Contracting on Litigation*

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Abstract

Two risk-averse litigants with different subjective beliefs negotiate in the shadow of a pending trial. Through contingent contracts, the litigants can mitigate risk and/or speculate on the trial outcome. The opportunity for contingent contracting decreases the settlement rate and increases the volume and costs of litigation. These contingent contracts mimic the services provided by third-party investors, including litigation funders and insurance companies. The two litigants (weakly) prefer to contract with the external capital market when third-party investors are risk neutral and the capital market is transaction-cost free. However, contracting with third parties further decreases the settlement rate, increases the volume and costs of litigation, and may increase the aggregate cost of risk bearing. In this sense, third-party involvement in litigation can reduce social welfare.

JEL Codes: K41, G32, D84, D86

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1 Introduction

This paper studies contingent settlement contracts, exploring both the deals that are struck between the litigating parties themselves and their agreements with outside investors. Traditionally, scholars have viewed settlement as a simple transfer payment from the defendant to the plaintiff in exchange for the plaintiff abandoning a claim.[1] But in reality, parties can and often do write detailed contracts before trial that turn on the future trial outcome. We explicitly account for this by allowing litigating parties to write general contracts with each other that are contingent on the outcome of litigation. Then, placing lawsuits into a market context, we compare these "inside" contracts to the "outside" contracts offered by competitive third-party investors. While the inside and outside contracts create value in similar ways, we show that contingent contracts between the litigants themselves may lead to relatively fewer trials, less wasteful litigation spending, and less aggregate risk.

Contingent settlement contracts appear in many different legal contexts and take a variety of forms. Consider the following examples: In an automobile liability case, a \$125,000 jury award was reduced to just under \$94,000 because the parties agreed in advance to a 75%/25% split of any court-awarded damages.[2] In a high-stakes medical malpractice case, a \$30 million jury award was reduced to \$5.3 million pursuant to a "high-low" contract signed by the parties before trial.[3] In yet another lawsuit, the parties agreed to a damage payment of \$6,000 if the jury found the defendant to be less than 50% at fault, \$11,250 if she were found to be exactly 50% at fault, and \$22,500 if she were more than 51% at fault.[4] Contingent contracts with third-party financial service providers, including insurance companies and litigation funders, have become increasingly common as well.

This paper explores the positive and normative implications of contingent settlement agreements in a model with two risk-averse parties, a plaintiff and a defendant. At trial, the factfinder (who may be a judge, a jury, or an arbitrator) will award damages. Trials are costly and risky, and the parties have potentially different subjective beliefs about what will happen. The parties' subjective be-

[1]Surveys include Spier (2007) and Daughety and Reinganum (2012).

[2] Palimere v. Supermarkets Gen., No. 05186, 1989 WL 395822 (Pa. Com. Pl. Dec. 1989) (Verdict and Settlement Summary).

[3] Andersen (2013). According to *Black's Law Dictionary*, a high-low agreement is one "in which a defendant agrees to pay the plaintiff a minimum recovery in return for the plaintiff's agreement to accept a maximum amount regardless of the outcome of trial" (Garner, 2004). These contracts are binding and are not necessarily disclosed to the judge, jury, or arbitrator (Prescott and Spier, 2016, pp. 85-86).

[4]Claudia Clemente v. Lisa Duran, 2006 WL 4643243 (N.J.Super.L.) (Verdict and Settlement Summary).

liefs, preferences, and litigation costs are assumed to be common knowledge, so negotiations take place under complete information. The parties may decide to completely settle out of court, thereby ending the dispute and avoiding the risks and costs of trial. Through a simple out-of-court settlement, the defendant is effectively purchasing 100% of the plaintiff's risky legal claim. Alternatively, the parties may "agree to disagree" and bring the dispute to trial. In this environment, the litigating parties may enter into contingent agreements with each other and/or with outside investors.

First, ignoring the external capital market, we show that the parties will write an inside contract that specifies a lump-sum payment and a contingent payment that is monotonic in the likelihood ratio of their subjective beliefs. If the parties have CARA expected utility and their beliefs are normally distributed with divergent means, then the defendant pays the plaintiff a guaranteed lump sum and a fixed proportion of the court-determined damages. These contingent settlement contracts bear a striking resemblance to the financial contracts traditionally offered by third-party investors. Through the contingent settlement contract, the defendant is in effect buying a partial equity stake in the plaintiff's claim. Similarly, through the contract, the plaintiff is selling an insurance policy to the defendant.

Finally, we allow the litigating parties to write contingent contracts with outside investors. These investors are risk neutral, share common beliefs, and operate in a competitive environment. In these idealized circumstances, the litigating parties jointly prefer to write financial contracts with third-party investors rather than with each other (although this preference is weak). Since the parties perceive themselves to be better off with the backing of outside investors, some cases that would otherwise have settled will go to trial instead. Thus, with outside investors, the settlement rate falls and the litigation rate rises. Interestingly, we show that the optimal contracts with outside investors may actually expose the litigating parties to more risk rather than less. Insofar as they increase both the costs and aggregate risks of litigation, third-party involvement in litigation reduces social welfare.

Litigation Literature. This paper takes the literature on the economics of litigation in a new direction. Many scholars have argued that settlement negotiations may fail when the parties have divergent beliefs or non-common priors about what will happen at trial (Landes, 1971; Posner, 1973; Gould, 1973; Shavell, 1982; Bar-Gill, 2006). In these models, as here, the litigants are stubborn, and do not update their beliefs when confronted with the differing opinions of others.[5] Other

[5]Such models have been used in empirical work on litigation (Waldfogel, 1995) and have been employed to explore fee-shifting (Shavell 1982), the selection of cases for trial (Priest and

scholars have explored bargaining failures in settings where the parties are asymmetrically informed about what will happen at trial (Bebchuk, 1984; Reinganum and Wilde, 1986; Spier, 1992).[6] With a few notable exceptions discussed below, the literature has not considered the possibility for contingent settlement contracts. This is a significant oversight, since contingent settlement contracts are both implied by theory and used in practice.

Prescott and Spier (2016) document a broad range of contingent settlement contracts, including agreements that specify shares of liability and litigate damages only, and agreements to modify or place bounds on damage payments.[7] In a sample of more than 2,700 cases from New York State's summary jury trial program, Prescott and Spier (2016) show that approximately eighty percent had high-low agreements (a particular type of contingent settlement contract).[8] Using insurance claims data from a large national insurance company, Prescott et al. (2014) show that contested insurance claims with above-median risk were four to five times more likely to use high-low agreements than claims with below-median risk. This latter paper also illustrates the value of these agreements in a simple binary model with two possible trial outcomes. The current paper crowns our prior work by considering general distributions of trial outcomes, general contingent settlement contracts, and the role of third-party investors.[9]

The last several years have seen growth of companies that specialize in investing in lawsuits (Garber, 2010; Steinitz, 2012). In a model with asymmetric information and risk-neutral parties, Daughety and Reinganum (2014) argue that third-party litigation funding can mitigate asymmetric information problems, thereby reducing bargaining failures and increasing the settlement rate.[10]

Klein 1984), bifurcation (Landes 1993), and tort reform (Babcock and Pogarsky, 1999; Landeo et al., 2013). Other papers have considered dynamic models with learning in conjunction with optimism (Yildiz, 2004; Watanabe, 2005; Yildiz and Vasserman, 2016).

[6]The plaintiff may have better information about the damages while the defendant may know more about liability. In Farmer and Pecorino (1994) and Heyes et al. (2004), parties privately observe their risk preferences.

[7]Examples include 90%/10%, 80%/20%, 70%/30% and 50%/50% splits (among others). See Prescott and Spier (2016, p. 112).

[8]The cases with high-low agreements had significantly fewer subsequent settlements than those cases without high-low agreements. High-low contracts are featured in several state-sponsored alternative dispute resolution programs (Hannaford-Agor, 2012).

[9]Lavie and Tabbach (2017) build on Prescott and Spier (2016) by exploring contingent contracting in a model where the defendant is privately informed about the outcome at trial. Spier (1994) presents an analysis of direct revelation mechanisms with two-sided asymmetric information, and an application to fee-shifting rules. Although the two approaches – divergent expectations and asymmetric information – are analytically different, we view their insights as being complementary.

[10]Avraham and Wickelgren (2014) argue that the terms of a litigation funding contract may

By contrast, we find that bargaining failures are more common and settlement less likely with third-party litigation funding. In our model, risk-averse litigants benefit from shifting risk and speculating through outside investors, which in turn makes trials more likely.[11] The literature on liability insurance focuses on policies acquired before an accident arises,[12] although the possibility of after-the-event insurance has also been explored (Molot, 2009). These papers do not explore the role of divergent prior beliefs or the implications for aggregate risk bearing.

Divergent Prior Beliefs. Our paper is part of a broader theoretical literature on contracting with non-common prior beliefs. See Morris (1995) for general discussion. There are a number of recent papers in the financial economics literature that are related to ours. Weyl (2007) and Dieckmann (2011) show that insurance markets for rare events can increase the aggregate risk when parties have divergent beliefs about their likelihood. Simsek (2013) shows that new financial products will magnify traders' bets on existing financial assets, increasing portfolio risk. Our result that contingent settlement contracts with outside litigation funders and suppliers of capital may increase aggregate risk is in the same spirit.

There are different ways that one can evaluate welfare in models with divergent prior beliefs. First, one might simply consider the subjective well beings of the litigants themselves. With this approach, if the parties perceive themselves to be jointly better off going to trial, then one would say that welfare is higher. Second, one might instead evaluate the well being of the litigants using a single, objective truth (as in Weyl, 2007; Sandroni and Squintani, 2007; Brunnermeier et al., 2014). This second approach explicitly recognizes that with divergent beliefs, not everyone can be correct.[13] We present both approaches. First, we analyze the effects of inside and outside contracts on the subjective well-being of the litigants, using their divergent beliefs. Next, we analyze them using a single set of objective, true beliefs. For the latter, we follow Brunnermeier et al. (2014) and assume that the objective truth is any convex combination of the beliefs of the parties themselves. Our results do not depend on the particular weights applied.[14] So although it might be natural to assume that the capital market has unbiased beliefs, this is not required for our results.

Our assumption that parties hold different subjective beliefs is empirically

signal the plaintiff's private information to the court. They do not consider settlement.

[11]Contingent fees with lawyers can also more efficiently allocate risk (Danzon, 1983) and overcome agency problems (Rubinfeld and Scotchmer, 1993; Dana and Spier, 1993).

[12]In many cases, insurance companies replace the defendants in litigation (Sebok, 2014).

[13]Note that if the parties themselves were choosing a social welfare function from behind a veil of ignorance, before their beliefs are formed, then the parties would choose this second, admittedly paternalistic, approach.

[14]In particular, the true beliefs may coincide with those of the outside investors.

relevant. Indeed, according to DeBondt and Thaler (1995), "Perhaps the most robust finding in the psychology of judgment is that people are overconfident." In a controlled laboratory setting where subjects were randomly assigned to the roles of plaintiff or defendant, Loewenstein et al. (1993) find strong evidence of self-serving assessments that were correlated with settlement breakdowns and trial. Eigen and Listokin (2012) find evidence of optimism bias in a natural experiment where subjects were randomly assigned sides in moot court cases. These experimental findings are not consistent with asymmetric information. In a study of practicing litigators, Goodman-Delahunty et al. (2010) find that lawyers with more years of experience exhibit the very same overconfidence as their less experienced counterparts, and that overconfidence does not wane as the time to trial becomes shorter.[15] In practice, divergent beliefs appear to be both commonplace and persistent.

Our analysis gives a number of empirical predictions. First, contingent contracts will tend to be flatter (less sensitive to the trial outcome) when the risk of trial is larger, when the parties are more averse to risk, and when the parties have more aligned beliefs. Second, our model predicts that contracting on litigation between the litigants themselves may be more common in cases when the market for third-party funding is limited by transactions costs or law.[16] Indeed, restrictions on litigation funding vary by jurisdiction, with participants being subject to usury laws, champerty restrictions, and rules of professional responsibility and ethical guidelines.[17] Finally, when the market for third-party funding is limited, fewer lawsuits will go to trial and, for those that do go to trial, the aggregate risk borne by the participants may be lower.

The outline of the paper is as follows. The next section presents the basic model and solves for the equilibrium outcomes of the three regimes: naked trials, inside contracts, and outside contracts. For each regime, we evaluate the parties' decision to settle versus litigate, the risks and the costs of litigation. Section 3 presents the social welfare analysis, analyzing the private subjective benefits of litigation and the social costs of litigation across the three contractual regimes.

[15]Relatedly, Wistrich and Rachlinski (2013) present evidence that lawyers and judges are susceptible to confirmation bias.

[16]This may be consistent with the observed popularity of partial settlement contracts in the small stakes cases in Prescott and Spier (2016). Note, however, that in jurisdictions where litigation funding is prohibited, there may be fewer lawsuits.

[17]See, for example, Steinitz (2012, pp. 485-7) and the references it includes. In practice, outside investors exert various types and degrees of control in the litigation process. Plaintiffs may transfer control to investors through assignment or subrogation (Sebok, 2014). Contractual mechanisms in litigation funding contracts include staged financing, duties to cooperate, and information sharing (Steinitz, 2012).

Section 4 offers concluding remarks. All proofs are in Appendix A. Appendix B presents a numerical example and extends the analysis to a rent-seeking contest.

2 The Model

Suppose that there are two parties to a dispute, a plaintiff (p) and a defendant (d), who are negotiating prior to a trial. If the case goes to trial, the court will order a transfer of x from the defendant to the plaintiff and the parties will bear litigation costs c_d and c_p. The parties have CARA expected utility functions, $u_i(z) = -\exp(-a_i z)$ where $a_i > 0$, $i = p, d$ are the coefficients of absolute risk aversion for the parties.[18] The parties to the dispute may choose to negotiate a full settlement before trial, where the defendant pays a fixed amount and the plaintiff withdraws the case. A full settlement completely ends the dispute, avoiding the risks and the costs of litigation. We assume that the plaintiff has a credible threat to litigate.[19]

The litigants have potentially different subjective beliefs about the probability distribution of the court's award, $f_i(x), i = p, d$. Unless specified otherwise, we assume that these beliefs are normally distributed with means μ_p and μ_d, respectively, and common variance σ^2.[20] Later, we will introduce a competitive capital market with risk-neutral investors who share the common belief that the court award x is distributed with mean μ_0 and variance σ^2. The distributions, litigation costs, and risk aversion coefficients are all assumed to be common knowledge so there is no learning over time.[21]

We analyze three different contractual settings. First, as a benchmark, we consider "naked trials" where the parties cannot write contingent contracts with

[18] This specification does not have income or wealth effects and generates straightforward predictions and comparative statics. Large corporate defendants, or defendants who have been replaced by diversified insurance companies, may be less risk averse than small plaintiffs. Note however that corporations are managed by risk-averse agents who are concerned about career prospects and performance pay.

[19] If the plaintiff did not have a credible threat to litigate, then the defendant could refuse to negotiate and the case would be dropped. Contracting with third parties would strengthen the plaintiff's bargaining position and would enhance the plaintiff's access to the courts. These issues will be discussed later.

