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THREATS TO SUE
AND COST DIVISIBILITY
UNDER ASYMMETRIC INFORMATION

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Abstract

Not all disputes make it to the court system. Some claims are settled against the threat of litigation, whereas others are "lumped off" as claimants find the cost of pursuing them higher than their value. Threatened to be sued, a potential defendant would not agree to settle for any positive amount unless the plaintiff's threat to sue is credible. In this paper we analyze the effects of cost divisibility and information asymmetry on the credibility of the plaintiff's threat to sue. Previous literature has shown that under symmetric information divisibility of the plaintiff's litigation costs can enhance her ability to extract a positive settlement from the defendant. We show that when the defendant holds private information concerning his liability the plaintiff is discouraged from filing her suit when her total costs are sufficiently large, even if these costs are very finely divided. In equilibrium the defendant signals his information by refusing to settle and thus the plaintiff always has to bear some of her litigation costs, reducing her expected payoff from the suit. The higher the plaintiff's litigation costs, the higher the level of information asymmetry and the lower the plaintiff's probability of success, the less pronounced is the effect of cost divisibility on the credibility of her threat to sue. Hence, under substantive rules that increase the variance of the possible judgment, such as negligence rules, cost divisibility would be less significant than under rules such as strict liability where the variance is lower. Also, increased divisibility would tend to encourage low probability – high stake suits more than high probability – low stake suits having the same expected judgment.

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Threats to Sue and Cost Divisibility under Asymmetric Information

Alon Klement*

1. Introduction

Not all disputes make it to the court system. Some claims are settled against the threat of litigation, whereas others are "lumped off" as claimants find the cost of pursuing them higher than their value. Threatened to be sued, a potential defendant would usually estimate the credibility of such a threat based on the value of the claim and the potential costs the claimant has to spend to pursue it in court. Unless the defendant has interests that do not depend on the prospect of litigation (such as reputational concerns), he will respond in negative to any request from the claimant if he finds her threat to litigate incredible.

The early literature on litigation and settlement assumed that the plaintiff's threat to litigate is only credible when her litigation value - the difference between the expected judgment and her litigation costs - is positive.[1] More recently however, Bebchuk (1996a) and Bebchuk (1996b) have suggested that under symmetric information, even if the plaintiff's litigation value is negative, divisibility of her litigation costs can render credibility to her threat to sue.[2] When litigation is divided into several stages and the

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[1] See Gould (1973), Landes (1971), Posner (1973) and Shavell (1982).

[2] See also Croson and Mnookin (1996) (Demonstrating the plaintiff's ability to obtain a positive settlement in a suit whose litigation value is negative if she can commit to pay her attorney part of the litigation cost in

plaintiff's litigation costs in the last stage are lower than the expected judgment, her threat to proceed to judgment in this stage is credible. To avoid at least part of his litigation costs, the defendant is willing to settle the suit before this stage. But then, if the expected settlement is higher than the plaintiff's costs in the previous stage, her threat to proceed in that stage is also credible, and again, the defendant is better off settling before. By backward induction the suit is expected to settle immediately after it is filed, even if the plaintiff's total litigation costs are higher than the expected judgment.

This reasoning relies on the plaintiff's certainty that in each stage of the litigation the defendant would agree to settle the case. Even if the defendant threatens not to settle in the following stage, the plaintiff does not believe this threat in the absence of a way for the defendant to credibly commit to carry his threat out. It seems counter-intuitive, however, that the plaintiff would maintain such a belief when the defendant consistently declines her settlement demands. After all, so the plaintiff might reason, the defendant may know something that justifies rejecting all her settlement offers. But then the plaintiff should update her beliefs and become less confident that the defendant would settle the case, thus increasing the risk from pursuing the case further. Obviously, this reasoning only reinforces the defendant's inclination to respond in negative to the plaintiff's offers, which again, undermines the plaintiff's certainty that the case would settle. Introducing asymmetric information we prove that such updating may indeed take

advance). Other explanations why a plaintiff whose litigation value is negative may still extract some positive settlement from the defendant include Private information held by the plaintiff (Bebchuk (1988); Katz (1990)), lawyer's reputation for pursuing suits whose litigation value is negative (Farmer and Pecorino (1998)), and certain sequencing of litigation costs between the plaintiff and the defendant (Roesenber and Shavell (1985).

place, in which case the conclusions from Bebchuk's symmetric information model are significantly qualified.[3]

