanding conclusion that the Spier model aptly describes individual proposal strategies in the lab.

Like much experimental work on ultimatum and alternating-offer bargaining models (see, for example, Roth et al. 1991; Ochs and Roth 1989; Roth 1995), the comparison of actual and predicted acceptance or rejection decisions is also mixed. As shown in Figure 4*B* for the pooled subsample of disputes in the control and law school bargaining environments, trial outcomes were predominantly observed for exactly the range of injury draws predicted to end in trials. But as shown in Figure 4*A*, the observed timing of settlement-by-injury draw is inconsistent with predicted strategies. This is not necessarily surprising given the complicated reasoning that motivates settlement timing in the predicted equilibrium and especially given that observed sequences of settlement proposals often devi-



A. Settlement time given plaintiff's injury draw

B. Plaintiff's injury draw given rejection

Figure 4. Comparison of observed and predicted acceptances and rejections

ated from prediction. For possibly similar reasons, Figure 4*A* also shows a number of settled disputes with injury draws that theoretically should have ended in trial outcomes.

Interestingly, the mixed results for settlement offers and acceptance or rejection decisions combine to effect a distribution of delay-to-resolution outcomes that very closely mirror the theoretic prediction. This is shown in Figure 1*A* and 1*B*. Put another way, despite the noted differences between theory and practice on the joint distribution of injury and settlement time, the marginal distribution of settlement time alone closely approximates the model's predictions. And the observed rate of trial verdicts also closely approximates predictions.

4.4. *Settlement Delay under Symmetric Information*

One last collateral inquiry concerns the measurement of persistent settlement delay in symmetric-information treatments of this experiment. Consistent with much experimental research on negotiation, symmetrically informed subjects did not uniformly and immediately settle their disputes as predicted by the unique subgame perfect equilibrium of this game.[23] The distribution of delay and bargaining failure under exposure to symmetric information is shown in Figure 1*C* for the pooled sample of control and law student disputes. While settlement delay is less pervasive in the symmetric-information treatment than it is in the asymmetric-information treatment, residual settlement delay and bargaining failure remain far from negligible.

Combined with the previous analysis, experimental results thus support two basic conclusions about the causes of settlement delay. Exposure to asymmetric information in settlement negotiation can increase the time it takes litigants to reach agreement. But not all settlement delay is explained by the controlled informational asymmetry introduced in this experiment.

Persistent settlement delay in the symmetric-information treatment may be attributable to many possible causes: examples include uncontrolled informational asymmetries, divergent expectations (Babcock, Loewenstein, and Issacharoff 1997), sociological considerations (see Roth, Malouf, and Murnighan 1981), coordination problems (see Schelling 1980), or other uncontrollable frictions of interaction and negotiation. The experiment was not designed to identify or distinguish between these potential explanations, and the pragmatic assumption must be that many factors could combine to explain residual settlement delay in both the laboratory and the field (compare Binmore 2005, sec. 3.5). In this respect, experimental results serve as a reminder that validation of the asymmetric-information hypothesis does not invalidate other potential explanations for settlement delay.

An even broader implication of persistent settlement delay in the symmetric-information treatments speaks to experimental research on deadline effects in bargaining games with exogenous stopping points. In experimental study of bargaining games with complete information, agreements are often observed with disproportionate frequency in the final stretch of interaction before a fixed end date (for example, Roth, Murnighan, and Schoumaker 1988).[24] In some circumstances, this deadline effect may work to delay agreement, such that introducing a binding cutoff on negotiation may increase delay relative to unconstrained negotiation (Gneezy, Haruvy, and Roth 2003).

The trial outcome in this experiment is the quintessence of a termination point on bargaining, but as shown in Figure 1*C*, settlement bargaining under symmet-

[23] On similar bargaining-failure deviations from equilibrium, see, for example, Güth, Schmittberger, and Schwarze (1982); Roth et al. (1991); Forsythe et al. (1994); Hoffman et al. (1996). On similar delayed-agreement deviations from equilibrium, see, for example, Roth et al. (1988); Ochs and Roth (1989); Gneezy, Haruvy, and Roth (2003); Güth, Levati, and Maciejovsky (2005).

[24] Güth, Levati, and Maciejovsky (2005) collect and review many studies in this literature.

ric information exhibits no evidence of a deadline effect. One interpretation is that this agrees with the conclusion of Güth, Levati, and Maciejovsky (2005): that nontrivial delay costs in long-horizon games may suffice to mitigate deadline effects in negotiation. But an intriguing alternative interpretation is suggested by Figure 1*B* and 1*C*. The observation of a modest deadline effect under asymmetric information, and no such effect under symmetric information, hints that asymmetric information may in some cases cause the type of delayed agreement often characterized as a deadline effect. How far this generalizes—whether observed deadline effects are frequently the result of uncontrolled informational asymmetries—is a question for another paper.