[20] Technically, with these densities, the court award could be negative. Since the slope of the optimal contract in (5) depends on the natural logarithm of the ratio of the densities, our results would hold if we truncated the densities at zero.

[21] The beliefs of the litigants and the capital market are modeled as primitives of the model. One could imagine that the beliefs are instead randomly drawn signals from an underlying distribution. Our parties are decidedly not Bayesian – they do not revise their own beliefs as they learn about the signals of others.

each other or with third parties. At the conclusion of trial, x is transferred from the defendant to the plaintiff. Second, we consider litigation with "inside contracts," where the parties agree before trial to modify the court's award so that $s(x)$ is transferred instead of x.[22] Third, we consider litigation with "outside contracts," where each party can write contingent contracts with investors from the external capital market. So, for example, the plaintiff might agree to sell shares of the case to outside investors, and the defendant might agree to purchase an insurance policy.

For each setting, we characterize the set of subjective Pareto-optimal contracts. That is, given the parties' divergent subjective beliefs, we describe the set of contracts where it is impossible to make one party subjectively better off without making the other party subjectively worse off. In designing their contracts, the parties trade off their desire to hedge risk and their desire to speculate and gamble on the trial. Our concept of Pareto optimality shows the utmost respect for the divergent subjective beliefs of the parties. For each setting, we quantify the joint subjective value the parties derive from going to trial and the level of risk that they jointly bear, and characterize the parties' decision to fully settle out of court or go to trial. We adopt the generalized Nash bargaining solution where the defendant captures share $\pi \in [0, 1]$ and the plaintiff captures share $1 - \pi$ of any bargaining surplus.[23]

We also evaluate welfare in the three contractual settings using a single, objective assessment of the truth. With this approach, the subjective value that the litigants think that they are getting from the trial does not reflect a legitimate social benefit. Following Brunnermeier et al. (2014), we assume that the true distribution of the court award is a convex combination of the parties' beliefs.[24] Specifically, we assume that the truth is normally distributed with mean μ_t and variance σ^2. The "truth" μ_t may coincide with the beliefs of the plaintiff ($\mu_t = \mu_p$), the beliefs of the defendant ($\mu_t = \mu_d$), or the beliefs of the capital market ($\mu_t = \mu_0$), or it could differ from all three.

As we will see, our results regarding the aggregate risks from inside and outside contracts do not depend on the precise value of μ_t – our welfare results

[22]Equivalently, the parties could write a contract that specifies side payments, $\tau(x)$, from the plaintiff to the defendant after the payment of the damage award x. Specifically, $\tau(x) = x - s(x)$ would require the plaintiff to return the damage award x to the defendant but keep an amount $s(x)$.

[23]This is equivalent to a random-offeror model where the defendant makes a take-it-or-leave-it offer with probability π.

[24]Brunnermeier et al. (2014) define the set of "reasonable beliefs" to be the set of convex combinations of the beliefs of the parties themselves. Although in general economic environments Brunnermeier et al.'s (2014) "belief-neutral welfare criterion" yields an incomplete ranking of public policies, it yields clear comparisons in our litigation setting.

hold regardless of whose beliefs are correct. To be sure, it is natural to imagine that corporate defendants, big insurance companies, and Wall Street financiers, are more sophisticated and less subject to optimism and self-serving biases than small plaintiffs. After all, large commercial litigation investors are repeat players. In this case, it may well be the case that the outside investors have more accurate beliefs than the litigants themselves. But our model's implications for the subjective benefits of private contracting and the aggregate level of risk bearing would be valid even if this were not true.

2.1 Naked Trials

Suppose that the parties choose between a full settlement and a naked trial. With our assumptions on preferences and normally-distributed beliefs, the least the plaintiff would be willing to accept in settlement is $\underline{s} = \mu_p - a_p\sigma^2/2 - c_p$.[25] This is the plaintiff's expected value of the court award, evaluated at the plaintiff's subjective belief, minus the risk premium and litigation cost. Similarly, the most the defendant would be willing to pay in settlement is $\overline{s} = \mu_d + a_d\sigma^2/2 + c_d$. If $\underline{s} \leq \overline{s}$ the parties will agree to settle out of court for some amount $s \in [\underline{s}, \overline{s}]$, avoiding the costs of trial. The parties will go to trial if $\underline{s} > \overline{s}$, or

$$c_p + c_d < B^N(\mu_p, \mu_d, a_p, a_d, \sigma^2) = (\mu_p - \mu_d) - (a_p + a_d)\sigma^2/2. \tag{1}$$

The left-hand side of this expression is the joint cost of trial. The right-hand side, $B^N(\centerdot)$, is the joint benefit of trial, as perceived by the parties. The first term is their joint benefit of speculation, and the second term is the sum of their risk premiums. If the parties had the same beliefs or were mutually pessimistic, $\mu_p - \mu_d \leq 0$, then $B^N(\centerdot)$ is negative and the case would surely settle.[26] But if the parties are sufficiently optimistic, so $\mu_p - \mu_d$ is positive and large, then the case will go to court.

Although the parties may find trial mutually attractive based on their subjective beliefs, trials are wasteful from a social welfare perspective. When evaluated using the "true" objective beliefs, μ_t, the plaintiff's certainty equivalent of a trial is $\mu_t - a_p\sigma^2/2 - c_p$ and the defendant's certainty equivalent is $\mu_t + a_d\sigma^2/2 + c_d$. Subtracting these expressions, the net social value of a naked trial is negative and equal to $-(a_p + a_d)\sigma^2/2 - (c_p + c_d)$. Letting $R^N(\centerdot)$ denote the sum of the risk premiums,

$$R^N(a_p, a_d, \sigma^2) = (a_p + a_d)\sigma^2/2, \tag{2}$$

[25] This is a standard implication of the CARA-normal framework and will not be reproduced here. See for example Grossman (1976).

[26] With generalized Nash bargaining the case would settle for $\pi\underline{s} + (1 - \pi)\overline{s}$.

and the social value of a naked trial is

$$S^N(a_p, a_d, \sigma^2) = -R^N(a_p, a_d, \sigma^2) - (c_p + c_d). \tag{3}$$

Trials are socially wasteful because they impose both risks and costs on the parties.[27] Note that in our benchmark case, social welfare does not depend on the parties' subjective beliefs μ_p and μ_d. Later, when financial contracts are introduced, social welfare will depend on these parameters indirectly (since the parties' beliefs influence their choice of contract).

2.2 Inside Contracts

We now allow the two parties to the dispute (the insiders) to contract with each other before trial, but do not allow them to write contracts with third parties. Under the terms of the contract $s(x)$, the defendant will pay $s(x)$ to the plaintiff. This contract overrides any court award, x. Using the parties' subjective beliefs, Pareto optimality requires that $s(x)$ maximize a weighted sum of the parties' expected utilities:

$$\beta \int u_p(s(x) - c_p) f_p(x) dx + (1 - \beta) \int u_d(-s(x) - c_d) f_d(x) dx$$

where $\beta \in (0, 1)$ and $(1 - \beta)$ are arbitrary weights.[28] Maximizing this expression pointwise, we have $s(x)$ implicitly solves $\beta u_p'(s(x) - c_p) f_p(x) - (1 - \beta) u_d'(s(x) - c_d) f_d(x) = 0$ for all x, so $s(x)$ satisfies

$$\frac{f_p(x)}{f_d(x)} \frac{u_p'(s(x) - c_p)}{u_d'(-s(x) - c_d)} = \frac{1 - \beta}{\beta}. \tag{4}$$

With CARA expected utility, any equilibrium contract will take the form:[29]

$$s(x) = k + \left(\frac{1}{a_p + a_d} \right) \ln \left(\frac{f_p(x)}{f_d(x)} \right) \tag{5}$$

[27] Using equations (1), (2), and (3), the litigants' joint subjective value of a naked trial is $B^N(\cdot) - (c_p + c_d) = (\mu_p - \mu_d) - (a_p + a_d)\sigma^2/2 - (c_p + c_d) = (\mu_p - \mu_d) + S^N(a_p, a_d, \sigma^2)$. If the parties are mutually optimistic, $\mu_p > \mu_d$, then the litigants' joint subjective value of a naked trial is higher than its social value, $S^N(a_p, a_d, \sigma^2)$. If the parties are mutually pessimistic, $\mu_p < \mu_d$, then the litigants' joint subjective value of a naked trial is lower than its social value.

[28] Suppose that the plaintiff (for example) were choosing the contract $s(x)$ to maximize his or her own expected utility subject to the defendant's individual rationality constraint. The resulting Lagrangian would have this form.

[29] See the proof in the appendix.

where k is a constant.

This expression describes the locus of contracts for which there is no alternative contract that makes both parties *subjectively* better off. The contracts in this locus differ from each other only in the fixed payment, k, a value that will be determined by negotiations between the parties.[30] The shape of the contract depends on the parties' subjective beliefs about the distribution of the court award, x, and the sum of their risk aversion coefficients, $a_p + a_d$. Specifically, the contract $s(x)$ hinges on the likelihood ratio, $f_p(x)/f_d(x)$. If the plaintiff believes that the outcome x is (relatively) more likely than the defendant, so $f_p(x)/f_d(x)$ is larger, then the contract will stipulate a higher payment for that particular realization of x. Conversely, if the plaintiff believes that an outcome is less likely than the defendant, so the ratio $f_p(x)/f_d(x)$ is smaller, then the contract $s(x)$ will specify a smaller amount. Note that if the distributions exhibit the monotone likelihood ratio property, so higher realizations of x are more consistent with the plaintiff's subjective beliefs than the defendant's, then the contract $s(x)$ will be monotonically increasing in the court's award x.[31]

With normally-distributed beliefs, the equilibrium inside contract $s(x)$ is linear in the court's award, x, and satisfies

$$s(x) = s_0 + s_1 x \quad \text{where} \quad s_1 = \frac{\mu_p - \mu_d}{(a_p + a_d)\sigma^2} \tag{6}$$

and s_0 is a negotiated constant which depends on the bargaining power of the two parties.[32] (See the appendix for a proof.)

When $\mu_p > \mu_d$, so the plaintiff believes that the average court award is higher than the defendant, then the slope of $s(x)$ is positive. When the parties are sufficiently risk averse, the slope of the contract is smaller than one, so the subjectively optimal contract imposes less risk on the parties than a naked trial. When the parties are not too risk averse and/or are sufficiently optimistic about their own cases, the contract will have a slope that is greater than one.[33] Rather than seeking to mitigate the risk at trial, the parties may find it in their mutual

[30] The plaintiff will prefer a higher fixed payment, and the defendant will prefer a lower one. The constant could be negative, in which case the plaintiff pays the defendant. The relative bargaining strengths of the parties affect the fixed payment, not the variable component.

[31] This situation corresponds to the mutual optimism of the two parties.

[32] Note that with more general beliefs, the inside contract would not be linear. One can construct beliefs where the optimal inside contract is a high-low contract. See Section 2.4. If the litigants' beliefs have divergent variances as well as divergent means, then the optimal inside contract would be quadratic.

[33] In this case, the corresponding transfer would be negative. So rather than the defendant making a lump-sum payment to the plaintiff, the plaintiff would make a lump-sum payment to the defendant for the opportunity to receive the augmented damages.

interest to amplify that risk and gamble on the court's award.[34] Amplification also occurs when the variance σ^2 is sufficiently small, so the parties have precise (albeit heterogeneous) beliefs.

When $\mu_p < \mu_d$, the parties are pessimistic relative to each other and the equilibrium contract has a negative slope. That is, the plaintiff receives less when the court's award is high than when it is low. While the possibility of a negative slope is interesting in theory, it may not be advisable in practice since a contract with a negative slope would give the parties a strong incentive to sabotage their own cases.[35] In reality, parties can control the presentation of evidence at trial, and can thus affect the level of damages awarded by the court, factors that were not included the model. So, unless the parties could commit themselves to putting their best cases forward, contracts along these lines would be rare in practice.

We now consider the parties' decision to settle out of court or go to trial. To construct the bargaining range, we make use of the following property: If a random variable x is normally distributed with mean μ and variance σ^2 then the random variable $y = \gamma_0 + \gamma_1 x$, where γ_0 and γ_1 are constants, is normally distributed with mean $\mu_y = \gamma_0 + \gamma_1 \mu$ and variance $\sigma_y^2 = \gamma_1^2 \sigma^2$. Using this property, the least that the plaintiff is willing to accept in settlement to avoid a trial is $\underline{s} = s_0 + s_1\mu_p - a_p s_1^2\sigma^2/2 - c_p$. Similarly, the most the defendant is willing to pay to avoid a trial is $\overline{s} = s_0 + s_1\mu_d + a_d s_1^2\sigma^2/2 + c_d$. Taken together, the parties will settle when $\underline{s} \leq \overline{s}$ and will go to trial if and only if $\underline{s} > \overline{s}$ or, equivalently,

$$c_p + c_d < s_1(\mu_p - \mu_d) - (a_p + a_d)s_1^2\sigma^2/2. \tag{7}$$

The first term on the right-hand side, $s_1(\mu_p - \mu_d)$, is the parties' joint subjective benefit from speculation. Since the slope s_1 has the same sign as $\mu_p - \mu_d$, the joint value of speculation is necessarily positive. The second term is the sum of the two parties' risk premiums. Importantly, the cost of risk may be higher or lower than the risk of a naked trial. When $s_1^2 < 1$ the parties are mitigating the risk through their contract, and when $s_1^2 > 1$ they are amplifying it.[36] Using the equilibrium contract defined in (6), the parties will go to trial instead of settle if

[34] Amplification may occur in practice. For example, contracts where the parties agree to shift litigation costs from the winner to the loser amplify the risk of trial. In most jurisdictions in the United States, each side bears its own litigation cost by default although parties remain free to contract around the default. Fee shifting is common in commercial contracts, although after-the-event fee-shifting is rare. See Donohue (1991).

[35] This is analogous to an athlete betting against his or her own team and then throwing the game. Appendix B extends our model to include endogenous litigation spending, and shows that spending increases when the slope of the contract is larger.

[36] The slope s_1 maximizes the joint benefit and thus optimally trades off the parties' need for insurance and their desire to speculate.

and only if

$$c_p + c_d < B^*(\mu_p, \mu_d, a_p, a_d, \sigma^2) = \frac{(\mu_p - \mu_d)^2}{2(a_p + a_d)\sigma^2}. \tag{8}$$

The function $B^*(\centerdot)$ is the joint subjective benefit of litigation with inside contracting. Note that this expression is increasing in the square of the divergence in the parties' beliefs. When the parties disagree about the outcome at trial, they can derive more joint value through speculative contracts. Also note that the joint benefit increases without bound as the sum of their risk aversion parameters approaches zero. Indeed, in the limit, $B^*(\centerdot)$ approaches infinity. With divergent beliefs and a high tolerance for risk, agents can design inside contracts to "pump" considerable value out of their exchange.[37]

Letting $R^*(\centerdot)$ denote the sum of the parties' risk premiums with the equilibrium inside contract defined in (6), we have:[38]

$$R^*(\mu_p, \mu_d, a_p, a_d, \sigma^2) = (a_p + a_d)s_1^2\sigma^2/2 = \frac{(\mu_p - \mu_d)^2}{2(a_p + a_d)\sigma^2}. \tag{9}$$

Note that $R^*(\centerdot)$ depends on the parties' subjective beliefs, μ_p and μ_d, but not on the truth, μ_t. When the parties' subjective beliefs are more divergent (i.e., μ_p and μ_d are farther apart), the inside contract in (6) is steeper and so the sum of the risk premiums in (9) is larger. When the parties become more risk averse, so $a_p + a_d$ rises, there are two offsetting effects. First, holding the slope of the inside contract s_1 fixed, the sum of the risk premiums increases. Second, the inside contract in (6) becomes flatter, and so the sum of the risk premiums falls. In equilibrium, this latter effect dominates.[39]

Evaluating the parties' payoffs with a single set of true beliefs, the social value of a trial with the inside contract is:

$$S^*(\mu_p, \mu_d, a_p, a_d, \sigma^2) = -R^*(\mu_p, \mu_d, a_p, a_d, \sigma^2) - (c_p + c_d). \tag{10}$$

[37] Using insurance claims data, Prescott et. al (2014) found that lawsuits with higher-than-average risk were much more likely to adopt high-low agreements. Our theoretical findings are consistent with this empirical pattern. One can show that an increase in the risk of litigation (that is, a higher value of σ^2) will correspond to a higher incremental value of contracting, $B^*(\centerdot) - B^N(\centerdot)$.