Litigation is modeled as a multiple period game, each period beginning with a bargaining stage, after which the plaintiff decides whether to drop the suit or proceed to the next period, forcing both litigants to spend part of their litigation costs. If the litigants do not settle in the last period then the case is decided by the court. The defendant is assumed to hold private information concerning the amount of damages he is liable for, taking two possible values, low - a strong defendant, and high - a weak defendant. It is shown that there exists a sequential equilibrium in which a strong defendant signals his information by repeatedly refusing to settle, and a weak defendant, trying to mislead the plaintiff to believe that his liability is low, also rejects the plaintiff's offers with some positive probability. Thus, rejection of her settlement offers provides the plaintiff an imperfect signal with respect to the expected judgment – the mean of the possible judgment. This mean decreases as litigation proceeds since the plaintiff expects the lower judgment with higher probability. If the plaintiff's remaining litigation costs are higher than some cutoff level then her expected return from proceeding is negative and therefore she drops the suit. The plaintiff's threat to litigate loses its credibility and anticipating this, the weak defendant refuses all offers as long as the plaintiff's remaining costs are higher than this cutoff level. By backward induction, the suit is not filed.

[3] For the use of information asymmetry to address the counter-intuitive feature of a backward induction solution in dynamic form games, see Fudenberg, Kreps, and Levine (1988). Part 4 of that paper shows how small perturbations of the players' payoffs can be used to motivate Nash equilibria that are not subgame perfect in games with symmetric information.

We show that the set of suits that are filed decreases as the level of information asymmetry (measured by the judgment's variance) and the plaintiff's total litigation costs increase. Although this "chilling effect" can be mitigated to some extent by increased divisibility, suits with low probability of success would not be filed even under very fine divisibility. Cost divisibility would become significant only for suits whose probability of success is high, and whose low expected value follows from the small stakes involved.

Applying these insights we find that a strict liability regime would discourage less suits from being filed than would a negligence regime, for any given expected judgment and number of litigation stages. Therefore, a negligence rule would reduce the number of suits filed not only because it reduces the expected judgment that a plaintiff may earn, but also because it increases the variance of that judgment. Another observation that follows from our model is that adding litigation stages, for example requiring participation in a nonbinding ADR procedure, may result in less suits being filed. The separation of such procedures from other litigation stages cannot eliminate the chilling effect caused by the additional costs imposed on the plaintiff in the presence of defendant's private information.

Two papers that discuss the effect of incomplete information on the plaintiff's ability to extract a positive settlement in suits whose litigation value may be negative are Bebchuk (1988) and Katz (1990). Both assume, unlike this paper, that the informed litigant is the plaintiff and show that the plaintiff is able to extract a positive settlement even if she knows the value of her claim is lower than her litigation costs, provided that the defendant believes the probability of a high judgment is sufficiently high. Other papers investigating litigation and settlement under incomplete information include Bebchuk (1984), Reinganum and Wilde (1986), and Schweizer (1989), but they all assume the plaintiff's litigation value is positive.[4]

In modeling the multiple period litigation we have closely followed Spier (1992) and Nalebuff (1987). Spier (1992) explored the dynamics of pretrial negotiations in a multiple period setting when the plaintiff's litigation value is always positive. Nalebuff (1987) discussed the effects of the credibility problem in a one period litigation model. Our main contribution is in examining the interaction between cost divisibility and the level of information asymmetry, and the effect of these two variables on the plaintiff's threat to sue, in a multiple period litigation and settlement context.

Section 2 offers a numerical example of a two period litigation, demonstrating the main arguments proved in the rest of the paper. Section 3 presents the model, and discusses its equilibria under both symmetric and asymmetric information. Section 4 discusses the interaction between cost divisibility and information asymmetry and their effect on the plaintiff's expected payoff and on the credibility of her threat to sue. Section 5 concludes. Proofs for all propositions and corollaries are given in the appendix.

[4] For a comprehensive review of the literature on litigation and settlement under incomplete information see Farmer and Pecorino (1996).

2. A Numerical Example

A risk neutral plaintiff decides whether to file a lawsuit against a risk neutral defendant. Filing costs are very low, but positive, so the plaintiff would sue if and only if her expected payoff from doing so is positive. Litigation is divided into two periods. In each period the litigants bargain over a possible settlement. If they fail to agree the plaintiff decides whether to proceed with litigation or drop the suit, and if she proceeds then both litigants spend their litigation costs in that period. If they don't settle in the second period the court renders its judgment. With probability 0.5 the court finds the defendant liable, and he has to pay the plaintiff her damages, equal to 100. Hence, the expected judgment, the plaintiff's damages times the probability the defendant is found liable, is 50. Each litigant has to spend 80 to litigate, and he bears his litigation costs irrespective of the court's judgment. Therefore, if the plaintiff has to spend all her litigation costs her expected payoff is negative, -30, and she does not file the suit. We assume, however, that litigation costs are equally divided between both periods, so in every period each litigant has to spend 40.