5. Conclusion

The asymmetric-information hypothesis enjoys strong theoretical support but has not been adequately validated in the empirical literature to date. This paper addresses that need. Data collected in the laboratory experiment support the following four empirical conclusions. First, asymmetric information can delay settlements. Delay to settlement increased by as much as 90 percent during exposure to asymmetric information in some treatments of the experiment. Second, the causal increase in settlement delay under asymmetric information appears quite robust. It varies only slightly under significant perturbations to the bargaining environment. Third, the Spier (1992) model of settlement delay aptly describes the average outcome of disputes in the lab but is less successful in describing other aspects of bargaining interaction. Fourth, the controlled informational asymmetry manipulated in the experiment is not the only explanation for persistent settlement delay. Delays remain even when litigants have the same access to controlled information in an otherwise sterile bargaining environment.

At the level of proof of concept, the first and second conclusions validate the asymmetric-information hypothesis as a plausible explanation of persistent settlement delay in civil litigation. But the qualifier "proof of concept" is important. While this paper demonstrates that asymmetric information can delay settlement, it does not demonstrate that asymmetric information actually does delay settlement in the field. In particular, nothing in this experiment shows that litigants are actually asymmetrically informed in many practical situations. Whether they are is an empirical matter in need of thorough and independent study.

The third and fourth conclusions caveat results to the information content of the data. While this experiment robustly measures how asymmetric information delays settlement, it provides less insight into the strategies that motivate this delay. Observed behavior is consistent with some aspects of the Spier (1992) model but is inconsistent with other aspects of the model. And even in this idealized bargaining environment, negotiation without controlled informational asymmetries still exhibits persistent settlement delay and bargaining failure. This underscores the potential for multiple sources to contribute to settlement delay and highlights the need for further research in this area.

Subject to these qualifications, the implications of this experiment are potentially far reaching. For example, the model of settlement bargaining studied in this paper describes the basic structure of many dispute-resolution problems: labor disputes, international conflicts, and merger-and-acquisition deals, among others. Empirical proof that asymmetric information can cause settlement delay in the civil litigation context supports analogous insights in these other settings as well. Similarly, this validation of the asymmetric-information hypothesis speaks to a broader question of whether asymmetric information may generally delay agreement in noncooperative negotiation (Kennan and Wilson 1993). These results contribute an unqualified validation of the hypothesis to a literature with few clear empirical answers to date (compare Roth 1995).

For legal practitioners in common-law jurisdictions, the results of this experiment may help to inform litigation strategies. For example, while playing key facts and legal arguments close to the vest may sometimes help to mitigate an opponent's ability to respond at trial, this asymmetric information may also disadvantage one's client by obstructing pretrial negotiation and foreclosing efficient resolution through rapid settlement. Given the disproportionate frequency of settlements over trial verdicts, less caution and secrecy during discovery and negotiation may be advantageous in some cases. At a minimum, this experiment should serve as a reminder to consider trial and discovery strategies with an eye toward informational asymmetries—perceived or real—and how they may influence settlement negotiations.

The results of this experiment are also likely to interest policy makers concerned with the slow speed and high cost of US civil litigation.[25] If asymmetric information is indeed a contributor to the settlement delay observed in civil litigation, then a natural question is whether any procedural reforms may mitigate this effect. The obvious possibility of further strengthening the tools of discovery is not especially compelling. Modern US discovery is already quite expansive, and even with open-file discovery practices, search costs and evasive practices may still work to preserve informational differences and frustrate rapid settlement.

An alternative approach is to consider procedural reforms aimed at mitigating not asymmetric information but its consequences for settlement delay. For example, litigation reforms such as caps on damages and prejudgment interest rules are often touted as ways to increase litigation efficiency and (implicitly) to speed settlement negotiation. But the practical efficacy of these reforms in reducing settlement delay is still largely unknown. Future research using laboratory experiments is a promising strategy for cheaply and efficiently assessing whether such reforms might, in fact, reduce the time it takes civil litigants to settle.

[25] See, for example, Senator Joseph Lieberman: "Everybody in America knows . . . that our civil justice system is not working well. . . . The average person on the street—I stop them in Hartford, New Haven, Bridgeport—knows that lawsuits take too long; that people do not get justice in a timely fashion; that too much of the money goes to lawyers. They know that" (Commonsense Product Liability Legal Reform Act of 1996—Conference Report. 142 Cong. Rec. S2569 [March 21, 1996]).

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