[38] The quadratic structure implies $R^*(\centerdot) = B^*(\centerdot)$.

[39] In the limit as $a_p + a_d$ approaches zero, $R^*(\centerdot)$ approaches infinity. This arises because when the parties become more tolerant of risk, they engage in increasingly large bets. If the parties were truly risk neutral, then there would be no welfare loss from gambling. So, the cost of risk is discontinuous when $a_p = a_d = 0$. If there were exogenous limits on speculative contracting, so the slope of the inside contract in (6) was bounded, then $R^*(\centerdot)$ would not diverge as $a_p + a_d$ approaches zero.

2.3 Outside Contracts

We now assume that the plaintiff and the defendant may enter into bilateral contracts with third-party investors (instead of with each other). As described earlier, we assume that the capital market has many identical risk-neutral investors who share the belief that the outcome at trial is normally distributed with mean μ_0 and variance σ^2.[40] These investors compete head-to-head for the opportunity to provide financial backing to the plaintiff and the defendant. The competitive market price of the lawsuit is μ_0, and the investors break even in expectation.

One might imagine that our setting would give rise to a proverbial "money pump" or "Dutch bookie" who could make unlimited profits by brokering trades between the two parties.[41] There are two reasons why this does not happen in our setting. First, strict convexity of preferences (e.g., risk aversion) will limit the gains that could be obtained by a bookie (Morris, 1995 p. 239). This underscores the importance of risk aversion for our analysis. Second, we assume that third-party investors are competitive; any value created through a money pump would be captured by the plaintiff and the defendant themselves rather than by the bookie. As will be discussed later, our core results are robust to alternative assumptions regarding market power.

We let $t(x)$ denote the contract between the plaintiff and the financial service provider, who may be a litigation funder or other third party. With this contract, the plaintiff receives $t(x)-c_p$ and the third party receives the residual amount $x-t(x)$. So, for example, if $t(x) = 100 + x/4$ then the investor is paying the plaintiff one hundred dollars for a seventy-five percent stake in the award. Similarly, we let $r(x)$ represent the contract between the defendant and the financial service provider. With this contract, the defendant is responsible for paying $r(x)+c_d$ and the third party pays the residual $x-r(x)$. Although this framework assumes that the plaintiff and the defendant are the ones to bear the litigation costs, c_p and c_d, this is without loss of generality. Note also that since $r(x)$ and $t(x)$ need not equal each other, these third-party contracts allow the plaintiff and the defendant to decouple their respective interests. Decoupling will allow the parties to fine-tune

[40] Although we place no restrictions on these beliefs, it may in fact be the case that investors have unbiased beliefs, $\mu_0 = \mu_t$, and that the plaintiff and the defendant are more optimistic about their cases than the outside investors, $\mu_d \leq \mu_0 \leq \mu_p$. The assumption that the outside investors share the same beliefs implies that they would not want to speculate with each other on the outcome of litigation. Risk neutral parties with different subjective beliefs (and no other constraints on their investment activities) would want to gamble with each other in addition to providing services to the plaintiff and the defendant.

[41] For a discussion of the "money pump" in environments with non-common priors, see Binmore (1992, p. 477) and Daughety and Reinganum (2012, pp. 399-400).

the outside contracts to reflect their subjective risk preferences and beliefs.

For concreteness, we assume the following timing. In the first stage, the two parties have the opportunity to settle with each other. If their negotiations fail, then in the second stage the parties turn to the outside capital market and buy and/or sell claims on their respective positions. As in the previous section, we characterize the (subjective) Pareto-optimal contracts between the parties and their respective third-party investors. In the third stage, the court announces the award, x, and all financial claims are settled.

With this timing, we are obviously – and very decidedly – abstracting from any conflicts of interest between the parties and their respective investors over whether to settle the case, and from any possible commitment value of third-party contracting.[42] This particular timing is not critical for the results, however. We could assume equivalently that the plaintiff and the defendant can sign contracts with third parties prior to settlement negotiations, so long as the parties and their backers can subsequently *renegotiate* their contracts if settlement negotiations fail.[43] So long as the parties and their respective investors negotiate settlements that are in their mutual interest, and can negotiate deals on the eve of trial that maximize their joint subjective value from trial, our results will hold.

It is instructive to begin the analysis by developing some general insights. Suppose the plaintiff can contract with a third-party investor who is risk averse with CARA coefficient $a_0 > 0$ and beliefs $f_0(x)$. Using the earlier methodology, any equilibrium contract $t(x)$ between the plaintiff and the third party will be of the form:

$$t(x) = t + \left(\frac{1}{a_p + a_0}\right) \ln\left(\frac{f_p(x)}{f_0(x)}\right) + \left(\frac{a_0}{a_p + a_0}\right) x \tag{11}$$

where t is a lump-sum payment.

It is interesting to compare expression (11) to our earlier expression (5), which characterized the equilibrium inside contract between the plaintiff and the defendant. The two contracts are similar, but there is an additional risk-sharing term in (11). Suppose that the third-party investor has the same beliefs and risk tolerance as the defendant, so $f_0(x) = f_d(x)$ and $a_0 = a_d$, then the outside contract

[42] There is an active literature exploring how contracts with third parties can be a valuable strategic commitment in litigation. Spier (2007) surveys this literature, which includes analyses of contingent fee lawyers (pp. 310-11), insurance companies (p. 330), and debtholders (pp. 331-32).

[43] In practice, the plaintiff may receive payments from investors before trial. By contract, if the case settles, the investor would receive a share of the settlement. This may create agency problems, since the interest of the plaintiff and the investor may subsequently diverge. With our assumptions, these issues do not arise.

in (11) would have a larger slope than the analogous inside contract in (5). Intuitively, reducing the slope of $s(x)$ in (5) reduces the risk *for both the plaintiff and the defendant*. In contrast, reducing the slope of $t(x)$ in (11) shifts risk *towards the third-party investor*. So, the outside contract $t(x)$ would expose the plaintiff to greater risk than the inside contract $s(x)$.

Now suppose that the third-party investors have normally-distributed beliefs with mean μ_0 and variance σ^2 and are risk neutral ($a_0 = 0$). The investors value the lawsuit at its expected value, μ_0. In the competitive equilibrium, the outside investors compete to provide financial services to the plaintiff and defendant. The competitive market price is μ_0 and the investors break even in expectation.

As proven in the appendix, the plaintiff's equilibrium outside contract is

$$t(x) = t_0 + t_1 x \quad \text{where} \quad t_0 = (1 - t_1)\mu_0 \quad \text{and} \quad t_1 = \frac{\mu_p - \mu_0}{a_p \sigma^2}. \tag{12}$$

This equilibrium contract makes intuitive sense. Suppose that the plaintiff and the third-party investors hold exactly the same beliefs, so $\mu_0 = \mu_p$. In this case, equation (12) tells us that $t_1 = 0$. In other words, the risk-averse plaintiff sells one hundred percent of the case to the risk-neutral investors for the competitive market price, $t_0 = \mu_0$. Suppose instead that $\mu_0 < \mu_p$, so the third-party investors think the case is weaker than the plaintiff believes it to be. Then, the plaintiff chooses to keep fraction $t_1 > 0$ of the case and sells the residual stake to the investors for the competitive market price, $t_0 = (1 - t_1)\mu_0$.[44] Finally, comparing (12) to the optimal inside contract in (6) reveals that if $\mu_0 = \mu_d < \mu_p$ then $t_1 > s_1$. If the capital market holds the same beliefs as the defendant, the optimal outside contract exposes the plaintiff to more risk than the optimal inside contract.

The defendant's equilibrium outside contract with their third-party backer has a similar form:

$$r(x) = r_0 + r_1 x \quad \text{where} \quad r_0 = (1 - r_1)\mu_0 \quad \text{and} \quad r_1 = \frac{\mu_0 - \mu_d}{a_d \sigma^2}. \tag{13}$$

With this contract, the defendant is paying third-party investors a lump sum $r_0 = (1 - r_1)\mu_0$ to accept responsibility for a fraction $1 - r_1$ of the court award. Since the market price is μ_0, the outside investors (just) break even on their investments. Note that if $\mu_d = \mu_0$, so the defendant and the capital market share the same beliefs, then $r_1 = 0$ in equation (13). In other words, the defendant would pay a price of $r_0 = \mu_0$ to insure one hundred percent of the court award.

We now evaluate the decision of the parties to settle their case out of court. If the parties' settlement negotiations fail, they will enter into contracts with

[44] If μ_p is much larger than μ_0, or if the plaintiff is not very risk averse, then $t_1 > 1$ and $t_0 < 0$.

third-party investors as outlined in (12) and (13) above and will go to trial. Using our earlier methods, it is not hard to construct the bargaining range. The plaintiff's certainty equivalent of going to trial with the third-party contract $t(x)$ is $\underline{s} = (1 - t_1)\mu_0 + t_1\mu_p - a_p t_1^2\sigma^2/2 - c_p$. Notice that this certainty equivalent is subjective, and is evaluated according to the plaintiff's subjective beliefs, μ_p. This is the very least that the plaintiff would accept in settlement. Similarly, the defendant's (subjective) certainty equivalent is $\overline{s} = (1-r_1)\mu_0+r_1\mu_d+a_d r_1^2\sigma^2/2+c_d$, which is the most that the defendant would be willing to pay to settle the case before trial. Combining these two expressions, $\underline{s} > \overline{s}$ if and only if

$$c_p + c_d < (\mu_p - \mu_0)t_1 - a_p t_1^2\sigma^2/2 + (\mu_0 - \mu_d)r_1 - a_d r_1^2\sigma^2/2. \tag{14}$$

Using the slopes t_1 and r_1 from (12) and (13) above, we conclude that the parties will go to trial if and only if the costs of litigation are smaller than the parties' joint subjective benefits from trial,

$$c_p + c_d < B^0(\mu_0, \mu_p, \mu_d, a_p, a_d, \sigma^2) = \frac{(\mu_p - \mu_0)^2}{2a_p\sigma^2} + \frac{(\mu_0 - \mu_d)^2}{2a_d\sigma^2}. \tag{15}$$

Since the third-party investors are breaking even in expectation, the right-hand side is also the joint subjective benefit of trial for all four parties.

It is straightforward to compute the aggregate cost of risk and social welfare. Since the third-party investors are risk neutral, we need only consider the risk premiums of the litigants,

$$R^0(\mu_0, \mu_p, \mu_d, a_p, a_d, \sigma^2) = a_p t_1^2(\sigma^2/2) + a_d r_1^2(\sigma^2/2) = \frac{(\mu_p - \mu_0)^2}{2a_p\sigma^2} + \frac{(\mu_0 - \mu_d)^2}{2a_d\sigma^2}. \tag{16}$$

Evaluating the parties' payoffs with a set of objective beliefs, the social value of a trial with outside contracts is

$$S^0(\mu_0, \mu_p, \mu_d, a_p, a_d, \sigma^2) = -R^0(\mu_0, \mu_p, \mu_d, a_p, a_d, \sigma^2) - (c_p + c_d). \tag{17}$$

2.4 Discussion

Coexistence of Inside and Outside Contracting. We have assumed that the litigants either write inside contracts with each other or outside contracts with third-party investors. We have not explored the possibility that the parties may use both types of contracts, sharing risk with each other in addition to risk sharing with the external capital market. In the appendix we state and prove that if both the plaintiff and the defendant write the (subjectively) optimal contracts with the third parties in (12) and (13), then there is no additional value to be captured with inside contracts. Intuitively, gains from trade fail to exist because the plaintiff and defendant have exactly the same opportunity cost of funds.[45] The plaintiff would be delighted to sell some additional insurance to the defendant if the defendant was willing to pay more than μ_0 (which is the price paid by the litigation funder). But the defendant has no interest in paying this inflated price since he can already purchase as much insurance as he wants from the capital market at price μ_0.

Unequal Access to Capital. Our previous analysis assumed that the litigants had equal access to the outside capital market. But in practice, litigation funding for plaintiffs is much more common than after-the-event insurance for defendants. Perhaps surprisingly, the parties can and will obtain the very same joint benefits when only the plaintiff can access the capital market as when they both can access it. To see why this is true, note that the plaintiff and the defendant can write an inside contract that mimics the optimal outside insurance policy in (13), $r(x) = r_0 + r_1 x$ where $r_0 = (1 - r_1)\mu_0$. The plaintiff could then supplement this inside contract by selling a fraction $r_1 - t_1$ of the case to an outside litigation funder for the market price $(r_1 - t_1)\mu_0$.[46] Similarly, if only the defendant could access the market, the defendant could purchase a stake in the plaintiff's case with an inside contract and acquire additional insurance (if necessary) from the capital market with an outside contract. Thus, even when only one party can access to the capital market, the parties can perfectly replicate $r(x) = r_0 + r_1 x$ and $t(x) = t_0 + t_1 x$ just as before.[47]

Investor Market Power. Our qualitative results would continue to hold if the third-party investors have market power. To see why, suppose that a third-party investor could make a take-it-or-leave-it contract offer to the plaintiff before trial. The equilibrium contract offer would be Pareto-optimal, and would necessarily

[45] If the outside investors were risk averse and cannot diversify their own portfolios, then the plaintiff and the defendant would find it mutually beneficial to share risk with each other in addition to their respective funders. In the cases studied by Prescott et al. (2014) and Prescott and Spier (2016), many of the litigants who write inside contracts also have insurance policies and/or contingent fee lawyers.

[46] Equivalently, the plaintiff can be an insurance middleman, purchasing the policy $r(x) = r_0 + r_1 x$ from the capital market and then reselling it to the defendant. The plaintiff would then sell a fraction $1 - t_1$ of the case to a litigation funder with the contract $t(x) = t_0 + t_1 x$, thereby replicating the outside contracting equilibrium.