To simplify the analysis it is assumed that the plaintiff makes a take-it-or-leave it offer in both periods, thus having the complete bargaining power. As we show, even though we are stacking the deck against the defendant he is still able to deter the plaintiff's suit when the level of information asymmetry is sufficiently high.

2.1. Symmetric information

When information is symmetric neither litigant knows whether the defendant would be found liable. Their decisions, therefore, depend only on the expected judgment, 50. Since the plaintiff's litigation costs in each period are lower than 50 the suit is settled in the first period for the sum of the expected judgment and the defendant's total litigation costs, 130.

To see why that is true begin by analyzing the litigants' strategies in the second period. At that point the plaintiff has already spent half of her litigation costs, and as these costs are sunk she only considers her remaining costs when deciding whether to drop the suit or proceed to judgment. Since her remaining costs, 40, are lower than the expected judgment, 50, her threat to proceed with litigation is credible, and therefore the defendant is willing to pay her as much as the sum of the expected judgment and his remaining litigation costs, 90. To maximize her payoff the plaintiff offers the defendant exactly that amount.

In the first period the plaintiff has to spend 40 to proceed to the second period. Knowing that if she proceeds to the second period her payoff would be 90, the plaintiff's threat to proceed in the first period is therefore credible. The defendant is therefore better off settling in the first period for any amount that is not higher than the sum of the expected settlement in the second period, 90, and his litigation costs in the first period, 40. Hence, the suit is settled after it is filed for 130.

It is important to notice that the plaintiff's threat to sue is credible only because the defendant cannot commit not to settle in the second period. If the defendant were able to credibly commit to reject every settlement offer in the second period then the plaintiff would not proceed in the first period, knowing that she would have to spend a total of 80 to get an expected judgment of 50, leaving her with a net expected loss. Expecting the plaintiff to drop the suit, the defendant would not accept any settlement offer in the first period as well. Hence, if the plaintiff files the suit she would have to spend a positive filing cost to get a zero payoff, which she would obviously not do. The defendant's problem is that in the absence of any commitment mechanism his threat to reject the plaintiff's offer in the second period is not credible.[5]

2.2. Asymmetric information

Assume now that information is not symmetric. The defendant knows whether he is liable or not whereas the plaintiff only knows that the probability the defendant is liable is 0.5. Thus, the plaintiff does not know which of the two possible types of defendant – liable or not liable – he faces.

Under such information asymmetry the defendant is able to deter the plaintiff from filing the suit. We may think of the defendant as announcing that he would refuse any positive settlement in the first period of litigation, independent of his liability. As we now show the defendant would carry out this threat even if he is liable, and the plaintiff would incur a net loss if she would file the suit.[6]

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[5] More formally, there is a Nash equilibrium in which the defendant never settles and the plaintiff does not file the suit. However, this equilibrium is not subgame perfect.

[6] There are other equilibria in which the plaintiff is able to extract some nuisance value from both types of defendants. The equilibrium we demonstrate here is unique only if we impose the additional requirement that the plaintiff's belief in case her offer is *unexpectedly* rejected is that the defendant is not liable with probability 1. For further elaboration see ***infra***, note 7 and section 3.2.3. below.

As we did in the symmetric information case, we first analyze the litigants' strategies in the second period. Thus, suppose that the plaintiff files the suit and the defendant rejects her settlement offer in the first period, whether he is liable or not. In this case, at the beginning of the second period the plaintiff believes that the defendant is liable with probability 0.5. The following argument shows that when the plaintiff reaches the second period she expects *any* offer she makes to be rejected by the defendant with some positive probability. This probability reflects, first, the non-liable defendant's strategy, which is to reject every offer, and second, the liable defendant's strategy, which is to reject every such offer with some positive probability.