[47] Note that if a party who lacks direct access to the capital market would be at a bargaining disadvantage. So if the defendant lacks access, the plaintiff will be able charge more than r_0 for the insurance policy. In the text, we maintained the original market price r_0 for illustrative ease.

satisfy the condition in equation (11).[48] Although the lump-sum payment would be lower than it was before (since the third party investor can capture rents), the slope of the contract would be exactly the same as in equation (12).[49] Similarly, if a third party had some market power over the defendant, he could demand a higher lump-sum payment than $r_0 = (1 - r_1)\mu_0$. However, the slope of the contract r_1 would not depend on the allocation of bargaining power. Thus, the slopes of the outside contracts r_1 and t_1, and the aggregate cost of risk, do not depend on the competitiveness of the capital market.

Negative Expected Value Claims. Our earlier analysis assumed that the plaintiff always had a credible threat to litigate. That is, we assumed that the plaintiff's subjective payoff from a naked trial was non-negative, $\mu_p - a_p\sigma^2/2 - c_p \geq 0$. So, if negotiations broke down, the plaintiff would not want to drop the case. If instead the plaintiff's case had negative expected value, then the plaintiff could not credibly threaten the defendant to go to trial. The defendant, knowing that the plaintiff's case is not viable and would be dropped, could simply refuse to participate in contract negotiations.[50] With outside contracts, the plaintiff has a stronger threat to go to trial. If negotiations with the defendant break down, the plaintiff can turn to the capital market, boosting the plaintiff's subjective value from litigation. The plaintiff-litigation funder team would have a credible threat to go to trial when $(1-t_1)\mu_0 + t_1\mu_p - a_p t_1^2\sigma^2/2 - c_p \geq 0$. Since litigation funding improves the plaintiff's outside option, it strengthens the plaintiff's threat to go to trial and benefits the plaintiff (in a subjective sense) at the expense of the defendant.

Endogenous Litigation Spending. In the model, the costs of litigation were exogenous and did not depend on the inside or outside contracts signed. In practice, these contracts could change the equilibrium incentives of the parties to invest in litigation. In Appendix B, we extend the model to consider litigation as a rent-seeking contest where, by spending additional money in preparation for trial, a party can move a factfinder's decision in his or her favor.[51] We show that inside

[48] We are assuming here that outside contracts are negotiated on a case-by-case basis. If outside investors had to offer the same contract terms to all litigants, then monopoly distortions could arise.

[49] The insight that market power would not change the slope of the contract is also evident from our general characterization of inside contracts in (6). All Pareto-optimal contracts share the same slope.

[50] Inside contracting may still arise when μ_p is much larger than μ_d so that the slope is greater than one. In this case, the lump-sum payment is negative and the plaintiff pays the defendant to go to trial as before.

[51] See Konrad (2009) for a survey of the contest literature. Applications to litigation include Posner (1973, appendix), Katz (1988), and Rosenberg and Spier (2014).

contracts that mitigate the risk of trial also curb the parties' incentives to spend money litigating the suit.[52] This private and social benefit may be foregone when the parties contract instead with third-party investors. Intuitively, the plaintiff-investor team shares the unmitigated damage award, and defendant-investor team bears the corresponding unmitigated loss. Since each team faces the full exposure of a trial, they have no joint incentive to curb their spending.[53]

Wealth Constraints. In our analysis, neither the plaintiff nor the defendant were wealth constrained. The plaintiff had adequate funds to pay for the cost of litigation, c_p, and the defendant had adequate resources to pay for the litigation costs c_d and any damage award x, and we placed no restriction on the lump-sum transfer payments in their inside and outside contracts. These assumptions may be appropriate in some circumstances, such as in settings involving well-heeled companies and commercial litigation. In settings where plaintiffs and their lawyers are liquidity constrained, better access to litigation funding and other outside contracts may be instrumental for giving plaintiffs greater access to the legal system. Without outside capital, plaintiffs may simply be unable to proceed to trial and defendants, knowing this, would refuse to settle.[54]

High-Low Agreements. In actual litigation practice, one observes partial settlement agreements with a variety of functional forms. While some of these agreements have a linear structure, others do not.[55] One relatively common contingent settlement contract is the high-low agreement, where the ultimate payout is constrained by a floor and a ceiling (Prescott et al., 2014; Prescott and Spier, 2016).[56]

It is not difficult to construct subjective beliefs and preferences that generate high-low agreements in equilibrium (or contracts that are "close" to high-low

[52]When designing their inside contract, the parties have a joint incentive to make it flatter (relative to what they would do with exogenous litigation costs) as a commitment to not engage in future wasteful rent seeking.

[53]This argument is premised on the assumption that there is Coasian bargaining between a litigant and his/her financial service provider, but not between the two litigants. See Appendix B for details and discussion.

[54]A potentially insolvent defendant may have less incentive to purchase a generous insurance policy, since the premiums would be high and the benefit of generous insurance may largely accrue to the plaintiff.

[55]In 2010, SAP paid Oracle \$120 million in exchange for Oracle agreeing not to seek punitive damages (see Prescott and Spier, 2016, p. 97). In Palimere v. Supermarkets in footnote 2, the parties agreed to a 75%/25% split of damages. See Prescott and Spier (2016, p. 112) for additional examples.

[56]With a high-low agreement, the plaintiff has the option to sell the claim for the floor value (put option), and the defendant has the option to buy the claim for the ceiling value (call option). See footnote 3.

agreements). First, high-low agreements are often optimal when the parties' subjective beliefs are binary on a common support. For example, the parties may share common beliefs about level of damages, but fundamentally disagree about the probability that the plaintiff will win. Moderately risk-averse parties would use a high-low contract to pull the binary outcomes ("win" and "lose") closer together.[57] Second, one can modify normally-distributed beliefs in a way that is fully consistent with high-low agreements. Technically, one could change the shape of the tails so that the likelihood ratios in the tail regions are constant.[58] Finally, with triangular distributions with different modes and CARA preferences, one can get contracts that are remarkably similar to high-low contracts.[59]

That said, the popularity of high-low agreements in litigation practice is probably due more to their simplicity and intuitive appeal than to their analytical purity. In practice, it is not uncommon for the "high" and the "low" values to be the plaintiff's and defendant's last and final settlement offers before reaching a bargaining impasse. In the examples given above, generating a slope of exactly one, $s'(x) \equiv 1$, in some middle region requires a knife-edged configuration of parameter values.[60] Although high-low agreements may not be Pareto optimal, they can avoid extreme outcomes and thus accomplish the risk-sharing benefits of more elaborate and sophisticated schemes.

3 Welfare Analysis

We will now compare the three contractual regimes – naked trials, inside contracts, and outside contracts – in terms of their subjective value to the litigants and their costs to society.

Before we begin, it is helpful to define a piece of new notation. Let $\widehat{\mu}_0$ be

[57]See Prescott et al. (2014). Extremely risk-averse parties would settle out of court. They also point out that high-low contracts reduce incentives for wasteful rent seeking to influence the trial outcome. See Appendix B. Similarly, high-low contracts eliminate incentives for the parties to waste resources in activities that influence the tails of the distribution, e.g., efforts to discredit an otherwise credible witness.

[58]Consider a bounded support that is divided into three regions. Suppose that the beliefs follow the normal curves in the middle region, but have modified tails with constant likelihood ratios $f_p(x)/f_d(x)$ in the bottom and top regions (uniform or linear beliefs would work).

[59]Suppose for example that $f_p(x)$ and $f_d(x)$ are triangular and defined on support $[20, 120]$ (in thousands) and that the mode values are 40 and 100 for the defendant and plaintiff, respectively. The likelihood ratio $f_p(x)/f_d(x)$ is constant when $x < 40$ or $x > 100$, creating a floor and a ceiling. When $a_p + a_d = .00002$, the slope in the middle region is close to one.

[60]In the numerical example in Appendix B, with $\mu_p = 90, \mu_d = 50, \sigma = 20$ and $a_p+a_d = .0002$, the inside contract has a slope of $s_1 = .50$. This is discussed further in Section 3.3. If the $a_p + a_d = .0001$ instead, then the slope would be unity.

the following weighted average of the plaintiff's and the defendant's subjective beliefs, μ_p and μ_d:

$$\widehat{\mu}_0 = \frac{a_d\mu_p + a_p\mu_d}{a_p + a_d}. \tag{18}$$

When the beliefs of the external capital market coincide with this threshold, so $\mu_0 = \widehat{\mu}_0$, then slopes of the inside contract $s(x)$ and the slopes of the outside contracts $t(x)$ and $r(x)$ are all exactly the same.

The fact that there exists a threshold $\widehat{\mu}_0$ where the slopes of the three contracts coincide is intuitive. The inside contract $s(x) = s_0 + s_1x$ in equation (6) creates a Pareto-optimal allocation of risk for the plaintiff and defendant (from a subjective perspective). By the second fundamental theorem of welfare economics, this allocation can be supported as a competitive equilibrium. If the price of the lawsuit were fixed at $\widehat{\mu}_0$ defined in (18), the plaintiff would choose to keep fraction s_1 of the lawsuit and sell the residual fraction. Similarly, the the defendant would choose to retain fraction s_1 of the risk and purchase insurance for the residual fraction. So, when the market price of the lawsuit is $\widehat{\mu}_0$, then the slopes of the inside and outside contracts coincide: $r_1 = s_1 = t_1$.

LEMMA 1: *If $\mu_0 = \widehat{\mu}_0$ then $r_1 = s_1 = t_1$, if $\mu_0 < \widehat{\mu}_0$ then $r_1 < s_1 < t_1$, and if $\mu_0 > \widehat{\mu}_0$ then $r_1 > s_1 > t_1$ where r_1, s_1, and t_1 are defined in (6), (12), and (13).*

Figure 1 shows how the slopes of the three contracts depend on the competitive market price μ_0 for the case where $\mu_d < \mu_p$. If the capital market has the same beliefs as the defendant, so $\mu_0 = \mu_d$, then the defendant insures the entire loss at trial ($r_1 = 0$) and the plaintiff sells part (but less than one hundred percent) of the case to litigation funders ($t_1 > 0$). As the outside market price μ_0 rises, two things happen: the defendant purchases less insurance (r_1 rises) and the plaintiff seeks more litigation funding (t_1 falls). At the other end of the spectrum, when $\mu_0 = \mu_p$, then the plaintiff sells the entire lawsuit to third-party investors ($t_1 = 0$) for a competitive price μ_0 and the defendant purchases partial insurance ($r_1 > 0$). When $\mu_0 = \widehat{\mu}_0$, the stake sold by the plaintiff is equal to the insurance demanded by the defendant and $r_1 = s_1 = t_1$.

3.1 The Subjective Benefits of Litigation

We now compare the parties' joint subjective value in the three contractual regimes – naked trials, inside contracts, and outside contracts.

First, and most obviously, the parties are subjectively better off with inside contracts than with naked trials. This follows from revealed preference. More interestingly, the plaintiff and defendant are weakly better off (in a joint subjective

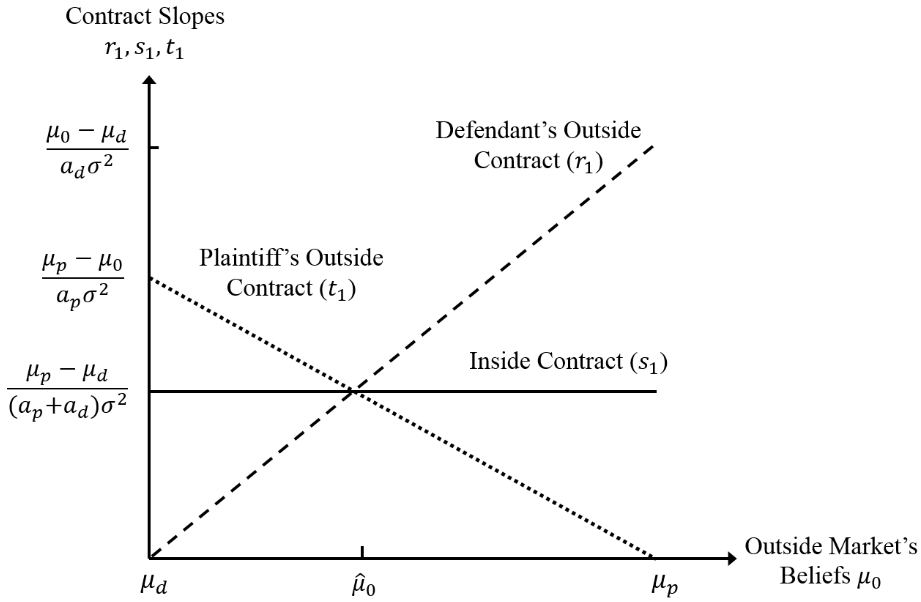

Figure 1: Inside and Outside Contracts ($\mu_d < \mu_p$)

sense) when they can transact with the outside capital market. With inside contracts, the fortunes of the plaintiff and defendant are inextricably tied together. In contrast, the outside market affords the litigants the flexibility to fine-tune their stakes to better suit their subjective beliefs and risk preferences.[61] Through the outside market, the plaintiff and defendant can decouple their financial interests, and this works to their mutual advantage.

To see these results formally, compare the subjective joint benefit of litigation from the outside contracts $B^0(\centerdot)$ given in equation (15) to the subjective joint benefit of the inside contract $B^*(\centerdot)$ given in equation (8). Using the definition of $\widehat{\mu}_0$ in (18), one can show that

$$B^0(\centerdot) = B^*(\centerdot) + \left(\frac{a_p + a_d}{2a_p a_d \sigma^2}\right)(\mu_0 - \widehat{\mu}_0)^2. \tag{19}$$

Since $(\mu_0 - \widehat{\mu}_0)^2 \geq 0$, we have $B^0(\centerdot) \geq B^*(\centerdot)$. The plaintiff and defendant are weakly better off with outside contracting than with inside contracting. Next, comparing the subjective joint benefit of the inside contract represented in equa-

[61]Suppose that $\mu_0 < \widehat{\mu}_0$, so the capital market's beliefs are more closely aligned with the defendant's beliefs. Since $r_1 < s_1$ from Lemma 1, the defendant would strictly prefer to insure an even higher fractional stake of the case. Conversely, the plaintiff would prefer sell a smaller stake to the capital market, $t_1 > s_1$.

tion (7) to the joint benefit of the naked trial $B^N(\cdot)$ in (1), we find that

$$B^*(\cdot) = B^N(\cdot) + \frac{(a_p + a_d)\sigma^2}{2}(1 - s_1)^2. \tag{20}$$

The inside contract creates more value than the naked trial when the slope of the inside contract $s_1 \neq 1$. We have the following result.

PROPOSITION 1: *The joint subjective value of litigation is lowest when all contingent contracts are prohibited, weakly higher when only inside contracts between the parties to the dispute are permitted, and weakly higher still when parties are free to write contracts with the outside capital market, $B^N(\cdot) \leq B^*(\cdot) \leq B^0(\cdot)$. Inside and outside contracts create the same joint subjective value if and only if the capital market's beliefs are $\mu_0 = \widehat{\mu}_0$ defined in (18). Inside contracts and naked trials create the same joint subjective value if and only if the inside contract in (6) has a slope of one, $s_1 = 1$.*

When the capital market's beliefs are a properly weighted average of the litigants' beliefs, $\mu_0 = \widehat{\mu}_0$, then the parties do just as well contracting with each other as they do contracting with third parties, $B^*(\cdot) = B^0(\cdot)$. In other words, there is a measure zero set of parameter values that eliminates the value of trading with outside investors.[62] This follows from the fact that when $\mu_0 = \widehat{\mu}_0$, the slopes of all three contracts are the same, $r_1 = s_1 = t_1$ (Lemma 1). Given the market price $\widehat{\mu}_0$, the plaintiff would choose to sell a fraction $1 - s_1$ of the lawsuit to a litigation funder for a lump-sum payment $(1 - s_1)\widehat{\mu}_0$, and the defendant would pay investors $(1 - s_1)\widehat{\mu}_0$ to insure a fraction $1 - s_1$ of their future loss. In this knife-edged case, the plaintiff and the defendant do not need the outside capital market. They can achieve the very same subjective benefits by contracting with each other and cutting out the middleman.

This result is perhaps all the more surprising since by design we have stacked the deck in favor of third-party investors by assuming that they are risk neutral, competitive, and transaction-cost free. If there were any transactions costs of dealing with outside suppliers of capital (costs of negotiating contracts, agency, or due diligence), then there will be a range of parameter values where the parties are better off forgoing the external capital market. In other words, in practice the defendant may be in a better position than the market to supply funding to the plaintiff, and the plaintiff may be in a better position than the market to supply insurance to the defendant.

[62] If $\mu_p = \mu_d$ then the inside contract would have a slope of zero – the plaintiff and defendant would face no risk. If $\mu_0 = \widehat{\mu}_0 = \mu_p = \mu_d$, then with outside contracts litigation investors would purchase one hundred percent of the plaintiff's case and insure one hundred percent of the defendant's case.

Although the plaintiff and the defendant are subjectively better off in a joint sense when outside capital markets are available, it does not necessarily follow that the plaintiff and defendant are better off *individually*. Whether an individual litigant is better off or worse off will depend on the beliefs of the capital market, μ_0, how risk averse they are, and the bargaining power of the litigants when negotiating the inside contract, π and $1 - \pi$. The next proposition provides a partial ranking of the individual subjective benefits of outside versus inside contracting. In the proposition, the bargaining power threshold $\widehat{\pi}$ depends on the risk aversion of the two parties and is defined as follows:

$$\widehat{\pi} = \frac{a_d}{a_p + a_d}. \tag{21}$$

PROPOSITION 2: *Suppose $\mu_0 = \widehat{\mu}_0$. The defendant is better off (worse off) and the plaintiff is worse off (better off) with the outside contract than with the inside contract if the defendant's bargaining power is low (high), $\pi < \widehat{\pi}$ ($\pi > \widehat{\pi}$). Suppose $\pi = \widehat{\pi}$. The defendant is better off (worse off) and the plaintiff is worse off (better off) with the outside contract than with the inside contract when the capital market believes that the damages are low (high), $\mu_p - a_p\sigma^2 < \mu_0 < \widehat{\mu}_0$ ($\widehat{\mu}_0 < \mu_0 < \mu_d + a_d\sigma^2$).*

Intuitively, the plaintiff will benefit from selling an equity stake to the outside capital market if the price that the outside market will pay is higher than than the inside price (the price that the plaintiff would otherwise negotiate with the defendant). The outside market price will tend to be high when the capital market believes that the expected damages are high, $\mu_0 > \widehat{\mu}_0$. The inside contract price will tend to be low when the plaintiff's bargaining power is low (π is high). On the flip side, the defendant would benefit from purchasing insurance from the outside market if the price of that insurance is lower than the inside contract price. Thus, the defendant will tend to be better off with the outside contract when the market price μ_0 is low and when the defendant's bargaining position is weak (π is low). Finally, note that if the plaintiff is much more averse to risk than the defendant then the plaintiff will be in a very bad bargaining position when negotiating an inside contract with the defendant. Formally, when the plaintiff is very risk averse, then $\widehat{\pi}$ in (21) is very small. In this case, the plaintiff is likely to obtain significant benefits from access to the outside capital market.

3.2 The Social Costs of Litigation

We begin by ranking the regimes according to the costs of litigation, or equivalently the litigation rate. Recall that the parties will choose to go to trial when the sum of their litigation costs, c_p+c_d, is smaller than the joint subjective benefit of litigation. Since the parties' joint subjective benefits of litigation are ranked in Proposition 1, $B^N(\centerdot) \leq B^*(\centerdot) \leq B^0(\centerdot)$, we have the following result.

PROPOSITION 3: *The litigation rate (and litigation costs) are lowest when all contingent contracts are prohibited, weakly higher when only inside contracts between the parties to the dispute are permitted, and weakly higher still when parties are free to write contracts with the outside capital market.*

This result is not surprising. By revealed preference, parties enter into contracts for the very purpose of making trial more attractive by mitigating risk and/or capturing benefits of mutual speculation. So, when compared with a world where contracting on the trial outcome is impossible or prohibited, contingent contracts will tend to discourage settlement and stimulate litigation. Although we do not have direct empirical proof that inside contracts will increase the rate of litigation in practice, the experience of New York's Summary Jury Trial Program is suggestive. In a data set of more than 2,700 lawsuits that entered this program, more than eighty percent included high-low contracts (Prescott and Spier, 2016). Furthermore, the cases with high-low agreements were eleven percent less likely to settle out of court, a figure that is highly statistically significant.[63]

We will now rank the three contractual regimes according to their aggregate litigation risks. Comparing the risks $R^*(\centerdot)$ from the inside contract in (9) to the risk $R^N(\centerdot)$ from the naked trial in (2) we have:

$$R^*(\centerdot) = R^N(\centerdot)s_1^2 \tag{22}$$

where s_1 is the slope of the equilibrium inside contract (6). Compared with a naked trial, the inside contract may either raise or lower the sum of the risk premiums, depending on whether the contract mitigates the risk (the slope $s_1^2 < 1$) or magnifies the risk ($s_1^2 > 1$). Next, comparing $R^*(\centerdot)$ to the risks from the outside contract $R^0(\centerdot)$ in (16) and using the definition of $\widehat{\mu}_0$ in (18) we show in the appendix that

$$R^0(\centerdot) = R^*(\centerdot) + \left(\frac{a_p + a_d}{2a_p a_d \sigma^2}\right)(\mu_0 - \widehat{\mu}_0)^2. \tag{23}$$

When the capital market's beliefs satisfy $\mu_0 = \widehat{\mu}_0$ then outside contracts and inside contracts create the same level of risk. This follows from our earlier

[63]One cannot attribute this pattern to causation, of course. Cases that are unlikely to settle have a greater need for high-low agreements. An empirical test of the causal effects of these contracts on settlement rates would require a randomized study, a natural experiment, or a laboratory experiment.

result that $r_1 = s_1 = t_1$. More strikingly, equation (23) tells us that outside contracts have a strictly higher costs of risk bearing whenever $\mu_0 \neq \widehat{\mu}_0$. If $\mu_0 < \widehat{\mu}_0$, for example, then $r_1 < s_1 < t_1$. In this case, the outside contract exposes the defendant to less risk and exposes the plaintiff to more risk than the inside contract. But taken together, the sum of the risk premiums is necessarily higher.[64] Thus, under the assumptions of the model, allowing the parties to the dispute to write contracts with risk-neutral competitive investors will never lower the amount of aggregate risk that they face, and will generally increase it.

PROPOSITION 4: *The aggregate costs of risk bearing are smaller with inside contracts than naked trials when the inside contracts mitigate risk ($s_1^2 < 1$) and are larger when the inside contracts magnify the risk ($s_1^2 > 1$). Outside contracts with third-party suppliers of capital create more aggregate risk than inside contracts,* $R^0(\centerdot) \geq R^*(\centerdot)$.

The result that outside contracts may actually raise the aggregate cost of risk-bearing (relative to inside contracts) is interesting. Recall that contracts create subjective value in two ways: risk allocation and speculation. Intuitively, parties who are limited to inside contracts have a joint subjective interest in supplying each other with additional insurance and forgoing some subjective benefits of speculation. The availability of risk neutral third-party investors gives the parties more degrees of freedom and greater opportunities for mutual speculation, raising the overall risk level. This insight is aligned with recent findings in the behavioral finance literature where the introduction of new financial products increases market risk when traders have heterogeneous beliefs (Simsek, 2013; Weyl, 2007; Dieckmann, 2011).

Even though the parties may believe subjectively that contingent contracts are in their mutual interest at the time of contracting, they may be jointly worse off when their payoffs are evaluated using a single set of objective beliefs. Recall that we defined social welfare to be the sum of the certainty equivalents of all parties (the litigants and the outside investors), evaluated using a single set of objective beliefs rather than the parties' subjective beliefs. If the case goes to trial, then social welfare reflects the costs of risk bearing and the costs of litigation,

$$S^i(\centerdot) = -R^i(\centerdot) - (c_p + c_d). \tag{24}$$

When the parties' payoffs are evaluated with a single set of beliefs, the parties' subjective benefit of speculation disappears and all that remains are the trial risks, $R^i(\centerdot)$, and the litigation costs, $c_p + c_d$.

[64] Conversely, if $\mu_0 > \widehat{\mu}_0$, then the outside contract exposes the plaintiff to less risk and the defendant to more risk but the sum of the risk premiums still rise.

PROPOSITION 5: *If the slope of the inside contract s_1 satisfies $s_1^2 < 1$ and the costs of litigation are not too large, $c_p + c_d < B^N(\bullet)$, then social welfare is strictly higher with the inside contract than with a naked trial, $S^*(\bullet) > S^N(\bullet)$. If $c_p + c_d > B^N(\bullet)$ or $s_1^2 > 1$ then social welfare is weakly lower with the inside contract than with a naked trial, $S^*(\bullet) < S^N(\bullet)$ Social welfare is weakly lower when the litigants can write outside contracts with third-party investors than when they can only write inside contracts with each other, $S^0(\bullet) \leq S^*(\bullet)$.*

According to Proposition 5, inside contracts may either raise or lower social welfare relative to a naked trial. If $c_p + c_d < B^N(\bullet)$ then the case will go to trial rather than settle in both the naked trial and inside contracting regimes. Since the litigation costs are the same here, any difference in welfare would hinge on the relative risks. If the slope of the inside contract is $s_1^2 < 1$ then the inside contract mitigates the risk and if $s_1^2 > 1$ then the inside contract magnifies or amplifies the risk. If $c_p + c_d > B^N(\bullet)$ then the case necessarily settles out of court with the naked trial. Since settlement is just a transfer payment, the social welfare is zero. Inside contracts can only reduce social welfare in this case, insofar as they increase the likelihood of risky trials.

Proposition 5 also implies that social welfare is lower when parties can write contracts with outside investors than when they are restricted to inside contracts. This is true for two reasons. First, cases are more likely to go to trial with outside contracts than inside contracts, raising the costs of litigation (Proposition 3). Second, the aggregate cost of risk bearing is lower with inside contracts than outside contracts (Proposition 4). In this sense, society would be better off prohibiting parties from entering into contracts with outside investors and forcing them to instead contract just with each other.

3.3 Discussion

Our welfare analysis focused exclusively on the subjective benefits of the litigants and the costs and aggregate risks of litigation. There are additional welfare concerns that are outside of the formal model but nonetheless very important.

The Defendant's Incentives for Care. The anticipation of contingent contracting could of course influence the behavior of the defendant ex ante, before lawsuits even arise. In the model, the litigants are better off ex post with contingent contracting. This follows from revealed preference, since the litigants enter into these contracts willingly.[65] If the defendant anticipates receiving positive

[65] A similar argument applies to simple non-contingent settlements. See surveys by Spier (2007) and Daughety and Reinganum (2012) for a general discussion of the effects of litigation

benefits of future contingent contracting, then the defendant's incentives to take precautions to avoid harming the plaintiff would be diluted. In this case, the defendant would take fewer precautions to avoid harming the plaintiff and there will be more accidents in equilibrium.[66]

The fact that litigants perceive themselves to be better off ex post with contingent contracting does not necessarily imply that litigants are subjectively better off ex ante. In many cases, individuals may share the objective beliefs before accidents arise, but then fall victim to self-serving biases ex post, after they learn if they are the victims (plaintiffs) or injurers (defendants). Insofar as potential defendants anticipate succumbing to future self-serving bias, and consequently bearing larger costs if the plaintiff suffers harm, a potential defendant would have stronger incentives to take precautions to avoid accidents. In this scenario, there would be fewer accidents in equilibrium.

The Plaintiff's Decision to Bring Suit. The opportunity to turn to the capital market for outside funding could in practice affect the plaintiff's decision to file a lawsuit against the defendant. As discussed earlier, access to the outside capital market can turn what would otherwise have been a negative expected value case into a positive expected value one. If negotiations break down, then the capital market might share the risk or facilitate speculation, thus improving the plaintiff's outside option.[67] The capital market can also make litigation feasible if the plaintiff is wealth constrained.

In these cases, access to litigation funding by the plaintiff will lead to more trials, and hence higher litigation costs and more aggregate risk, reinforcing our earlier results. Since litigation funding can turn a negative expected value case into one that is viable, this will feed back into providing stronger incentives for the defendant to take precautions to avoid harming the plaintiff to begin with. This is socially valuable if the defendant was otherwise under-deterred. But if the negative expected value claim is one that has little social value (a largely frivolous case that will not improve the defendant's incentives for care), the availability of litigation funding would be socially harmful.

Other Welfare Effects. While many of the costs of litigation are privately borne by the parties themselves, others are subsidized by taxpayers. The time costs of the judge, the foregone opportunities of jury members, and the costs

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and settlement on deterrence, including the role of litigation costs.

[66]This would obviously be bad for social welfare if the defendant was under-deterred to begin with, but could raise welfare if the defendant was over-deterred. See Shavell (1997) on the divergence between the private and social incentive to litigate.

[67]Note that a liquidity constrained plaintiff would benefit even more, since the outside capital market would make the lawsuit feasible.

of overhead and infrastructure, are not paid for by the direct users of the court services. Thus, the costs of litigation considered by the parties when crafting their settlement strategies may well understate the actual costs of increased litigation. Note also that lawsuits may in some circumstances create external benefits. One benefit is the development of case law, the stock of which may be viewed as a public good. Then, insofar as inside contracts stimulate additional litigation, they could increase the stock of this public good.[68] See Landes and Posner (1976) for an early theoretical and empirical analysis of precedent.

Aggregate Risk Bearing. Under the assumptions of our model (risk-averse litigants, CARA preferences, normally-distributed beliefs, etc.), outside contracts with risk-neutral third-party investors create more aggregate risk than inside contracts. This result may be seen in a numerical example where $\mu_p = 90, \mu_d = 50, \mu_0 = 80$ and $\sigma = 20$, all in thousands, and risk aversion coefficients $a_p = a_d = .0001$ (see Appendix B). With this configuration of parameter values, the inside contract has a slope of $s_1 = .50$, so the plaintiff sells half of the case to the defendant (equivalently, the defendant buys insurance for half of the case from the plaintiff). With outside contracts, the plaintiff bears less risk ($t_1 = .25$) and the defendant bears more risk ($r_1 = .75$). The sum of the plaintiff's and defendant's risk premiums is higher with outside contracts than with inside contracts because $(.25)^2 + (.75)^2 > (.50)^2 + (.50)^2$.