To understand why the non-liable defendant rejects every offer the plaintiff makes observe that the non-liable defendant always has less to lose from rejecting the plaintiff's offer than the liable defendant. Therefore, every offer that he accepts with a positive probability must be accepted by the liable defendant with probability 1. Rejection would therefore signal to the plaintiff that the defendant is not liable. Since the plaintiff would have to spend 40 to get a certain zero judgment, she would drop the suit. But then both types of defendant would be better off rejecting the offer, inconsistent with the plaintiff's expectation.[7]

[7] As proved in the formal analysis the non-liable defendant would reject even very low offers since in equilibrium he expects the plaintiff to drop the suit with high enough probability after every such rejection. It is still possible that both types of defendant accept the plaintiff's offer with probability 1 since then the plaintiff is not restricted by Bayes' rule in updating her beliefs if her offer is rejected and her threat to proceed to trial may therefore be credible. This would make accepting the plaintiff's offer rational for both types of defendant if the offer is lower than their remaining litigation costs. Then, a 'pooling' equilibrium will obtain, in which the case would settle immediately for an amount lower than 80. The problem with such a 'pooling' equilibrium is that it requires the plaintiff to interpret an unexpected rejection of her offer to signal that the defendant is liable with high enough probability. Since the non-liable defendant has always less to lose from rejecting the plaintiff's offer than the liable defendant such beliefs, although consistent, seem implausible. This intuition is further explained in section 3.2.3. below.

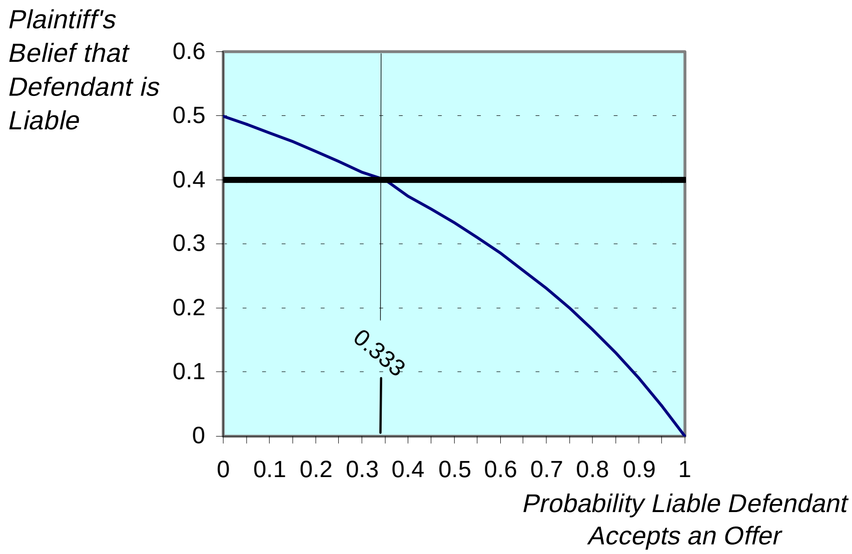
By the same argument it would not be consistent for the plaintiff to expect the liable defendant to always accept her offer, because then rejection would mean the defendant is not liable. Again, the plaintiff would have to spend 40 to obtain a certain zero judgment, which she would not do. She would therefore drop the suit if her offer is rejected, and expecting that, the liable defendant would be better off rejecting the plaintiff's offer.[8]

It is therefore the case that the non-liable defendant always rejects the plaintiff's offer in the second period, and the liable defendant accepts it with some probability that is lower than one. In fact, we can restrict the probability that the liable defendant accepts the plaintiff's offer even further. We know that after her offer is rejected the plaintiff's belief that the defendant is liable, given the expected probability of acceptance by the non-liable defendant, cannot be lower than 0.4. If it were lower then the plaintiff's net payoff from proceeding would be negative and she would drop the suit, in which case the liable defendant would be better off rejecting the offer. Applying Bayes' rule it is a matter of simple calculation to show that since the non-liable defendant always rejects the plaintiff's offer the liable defendant cannot accept it with probability that is higher than 1/3.[9] This maximum probability is derived graphically in Figure 1, plotting the plaintiff's updated belief as a function of the probability that the liable defendant accepts her offer, given that the non-liable defendant always rejects it.

[8] It would also not be consistent of the plaintiff to expect the liable defendant to always reject her offer. If this indeed were the liable defendant's strategy then the plaintiff would not change her prior belief after her offer is rejected. But then she would always spend the remaining 40 to get an expected judgment of 0.5*100=50. Expecting that, the liable defendant would be better off accepting any offer that is not higher than the sum of his remaining cost and the damages he will have to pay, 140. Since the plaintiff's maximum payoff is always less than 140, she would be better off offering slightly less than 140, which the liable defendant would accept, again contradicting the assumption that he rejects the offer.

[9] Let the probability of acceptance by a liable defendant be a_H. By Bayes' rule the plaintiff's belief after her offer is rejected, given that the non-liable defendant rejects it with probability 1, equals $0.5(1-a_H)/(1-0.5\,a_H)$. Since this belief cannot be lower than 0.4, $a_H \leq 1/3$.