The result that outside contracts lead to weakly higher costs of risk bearing, while interesting and provocative, was obtained under strong and stylized assumptions. In our model, both inside and outside contracts become steeper (more risky) when the parties become less risk averse. When a_p is very small, the plaintiff's outside contract with the capital market magnifies risk rather than reduces it. Indeed, as a_p approaches zero, the plaintiff's risk premium in (16) increases without bound.[69] If there were natural bounds on the ability of litigants to double down in this way, or legal constraints (anti-gambling statutes, for example), then the risk premiums would not increase without bound. Generalizing our model to include other preferences, belief structures, and liquidity constraints is beyond the scope of our paper and is left as an avenue for further work.

[68]This would lead a more efficient allocation of resources and incentives for care.

[69]Similarly, as a_d approaches zero the defendant's risk premium diverges. This reflects a discontinuity, since when litigants are risk neutral there is no social cost associated with extreme gambling. We thank a referee for pointing this out.

4 Conclusion

This paper characterizes the set of Pareto-optimal contracts that risk-averse parties with different subjective beliefs would choose to write with each other before trial. In contrast to traditional settlement agreements, we allow the parties to condition future payments on the trial outcome itself. Since the use of these contracts makes the trial more attractive for the parties, these contracts will tend to reduce the probability of settlement and increase the probability of litigation. Compared to a world where these contracts are not possible, risk could be lower or higher depending on whether the parties choose to mitigate risk or to amplify it. We also compare these "inside" contracts to a related set of "outside" contracts between the parties and third-party investors and show that, under the assumptions of our model, outside contracts increase both litigation costs and risks.

Access to a well-functioning capital market will generally improve the subjective joint payoffs of the parties relative to what they could achieve on their own through inside contracting. This result was of course derived under idealized circumstances with risk-neutral investors who competed with each other to provide services to the parties. In practice, however, these conditions are unlikely to hold. Although many defendants do have pre-existing insurance policies, many defendants enter litigation either uninsured or underinsured and have few viable options to mitigate their residual risks after the event.[70]

Our analysis suggests parties to a dispute can themselves secure many of the risk-shifting benefits provided by third-party investors.[71] Recall that equilibrium inside contracts include a lump-sum payment from the defendant to the plaintiff coupled with a contingent payment (e.g., a fraction of the court's award). Through this contract, *the defendant is effectively playing the role of a litigation funder*, paying a lump-sum purchase price to the plaintiff in exchange for a stake in the plaintiff's claim. On the flip side, *the plaintiff is effectively playing the role of an insurance company*. The lump-sum payment made by the defendant is analogous to an insurance premium. In return for this premium, the plaintiff-insurer bears a portion of the defendant's loss. Our theory suggests that parties

[70] In the United States, after-the-event insurance is largely unavailable. This "missing market" is perhaps unsurprising, since the parties to the suit will often have better collective information about claim value and characteristics than litigation funders or insurance companies. However, Molot (2014, 189) describes how Burford Capital, a litigation funder, participated in a defense-side insurance deal in the United States by essentially partnering with an insurance company. In England, where the winner's litigation costs are shifted to the loser, it is not uncommon for parties to take out litigation insurance policies to cover their opponent's litigation fees. See Molot (2009, 380); Molot (2014, 189).

[71] Bypassing the third-party investors can also reduce transactions costs.

are more likely to write creative contingent contracts with each other in settings where capital markets are imperfect and fail to operate efficiently.

Although the primary focus of this paper is litigation, our ideas may apply to other economic settings as well. Consider for example a small farmer who is planting a crop in advance of harvest, and a local food processor. The farmer and processor may choose to fix the sale price several months in advance of the harvest, eliminating the pricing risk, or sign a forward contract where the sale price is contingent on a benchmark provided by a reporting service (Paul et al., 1985). Alternatively, the farmer and processor might hedge their positions by contracting with third parties on a formal exchange. Through put and call options and other financial instruments, the farmer and processor can hedge risk and/or speculate on future commodity prices.[72] Our results imply that the aggregate risk borne in the vertical chain may actually be higher when the participants have access to the capital market and can actively trade in futures and options. The possible link between futures markets and price volatility has, historically, prompted disdain for speculators and discomfort with organized futures and options exchanges.[73]

Our model was premised on the assumption that the parties involved in litigation – the plaintiff and the defendant – may hold different subjective beliefs about the outcome at trial. Importantly, our model assumed that the litigants were stubborn in their beliefs and did not revise or update them when confronted with the differing opinions of others (including the capital market). As discussed earlier, divergent beliefs may reflect the self-serving biases or optimism of the litigants and/or their lawyers, the different experiences of the parties, or their different interpretations of the evidence. They could reflect mistakes on the part of one or both litigants, or cognitive limits in their ability to engage in Bayesian updating.

Although we believe that our theoretical approach is valuable and empirically relevant, we do not think that this is the only valuable approach. Future work could examine different (or more general) forms of preferences and beliefs, and the implications of contingent contracting for deterrence and the choice of harmful acts. Future research might explore contracting in a dynamic environment that includes Bayesian learning and/or asymmetric information. For example, litigants' beliefs may converge over time and through the discovery process as

[72]For example, a farmer may buy one call option at a low strike price while simultaneously selling a second call option at a higher strike price. As with the high-low contract in litigation, this creates a floor and a ceiling for the farmer's return.

[73]In 1958 the United States Congress passed Public Law 85-839, commonly known as the Onion Futures Act, to prohibit onion futures trading because "speculative activity in the futures markets causes such severe and unwarranted fluctuations in the price of cash onions ... " (United States Congress, 1958, p.1).

more details about the case come to light.[74] In addition, privately-informed parties may use their inside and outside contracts to signal the value of their claims to their opponents and the judge or jury.[75]

Finally, our work raises important policy questions. For example, should litigants be required to disclose their financial arrangements, both inside and outside, to courts? In practice, plaintiffs and defendants often hide their contingent settlement contracts (e.g., high-low agreements) from the judge and jury, out of an apparent concern that doing so could bias the court's judgment.[76] Litigation funding contracts are almost never disclosed, as plaintiffs and their attorneys are typically bound by nondisclosure agreements.[77] In response to this lack of transparency, three members of the U.S. Senate Judiciary Committee proposed the *Litigation Funding Transparency Act of 2018* which would require certain litigants to disclose the identity of "any commercial enterprise" that has a contingent financial interest in the outcome (settlement or judgment) of a case, and to produce the agreements "for inspection and copying." This is an exciting direction for future research.[78]

[74]Yildiz and Vasserman (2016) combine Bayesian learning with divergent beliefs.

[75]See Lavie and Tabbach (2017) for signaling with inside contracts and Avraham and Wickelgren (2014) for signaling with outside contracts.

[76]See Prescott and Spier (2016, p. 131).

[77]Litigation funders view these contracts as proprietary. See Steinitz (2012, p. 463).

[78]In his public statement, chairman Chuck Grassley (R-Iowa) says "For too long, obscure litigation funding agreements have secretly funneled money into our civil justice system, all for the purpose of profiting off someone else's case."

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Appendix A: Proofs

Equation (5): $s(x) = k + \left(\frac{1}{a_p+a_d}\right) \ln\left(\frac{f_p(x)}{f_d(x)}\right)$ *where k is a constant.*

Proof: Since $u_i'(z) = a_i \exp(-a_i z))$, we have,

$$\frac{f_p(x)}{f_d(x)} \frac{a_p \exp[-a_p(s(x) - c_p)]}{a_d \exp[-a_d(-s(x) - c_d)]} = \kappa$$

where κ is a constant. Using the property that $\exp(m)/\exp(n) = \exp(m-n)$ this becomes

$$\frac{f_p(x)}{f_d(x)} \frac{a_p}{a_d} \exp[-(a_p + a_d)s(x) + a_p c_p - a_d c_d)] = \kappa.$$

Taking the natural logarithm of both sides, and using the property that $\ln(mn) = \ln(m) + \ln(m)$, we have

$$\ln\left(\frac{f_p(x)}{f_d(x)}\right) + \ln\left(\frac{a_p}{a_d}\right) - (a_p + a_d)s(x) + a_p c_p - a_d c_d = \ln(\kappa),$$

Solving for $s(x)$ and renaming the collection of constant terms k gives equation (5). ■

Equation (6): $s(x) = s_0 + s_1 x$ *where* $s_1 = \frac{\mu_p - \mu_d}{(a_p+a_d)\sigma^2}$ *and s_0 is a constant.*

Proof: The probability density function for party $i = p, d$ is

$$f_i(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{-(x-\mu_i)^2}{2\sigma^2}\right),$$

which implies

$$\frac{f_p(x)}{f_d(x)} = \exp\left[\frac{-(x-\mu_p)^2 + (x-\mu_d)^2}{2\sigma^2}\right].$$

Substituting this likelihood ratio into equation (2) yields

$$s(x) = k' + \left(\frac{1}{a_p + a_d}\right)\left(\frac{-(x-\mu_p)^2 + (x-\mu_d)^2}{2\sigma^2}\right).$$

Expanding the numerator and rearranging terms, this becomes:

$$s(x) = k' - \left(\frac{1}{a_p + a_d}\right)\left(\frac{\mu_p^2 - \mu_d^2}{2\sigma^2}\right) + \left(\frac{1}{a_p + a_d}\right)\left(\frac{2\mu_p x - 2\mu_d x}{2\sigma^2}\right).$$

The first two terms are constant, which we call s_0, and a slight rearranging of the last term gives equation (6). ■

Equation (11): $t(x) = t + \left(\frac{1}{a_p+a_0}\right) \ln\left(\frac{f_p(x)}{f_0(x)}\right) + \left(\frac{a_0}{a_p+a_0}\right) x.$

Proof: Any Pareto-optimal contract between the plaintiff and the capital market satisfies:

$$\frac{f_p(x)}{f_0(x)} \frac{u_p'(t(x) - c_p)}{u_0'(x - t(x))} = k$$

where k is a constant. Since $u_i'(z) = a_i \exp(-a_i z))$, we have,

$$\frac{f_p(x)}{f_0(x)} \frac{a_p \exp[-a_p(t(x) - c_p)]}{a_0 \exp[-a_0(x - t(x))]} = \kappa$$

where κ is a constant. Using the property that $\exp(m)/\exp(n) = \exp(m - n)$ this becomes

$$\frac{f_p(x)}{f_0(x)} \frac{a_p}{a_0} \exp[-(a_p + a_0)t(x) + a_p c_p + a_0 x)] = \kappa.$$

Taking the natural logarithm of both sides, and using the property that $\ln(mn) = \ln(m) + \ln(m)$, we have

$$\ln\left(\frac{f_p(x)}{f_0(x)}\right) + \ln\left(\frac{a_p}{a_0}\right) - (a_p + a_0)t(x) + a_p c_p + a_0 x = \ln(\kappa),$$

Solving for $t(x)$ and renaming the collection of constant terms t gives the result. ■

Equation (12): $t(x) = t_0 + t_1 x$ *where* $t_0 = (1 - t_1)\mu_0$ *and* $t_1 = \frac{\mu_p - \mu_0}{a_p \sigma^2}$.

Proof: The proof closely mirrors the proof of Equation (6) and is omitted.

Equation (13): $r(x) = r_0 + r_1 x$ *where* $r_0 = (1 - r_1)\mu_0$ *and* $r_1 = \frac{\mu_0 - \mu_d}{a_d \sigma^2}$.

Proof: Any Pareto-optimal contract between the defendant and the capital market satisfies:

$$\frac{f_0(x)}{f_d(x)} \frac{u_0'(-x + r(x))}{u_d'(-r(x) - c_d)} = k,$$

where k is a constant. Since $u_i'(z) = a_i \exp(-a_i z))$, we have,

$$\frac{f_0(x)}{f_d(x)} \frac{a_0 \exp[-a_0(-x + r(x))]}{a_d \exp[-a_d(-r(x) - c_d)]} = \kappa$$

where κ is a constant. Using the property that $\exp(m)/\exp(n) = \exp(m - n)$ this becomes

$$\frac{f_0(x)}{f_d(x)} \frac{a_0}{a_d} \exp[-(a_0 + a_d)r(x) + a_0 x - a_d c_d)] = \kappa.$$

Taking the natural logarithm of both sides, and using the property that $\ln(mn) = \ln(m) + \ln(m)$, we have

$$\ln\left(\frac{f_0(x)}{f_d(x)}\right) + \ln\left(\frac{a_0}{a_d}\right) - (a_0 + a_d)r(x) + a_0 x - a_d c_d = \ln(\kappa),$$

Solving for $r(x)$ and renaming the collection of constant terms r gives

$$r(x) = r + \left(\frac{1}{a_0 + a_d}\right) \ln\left(\frac{f_0(x)}{f_d(x)}\right) + \left(\frac{a_0}{a_0 + a_d}\right) x.$$

The rest of the proof closely follows the proof of equation (6), and the details are omitted. The constant terms $t_0 = (1-t_1)\mu_0$ and $r_0 = (1-r_1)\mu_0$ allow the outside investors to break even on average. ■

Coexistence of Inside and Outside Contracting. *Suppose that the plaintiff and defendant purchase Pareto-optimal outside contracts from a competitive capital market as described in (12) and (13). Then, the parties derive no additional value from contracting with each other.*

Proof: The plaintiff's (subjective) certainty equivalent of the competitively-supplied contract is $(1 - t_1)\mu_0 + t_1\mu_p - a_p t_1^2 \sigma^2/2$ where t_1 is defined in (12). Let $\widetilde{\mu}_p = (1 - t_1)\mu_0 + t_1\mu_p$ and let $\widetilde{a}_p = a_p t_1^2$. The plaintiff's certainty equivalent may be written as $\widetilde{\mu}_p - \widetilde{a}_p\sigma^2/2$. So, our funded plaintiff is in the same position as a plaintiff with risk aversion coefficient $\widetilde{a}_p$ normally-distributed beliefs with mean $\widetilde{\mu}_p$ who is facing a naked trial.

Similarly, the defendant's certainty equivalent is $(1 - r_1)\mu_0 + r_1\mu_d + a_d r_1^2\sigma^2/2$ where r_1 is defined in (13). This may be written as $\widetilde{\mu}_d + \widetilde{a}_d\sigma^2/2$ where $\widetilde{\mu}_d = (1 - r_1)\mu_0 + r_1\mu_d$ and $\widetilde{a}_d = a_d r_1^2$. So, our defendant is in the same position as an uninsured defendant with beliefs $\widetilde{\mu}_d$ and risk aversion coefficient $\widetilde{a}_d$ who is facing a naked trial. We will now show that there are no gains from trade between these two (fictional) parties.

The Pareto-optimal inside contract (6) is

$$s_1 = \frac{\widetilde{\mu}_p - \widetilde{\mu}_d}{(\widetilde{a}_p + \widetilde{a}_d)\sigma^2} \tag{25}$$

Substituting the expressions above, this becomes

$$s_1 = \frac{(r_1 - t_1)\mu_0 + t_1\mu_p - r_1\mu_d}{(a_p t_1^2 + a_d r_1^2)\sigma^2} = \frac{t_1(\mu_p - \mu_0) + r_1(\mu_o - \mu_d)}{(a_p t_1^2 + a_d r_1^2)\sigma^2}. \tag{26}$$

Substituting $\mu_p - \mu_0 = a_p\sigma^2 t_1$ and $\mu_0 - \mu_d = a_d\sigma^2 r_1$ from (12) and (13),

$$s_1 = \frac{a_p\sigma^2 t_1^2 + a_d\sigma^2 r_1^2}{(a_p t_1^2 + a_d r_1^2)\sigma^2} = 1. \blacksquare \tag{27}$$

Lemma 1: *If $\mu_0 = \widehat{\mu}_0$ then $r_1 = s_1 = t_1$, if $\mu_0 < \widehat{\mu}_0$ then $r_1 < s_1 < t_1$, and if $\mu_0 > \widehat{\mu}_0$ then $r_1 > s_1 > t_1$ where r_1, s_1, and t_1 are defined in (6), (12), and (13).*

Proof of Lemma 1: Using the definitions, $s_1 > t_1$ if and only if $\frac{\mu_p - \mu_d}{(a_p + a_d)\sigma^2} > \frac{\mu_p - \mu_0}{a_p\sigma^2}$. Canceling σ^2 and cross multiplying, this becomes $a_p(\mu_p - \mu_d) > (a_p + a_d)(\mu_p - \mu_0)$ or equivalently $\mu_0(a_p + a_d) > a_d\mu_p + a_p\mu_d$. Dividing both sides by $a_p + a_d$ gives $\mu_0 > \frac{a_d\mu_p + a_p\mu_d}{a_p + a_d} = \widehat{\mu}_0$. Similarly, $s_1 > r_1$ if and only if $\frac{\mu_p - \mu_d}{(a_p + a_d)\sigma^2} > \frac{\mu_0 - \mu_d}{a_d\sigma^2}$. Rearranging terms, $a_d(\mu_p - \mu_d) > (a_p + a_d)(\mu_0 - \mu_d)$, or equivalently $\mu_0(a_p + a_d) < a_d\mu_p + a_p\mu_d$. Dividing through by $a_p + a_d$ gives us $\mu_0 < \frac{a_d\mu_p + a_p\mu_d}{a_p + a_d} = \widehat{\mu}_0$. $\blacksquare$

Equation (19): $B^0(\centerdot) = B^*(\centerdot) + \left(\frac{a_p + a_d}{2a_p a_d \sigma^2}\right)(\mu_0 - \widehat{\mu}_0)^2$.

Proof: Using expressions (1) and (8) we have:

$$B^*(\centerdot) - B^N(\centerdot) = \frac{(a_p + a_d)\sigma^2}{2}\left[\left(\frac{\mu_p - \mu_d}{(a_p + a_d)\sigma^2}\right)^2 - 2\left(\frac{\mu_p - \mu_d}{(a_p + a_d)\sigma^2}\right) + 1\right].$$

Rewriting,

$$B^*(\centerdot) = B^N(\centerdot) + \frac{(a_p + a_d)\sigma^2}{2}\left[1 - \frac{\mu_p - \mu_d}{(a_p + a_d)\sigma^2}\right]^2.$$

Next, expanding out expression (15) we have

$$B^0(\mu_0, \mu_p, \mu_d, a_p, a_d, \sigma^2) = \frac{1}{2a_p a_d \sigma^2}\left[a_d(\mu_p - \mu_0)^2 + a_p(\mu_0 - \mu_d)^2\right]$$

$$= \frac{1}{2a_p a_d \sigma^2}\left[a_d(\mu_p^2 - 2\mu_p\mu_0 + \mu_0^2) + a_p(\mu_0^2 - 2\mu_0\mu_d + \mu_d^2)\right]$$

$$= \frac{1}{2a_p a_d \sigma^2}\left[(a_p + a_d)\mu_0^2 - 2\mu_0(a_d\mu_p + a_p\mu_d) + a_d\mu_p^2 + a_p\mu_d^2\right]$$

$$= \frac{a_p + a_d}{2a_p a_d \sigma^2}\left[\mu_0^2 - 2\mu_0\left(\frac{a_d\mu_p + a_p\mu_d}{a_p + a_d}\right) + \frac{a_d\mu_p^2 + a_p\mu_d^2}{a_p + a_d}\right]$$

$$= \frac{a_p + a_d}{2a_p a_d \sigma^2}\left[\mu_0^2 - 2\mu_0\widehat{\mu}_0 + \frac{a_d\mu_p^2 + a_p\mu_d^2}{a_p + a_d}\right]$$

$$= \frac{a_p + a_d}{2a_p a_d \sigma^2}\left[\mu_0^2 - 2\mu_0\widehat{\mu}_0 + (\widehat{\mu}_0)^2 - (\widehat{\mu}_0)^2 + \frac{a_d\mu_p^2 + a_p\mu_d^2}{a_p + a_d}\right]$$

$$= \frac{a_p + a_d}{2a_p a_d \sigma^2}\left[\mu_0^2 - 2\mu_0\widehat{\mu}_0 + (\widehat{\mu}_0)^2 - \left(\frac{a_d\mu_p + a_p\mu_d}{a_p + a_d}\right)^2 + \frac{(a_p + a_d)(a_d\mu_p^2 + a_p\mu_d^2)}{(a_p + a_d)^2}\right]$$

$$= \frac{a_p + a_d}{2a_p a_d \sigma^2}\left[(\mu_0 - \widehat{\mu}_0)^2 + \left(\frac{-a_d^2\mu_p^2 - 2a_d a_p\mu_p\mu_d - a_p^2\mu_d^2 + a_p a_d\mu_p^2 + a_p^2\mu_d^2 + a_d^2\mu_p^2 + a_p a_d\mu_d^2}{(a_p + a_d)^2}\right)\right]$$

$$= \frac{a_p + a_d}{2a_p a_d \sigma^2}\left[(\mu_0 - \widehat{\mu}_0)^2 + \frac{a_p a_d\mu_p^2 - 2a_p a_d\mu_p\mu_d + a_p a_d\mu_d^2}{(a_p + a_d)^2}\right]$$

$$= \frac{a_p + a_d}{2a_p a_d \sigma^2}\left[(\mu_0 - \widehat{\mu}_0)^2 + \frac{a_p a_d(\mu_p - \mu_d)^2}{(a_p + a_d)^2}\right]$$

$$= \left(\frac{a_p + a_d}{2a_p a_d \sigma^2}\right)(\mu_0 - \widehat{\mu}_0)^2 + \frac{(\mu_p - \mu_d)^2}{2(a_p + a_d)\sigma^2}.$$

Using the definition of $B^*(\centerdot)$ in (8) gives

$$B^0(\centerdot) = \left(\frac{a_p + a_d}{2a_p a_d \sigma^2}\right)(\mu_0 - \widehat{\mu}_0)^2 + B^*(\centerdot). \blacksquare$$

Proposition 2: *Suppose $\mu_0 = \widehat{\mu}_0$. The defendant is better off (worse off) and the plaintiff is worse off (better off) with the outside contract than with the inside contract if the defendant's bargaining power is low (high), $\pi < \widehat{\pi}$ ($\pi > \widehat{\pi}$). Suppose*

$\pi = \widehat{\pi}$. The defendant is better off (worse off) and the plaintiff is worse off (better off) with the outside contract than with the inside contract when the capital market believes that the damages are low (high), $\mu_p - a_p\sigma^2 < \mu_0 < \widehat{\mu}_0$ ($\widehat{\mu}_0 < \mu_0 < \mu_d + a_d\sigma^2$).

Proof: Consider first the inside contract in (6) $s_1 = \frac{\mu_p - \mu_d}{(a_p + a_d)\sigma^2}$ and s_0 is negotiated between the plaintiff and defendant.

With probability π, the defendant makes a take-it-or-leave-it contract offer to the plaintiff. The lump sum s_0 would make the plaintiff indifferent between accepting the inside contract going to court where the plaintiff would receive a subjective value of $\mu_p - a_p\sigma^2/2$. So, when the defendant makes the offer, the plaintiff receives the outside option payoff of $\mu_p - a_p\sigma^2/2$. If the plaintiff could make a take-it-or-leave-it offer to the defendant instead, the plaintiff would choose s_0 to make the defendant indifferent between the inside contract and a naked trial, $s_0 + s_1\mu_d + \frac{a_d s_1^2 \sigma^2}{2} = \mu_d + a_d\sigma^2/2$. Rearranging terms, the plaintiff would offer $s_1 = \frac{\mu_p - \mu_d}{(a_p + a_d)\sigma^2}$ and s_0 where

$$s_0 = \mu_d + a_d\sigma^2/2 - s_1\mu_d - \frac{a_d s_1^2 \sigma^2}{2}$$

The plaintiff's private subjective value from this is therefore

$$s_0 + s_1\mu_p - \frac{a_p s_1^2 \sigma^2}{2} = \mu_d + a_d\sigma^2/2 - s_1\mu_d - \frac{a_d s_1^2 \sigma^2}{2} + s_1\mu_p - \frac{a_p s_1^2 \sigma^2}{2}.$$

$$= \mu_d + a_d\sigma^2/2 + s_1(\mu_p - \mu_d) - \frac{(a_p + a_d)s_1^2\sigma^2}{2}$$

and, using (7) and (8), this becomes

$$\mu_d + a_d\sigma^2/2 + B^*(\centerdot)$$

where $B^*(\centerdot)$ is defined in (8). So when the plaintiff has all of the bargaining power, the plaintiff can extract the defendant's maximum subjective willingness to pay plus the entire joint value of inside contracting.

Weighting the plaintiff's payoffs by π and by $1 - \pi$, we have the plaintiff's subjective value of the inside contract:

$$\pi\left(\mu_p - \frac{a_p\sigma^2}{2}\right) + (1 - \pi)\left(\mu_d + \frac{a_d\sigma^2}{2} + B^*(\centerdot)\right).$$

This expression is decreasing in π. The plaintiff is subjectively worse off when the defendant's bargaining power increases. When $\pi = \widehat{\pi}$ the plaintiff's subjective payoff from the inside contract is

$$\left(\frac{a_d\mu_p + a_p\mu_d}{a_p + a_d}\right) + \left(\frac{a_d}{a_p + a_d}\right)B^*(\centerdot) = \widehat{\mu}_0 + \left(\frac{a_d}{a_p + a_d}\right)B^*(\centerdot).$$

Now consider the plaintiff's subjective payoff from the outside contract. Using (12), the plaintiff's subjective value from the outside contract may be written as

$$(1-t_1)\mu_0 + t_1\mu_p - \frac{a_p t_1^2 \sigma^2}{2} = \mu_0 + \frac{(\mu_p - \mu_0)^2}{2a_p\sigma^2}.$$

This is increasing in μ_0 for $\mu_0 > \mu_p - a_p\sigma^2$. When $\mu_0 = \widehat{\mu}_0$ defined in (18) this becomes

$$\widehat{\mu}_0 + \frac{(\mu_p - \widehat{\mu}_0)^2}{2a_p\sigma^2} = \widehat{\mu}_0 + \frac{(\mu_p - \frac{a_d\mu_p + a_p\mu_d}{a_p+a_d})^2}{2a_p\sigma^2}$$

$$= \widehat{\mu}_0 + \left(\frac{a_d}{a_p+a_d}\right)\frac{(\mu_p-\mu_d)^2}{2(a_p+a_d)\sigma^2} = \widehat{\mu}_0 + \left(\frac{a_d}{a_p+a_d}\right)B^*(\centerdot).$$

Therefore the plaintiff's subjective payoff from the inside and the outside contract are exactly the same when $\pi = \widehat{\pi}$ and $\mu_0 = \widehat{\mu}_0$.

Similarly, the defendant's subjective payment with inside contracting is

$$\pi\left(\mu_p - \frac{a_p\sigma^2}{2} - B^*(\centerdot)\right) + (1-\pi)\left(\mu_d + \frac{a_d\sigma^2}{2}\right).$$

This is an increasing function of π, so the defendant is better off when his own bargaining power is stronger. When $\pi = \widehat{\pi}$, one can show as above that the defendant's subjective payment with the inside contract is

$$\widehat{\mu}_0 - \left(\frac{a_p}{a_p+a_d}\right)B^*(\centerdot).$$

Now we construct the defendant's subjective payment from he outside contract. Using (13), the defendant's payment is

$$(1-r_1)\mu_0 + r_1\mu_p + \frac{a_d r_1^2\sigma^2}{2} = \mu_0 - \frac{(\mu_0-\mu_d)^2}{2a_d\sigma^2}.$$

this is increasing in μ_0 when $\mu_0 < \mu_d + a_d\sigma^2$. When $\mu_0 = \widehat{\mu}_0$ then the defendant's subjective payment from the outside contract

$$\widehat{\mu}_0 - \left(\frac{a_p}{a_p+a_d}\right)B^*(\centerdot).$$

When $\pi = \widehat{\pi}$, this is exactly the same as the defendant's payment with the inside contract. ■

Equation (23): $R^0(\centerdot) = R^*(\centerdot) + \left(\frac{a_p+a_d}{2a_pa_d\sigma^2}\right)(\mu_0 - \widehat{\mu}_0)^2$.

Proof: Substituting the expressions for t_1 and r_1 from (12) and (13) into (16) gives:

$$R^0(\mu_0, \mu_p, \mu_d, a_p, a_d, \sigma^2) = \frac{\sigma^2}{2}\left(\frac{a_p(\mu_p - \mu_0)^2}{a_p^2\sigma^4} + \frac{a_d(\mu_0 - \mu_d)^2}{a_d^2\sigma^4}\right)$$

$$= \frac{1}{2\sigma^2}\left(\frac{(\mu_p - \mu_0)^2}{a_p} + \frac{(\mu_0 - \mu_d)^2}{a_d}\right)$$

$$= \frac{1}{2\sigma^2}\left(\frac{(\mu_p - \mu_0)^2}{a_p} + \frac{(\mu_0 - \mu_d)^2}{a_d} - \frac{(\mu_p - \mu_d)^2}{a_p + a_d} + \frac{(\mu_p - \mu_d)^2}{a_p + a_d}\right)$$

$$= \frac{1}{2\sigma^2}\left(\frac{(\mu_p - \mu_0)^2}{a_p} + \frac{(\mu_0 - \mu_d)^2}{a_d} - \frac{(\mu_p - \mu_d)^2}{a_p + a_d}\right) + \frac{(\mu_p + \mu_d)^2}{2(a_p + a_d)\sigma^2}.$$

The last term is the formula for $R^*(\centerdot)$ in (9), so

$$R^0(\centerdot) = \frac{1}{2\sigma^2}\left(\frac{a_d(a_p + a_d)(\mu_p - \mu_0)^2 + a_p(a_p + a_d)(\mu_0 - \mu_d)^2 - a_p a_d(\mu_p - \mu_d)^2}{a_p a_d(a_p + a_d)}\right) + R^*(\centerdot)$$

$$= \frac{1}{2\sigma^2}\left(\frac{\mu_0^2(a_p + a_d)^2 - 2\mu_0(a_p + a_d)(a_d\mu_p + a_p\mu_d) + (a_d\mu_p + a_p\mu_d)^2}{a_p a_d(a_p + a_d)}\right) + R^*(\centerdot)$$

$$= \frac{1}{2\sigma^2}\left(\frac{[\mu_0(a_p + a_d) - (a_d\mu_p + a_p\mu_d)]^2}{a_p a_d(a_p + a_d)}\right) + R^*(\centerdot)$$

$$= \frac{1}{2\sigma^2}\left(\frac{a_p + a_d}{a_p a_d}\right)\left[\mu_0 - \left(\frac{a_d\mu_p + a_p\mu_d}{a_p + a_d}\right)\right]^2 + R^*(\centerdot).$$

Using the definition of $\widehat{\mu}_0$ in (18) gives the result

$$R^0(\centerdot) = \frac{1}{2\sigma^2}\left(\frac{a_p + a_d}{a_p a_d}\right)(\mu_0 - \widehat{\mu}_0)^2 + R^*(\centerdot). \blacksquare$$

Appendix B

Numerical Example

We now illustrate the ideas using a simple numerical example. Suppose that the litigants are risk averse with coefficients $a_p = a_d = 0.0001$.[79] The plaintiff believes that the average court award is $\mu_p = 90$ (in thousands), the defendant believes it is $\mu_d = 50$, and the investors in the capital market believes it is $\mu_0 = 80$. The standard deviation is $\sigma = 20$.

Consider first a naked trial. The risk premium for each litigant is $a_i\sigma^2/2 = 20$. The plaintiff's risk-adjusted expected benefit from a naked trial, $\mu_p - a_i\sigma^2/2 = 70$, is just equal to the defendant's risk-adjusted expected loss, $\mu_d + a_i\sigma^2/2 = 70$. So the parties' joint benefit from a naked trial is zero, $B^N = 70 - 70 = 0$. Since going to trial is costly, $c_p + c_d$ is positive, the parties would be better off settling out of court for 70 than going to trial. The size of the lump-sum payment need not be 70; it would be subject to negotiation and would depend on the costs of litigation and the bargaining power of the parties.

Suppose that the parties can write an inside contract. Using (6) above, the equilibrium contract is $s(x) = s_0 + .50x$. In other words, the defendant pays s_0 to the plaintiff to settle half of the case. Note that since the slope s_1 is one half, the risk premiums are a quarter of their former levels, $s_1^2 a_i\sigma^2/2 = (.50)^2 20 = 5$. Letting $s_0 = 35$, the plaintiff's risk-adjusted benefit at trial is $35 + .50(\mu_p) - 5 = 75$ and the defendant's risk-adjusted loss is $35 + .50(\mu_d) + 5 = 65$. Since $75 > 70 > 65$, both litigants are subjectively better off with the inside contract than with a naked trial and, if $c_p + c_d < B^* = 10$ then the case will go to trial rather than settle.

Now suppose that the parties can transact with a competitive capital market. From (12) and (13), the plaintiff's contract is $t(x) = 60 + .25x$ and the defendant's contract is $r(x) = 20 + .75x$. The plaintiff is selling seventy-five percent of the case to a litigation funder for the market price $.75\mu_0 = 60$;[80] the defendant is paying $.25\mu_0 = 20$ for an insurance policy that covers twenty-five percent of the court award. The plaintiff's risk premium is lower now, $t_1^2 a_p\sigma^2/2 = (.25)^2 20 = 1.25 < 5$ and the defendant's risk premium is higher, $r_1^2 a_d\sigma^2/2 = (.75)^2 20 = 11.25 > 5$. Taken together, $R^0 = 1.25 + 11.25 = 12.5$ and the parties' joint subjective benefit is $B^0 = 60 + .25(\mu_p) - 1.25 - [20 + .75(\mu_d) + 11.25] = 81.25 - 68.75 = 12.5$. If $c_p + c_d < B^0 = 12.5$ then the case will go to trial rather than settle out of court.

In this example, the litigants perceive themselves to be jointly better off when they can secure the backing of outside suppliers of capital – their joint subjective benefit from the outside contracts is $B^0 = 12.5$ while the joint benefit of an inside contract is $B^* = 10$. However, more lawsuits will go to trial when the parties have access to the outside capital market, increasing the overall costs of litigation. In

[79]Using data from a popular game show, Metrick (1995) estimates the average contestant's α to be approximately 0.00007; using insurance data, Cohen and Einav (2007) estimate it to be 0.00025.

[80]If $\mu_0 = \mu_p$, then the plaintiff would sell the entire case to the litigation funder.

addition, the aggregate risks borne by the parties at trial is higher with outside contracts than inside contracts $R^0 = 12.5$ instead of $R^* = 10$.

Although the two litigants are jointly better off with the outside contract in this example, they are not individually better off. Since $\mu_0 > \widehat{\mu}_0$, our earlier results suggest that the plaintiff does better with the outside contract than the inside contract and the defendant does worse. This is confirmed in our example. The plaintiff's certainty equivalent with the outside contract is $60 + .25(90) - 1.25 = 81.25 > 75$, so the plaintiff is indeed better off. The defendant's certainty equivalent of the loss at trial with the outside contract is $20 + .75(50) + 11.25 = 68.75 > 65$, so the defendant is worse off. If the defendant had more bargaining power and could reduce s_0 from say 35 to 30, then the defendant and the plaintiff would both be better off.

Litigation as a Rent-Seeking Contest

The basic framework may be extended to include endogenous litigation spending in a rent-seeking contest.[81] When litigation is modeled as a rent-seeking contest, the litigants may strictly prefer inside contracting to contracting with third parties.

We make the following simplifying assumptions. First, we will focus on the case where the plaintiff is relatively more optimistic about winning, $\mu_p - \mu_d > 0$. Second, we assume that from the plaintiff's subjective perspective, x is normally distributed with mean $\mu_p + \sqrt{\theta c_p} - \sqrt{\theta c_d}$, where c_p and c_d are the endogenous investments, and variance σ^2. The parameter $\theta > 0$ is a measure of the sensitivity of award to the investments of the two parties. Similarly, from the defendant's perspective, the mean of the distribution is $\mu_d + \sqrt{\theta c_p} - \sqrt{\theta c_d}$ and from the third parties' perspective it is $\mu_0 + \sqrt{\theta c_p} - \sqrt{\theta c_d}$.[82] Finally, we restrict attention to contingent contracts that are linear in the court award.[83]

The timing of the game is as follows. First, the plaintiff and the defendant sign contracts with each other (or with their respective investors). Next, the two sides decide simultaneously and non-cooperatively how much to invest in litigation. If the plaintiff has a third-party investor, the "P-team" chooses the level of investment that maximizes their joint payoff. Similarly, if the defendant has financial backing, the "D-team" jointly decides how much to spend.[84] Thus,

[81] See Konrad (2009) for a survey of the contest literature. Applications to litigation include Posner (1973, appendix), Katz (1988), and Rosenberg and Spier (2014).

[82] Prescott et al. (2014) provide a partial analysis along these lines for binary outcomes and risk-neutral parties.

[83] It is possible that the introduction of rent-seeking contests would lead to Pareto-optimal contracts that are not linear. A full analysis of nonlinear contracts is beyond the scope of the current manuscript.

[84] In the United States, liability insurers often take control of lawsuits while litigation funders are formally prohibited from doing so. However, litigation funders can influence plaintiff's efforts and investments through staged investment and other control mechanisms. See Sebok (2014) and Steinitz (2012).

we are assuming that there is Coasian bargaining within the two teams but not between the two teams.[85]

We will show that inside contracting changes the parties' investment incentives. When parties enter into an inside contract with a slope of, say, fifty percent they have narrowed the scope of their disagreement. Since the plaintiff and the defendant are fighting over less money, they have less of an incentive to spend money to swing the outcome in their favor. By contrast, outside contracting does not change the parties' investment incentives. To see why this is true, suppose that the plaintiff enters into an outside agreement where the litigation funder receives fifty percent. The plaintiff and the funder still jointly own one hundred percent of the claim. So if the plaintiff and the litigation funder could jointly control the investment decision, and there are no agency problems, then their investment will reflect the full damage amount, x. Similarly, the defendant and its third-party backer want to jointly protect themselves against the full damage exposure at trial.[86]

Inside Contracts

Given a linear inside contract, $s(x) = s_0 + s_1 x$ with $s_1 \geq 0$, it is straightforward to characterize the Nash equilibrium investments of the two parties. The plaintiff's subjective certainty equivalent associated with this contract is $s_1(\mu_p + \sqrt{\theta c_p} - \sqrt{\theta c_d}) - a_p s_1^2 \sigma^2/2 - c_p$. Differentiating this expression with respect to c_p and setting the resulting expression equal to zero shows that the plaintiff will choose to invest $c_p = \theta s_1^2/4$.[87] An analogous calculation verifies that the defendant will spend the same amount, $c_d = \theta s_1^2/4$, so the total litigation spending is $c_p + c_d = \theta s_1^2/2$.

Note that the parties' investments in litigation are purely wasteful. In equilibrium, their expenditures cancel each other out. Note also that the parties' expenditures will be lower than those in a naked trial if $s_1 \in [0, 1)$ and will exceed those in a naked trial if $s_1 > 1$. Since lowering s_1 will reduce the litigation spending, the parties have a joint incentive at the time of contracting to flatten the slope of their inside contract to reduce their own incentives to spend money preparing for litigation.

Formally, the plaintiff and the defendant negotiate a contingent contract $s(x) = s_0 + s_1 x$ that maximizes their joint surplus, which is simply the difference between their subjective certainty equivalents of going to trial,

$$s_1(\mu_p - \mu_d) - (a_p + a_d) s_1^2 \sigma^2/2 - \theta s_1^2/2. \tag{28}$$

[85] Since litigation spending is jointly wasteful, the two teams would want to jointly commit not to spend any money at all. As described in Prescott et al. (2014), parties can and do sometimes constrain their litigation spending by contract. They can, for example agree in advance to not hire expert witnesses.

[86] This would no longer be true if a single investor served as both the plaintiff's litigation funder and the defendant's insurer and exerted centralized control. This single investor would have an interest in reducing the inefficient rent seeking. In practice, these roles are filled by different entities.

[87] If s_1 were negative, then the plaintiff would spend nothing at all or (if possible) sabotage the case.

Taking the derivative with respect to s_1, the slope of the subjectively optimal inside contract is:

$$s_1(\theta) = \frac{\mu_p - \mu_d}{\theta + (a_p + a_d)\sigma^2}. \tag{29}$$

Comparing (29) to (6) reveals that when litigation costs are endogenous, the inside contract has a smaller slope. This makes sense, since a smaller slope has the effect of reducing the parties' wasteful rent-seeking. Second, when the sensitivity of the award to investment levels, θ, is larger, then the slope $s_1(\theta)$ is smaller. Finally, recall that in our earlier model with exogenous litigation costs that if $a_p + a_d = 0$, so the parties are risk neutral, then they would gamble without bound. Here, the slope of the contract is bounded above by $(\mu_p - \mu_d)/\theta$.

Using (28) and (29), the parties' net joint subjective surplus with inside contracts is

$$\frac{(\mu_p - \mu_d)^2}{2[\theta + (a_p + a_d)\sigma^2]}. \tag{30}$$

Outside Contracts

We first establish that the investment decisions the P-team and the D-team are independent of their respective contracts. Consider a litigation funding contract $t(x) = t_0 + t_1 x$. The plaintiff's certainty equivalent is $t_0 + t_1(\mu_p + \sqrt{\theta c_p} - \sqrt{\theta c_d}) - a_p t_1^2 \sigma^2/2 - c_p$ and the funder's certainty equivalent is $-t_0 + (1 - t_1)(\mu_0 + \sqrt{\theta c_p} - \sqrt{\theta c_d})$.[88] Taking the sum, the plaintiff and funder's joint payoff from trial is

$$t_1 \mu_p + (1 - t_1)\mu_0 - a_p t_1^2 \sigma^2/2 + \sqrt{\theta c_p} - \sqrt{\theta c_d} - c_p. \tag{31}$$

Differentiating with respect to c_p verifies that the P-team would jointly invest $c_p = \theta/4$ which is independent of t_1. An analogous argument verifies that the D-team would invest $c_d = \theta/4$.

The equilibrium outside contracts are now easily characterized. At the time of contracting, the plaintiff, the defendant, and the capital market rationally anticipate future investments, $c_p = c_d = \theta/4$. It follows that the subjective beliefs of the parties are normally distributed with means μ_p, μ_d, and μ_0 and variance σ^2, and the third-party contracts are exactly the same as in the main text, (12) and (13).

Since the third-party contracts are the same as before, the parties' joint surplus from going to trial with outside contracts is simply $B^0(\cdot) - \theta/2$. Using expressions (8) and (19) in the main text, the parties' net subjective joint surplus of going to trial with outside investors can be written as:

$$\frac{(\mu_p - \mu_d)^2}{2(a_p + a_d)\sigma^2} + \left(\frac{a_p + a_d}{2 a_p a_d \sigma^2}\right)(\mu_0 - \widehat{\mu}_0)^2 - \theta/2, \tag{32}$$

[88] In this expression, we are imagining that the plaintiff is the one that directly bears the costs of litigation, but the analysis would be the same if the plaintiff and the funder contractually shared these costs.

where $\widehat{\mu}_0$ is defined in (18).

Implications

When litigation costs are endogenous, the parties may rationally choose to forego the external capital market in favor of inside contracts. Simply put, an inside contract with a slope less than unity (in absolute value terms) is a strategic commitment to curb litigation spending.

Formally, the parties prefer inside contracting to outside contracting when the joint surplus from inside contracting, (30), is larger than the joint surplus with outside investors, (32),

$$\frac{(\mu_p - \mu_d)^2}{2[\theta + (a_p + a_d)\sigma^2]} > \frac{(\mu_p - \mu_d)^2}{2(a_p + a_d)\sigma^2} + \left(\frac{a_p + a_d}{2a_p a_d \sigma^2}\right)(\mu_0 - \widehat{\mu}_0)^2 - \theta/2.$$

Rearranging terms, the litigants strictly prefer inside contracting when

$$\theta + \frac{(\mu_p - \mu_d)^2}{\theta + (a_p + a_d)\sigma^2} - \frac{(\mu_p - \mu_d)^2}{(a_p + a_d)\sigma^2} > \left(\frac{a_p + a_d}{a_p a_d \sigma^2}\right)(\mu_0 - \widehat{\mu}_0)^2.$$

When $\theta = 0$, the left-hand side of this expression is equal to zero. Since the right-hand side of this expression is weakly positive for all $\mu_0 \neq \widehat{\mu}_0$, we see that outside contracts are (weakly) preferred to inside contracts. As θ approaches infinity, the left-hand side of the above expression increases without bound. The litigants therefore strictly prefer inside contracting when θ is sufficiently large. Taking the derivative of the left-hand side with respect to θ and using the expression for $s_1(\theta)$ in (29) establishes that the left-hand side is an increasing function of θ when $s_1(\theta) < 1$ and a decreasing function of θ when $s_1(\theta) > 1$.[89]

[89] The relative *social* benefits of inside contracts may be either higher or lower when litigation spending is endogenous. Conditional upon going to trial, the litigation expenditures may be higher or lower when contracting with third parties is prohibited. If the $s_1(\theta) > 1$, so the plaintiff and the defendant are speculating on the outcome at trial, then the costs of litigation ($c_p + c_d = \theta s_1^2/2$) are higher with inside contracts than they would be with third-party investors ($c_p + c_d = \theta/2$). The sum of the risk premiums with inside contracts are smaller, however.

Appendix B: References

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