Figure 1



The crucial element in the foregoing arguments is that the plaintiff’s expected payoff in the second period is constrained by the requirement of consistency in face of the defendant’s expected responses in equilibrium. The plaintiff cannot be too optimistic and expect the probability of settlement to be higher than some cutoff level. Otherwise, rational inference would require the plaintiff to drop the suit if her offer is rejected, in which case the defendant would prefer to reject, and the plaintiff’s optimism would have nothing to support it.

The plaintiff’s payoff if she makes the maximum offer the liable defendant would accept, 140, is maximized when the probability of acceptance is the highest possible. The higher this probability the more litigation costs the plaintiff can avoid, and the more costs she can extract from the defendant in settlement.[10] Since the plaintiff believes that the probability the defendant is liable equals 0.5, the maximum probability she can expect her offer to be accepted is 0.5*0.33=0.166. Thus the plaintiff’s maximum expected payoff in the second period equals 140*0.166=23.33.

Now it should be clear why the defendant would indeed reject any settlement offer the plaintiff makes in the first period. Since the plaintiff knows that the maximum she may get by proceeding to the second period is 23.33 and her cost of proceeding is 40 she would always drop the suit in the first period. But then the defendant is better off rejecting her offer in the first period, independent of his liability. The plaintiff can only lose by filing the suit. If she drops the suit immediately she loses the filing cost, and if she proceeds to the second period she increase this loss by at least 16.66 (which is the difference between the cost of proceeding to the second period, 40, and the maximum payoff the plaintiff can get in that period, 23.33).

2.3. Discussion

The asymmetric information model allows the plaintiff to rationalize rejections of her settlement offers. Whereas under symmetric information the plaintiff must interpret any such rejection as a mistake on the defendant's side and go on with her initial plan, when the defendant holds private information any such rejection signals the plaintiff that her case is weaker than she previously thought. In equilibrium the non-liable defendant always carries his threat not to settle and the liable defendant declines to settle with some positive probability. The defendant's private information therefore enables him to commit not to settle, thus forcing the plaintiff to bear higher costs if she files the suit. When these costs are sufficiently high the plaintiff does not file the suit.

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[10] Let the plaintiff's belief that the defendant is liable after her offer is rejected be μ=0.5(1- a_H)/(1-0.5 a_H). The plaintiff's expected payoff is therefore 0.5a_H*140+(1-0.5a_H)(100μ-40). This expression is increasing in a_H.

It should be noted that even if the plaintiff's litigation costs are lower than 80 and the suit is filed, her expected payoff is lower than the one she gets when information is symmetric. For example, if her litigation costs in each period are 30, there exists an equilibrium in which the plaintiff's expected payoff is 16.36.[11] In this equilibrium the non-liable defendant still rejects any offer the plaintiff makes in both periods. The liable defendant, however, accepts every such offer with some positive probability that makes the plaintiff indifferent between proceeding to the next period and dropping the suit. In essence, the liable defendant tries to bluff and pretend he is not liable. Yet, he cannot do so too often since then the plaintiff would not buy this bluff, she would always proceed to the next period, and the liable defendant would be better off settling the case earlier.

3. The Model

A risk neutral plaintiff files a lawsuit against a risk neutral defendant. There is a small positive filing cost, arbitrarily close to 0.[12] There are n litigation periods, indexed by t=1,2,…,n. In each period the plaintiff makes a take-it-or-leave-it offer, denoted $S_t>0$.[13] If her offer is declined the plaintiff decides whether to continue or drop the suit. We denote the probability that the plaintiff proceeds in period t by $p_t(S_t)$. If the suit is not dropped then each litigant incurs his litigation costs in that period, and the game moves to the next period. If the plaintiff decides to proceed in the last period then the court renders its

[11] See Proposition 1 for the way to calculate this payoff.

[12] We assume small filing cost only to avoid cases where the plaintiff is indifferent between filing and not filing the suit.

[13] Allowing for $S_t \leq 0$ would not change any of our results but only complicate the discussion.

judgment, J.[14] With probability $\alpha>0$ the judgment is high and $J=W_H>0$. With probability $(1-\alpha)>0$ the judgment is low, $J=W_L \geq 0$, where $W_H > W_L$. Thus, the expected judgment is $EW=\alpha W_H+(1-\alpha)W_L$. It is assumed that each litigant's costs are equally divided among the n periods.[15] Thus, the plaintiff's (defendant's) litigation costs in each period are $c_p=C_p/n>0$ ($c_d=C_d/n>0$) where C_p (C_d) are her total costs.[16] Let the defendant's remaining litigation costs at the beginning of period t be $C^t_d=(n-t+1)c_d$. Each litigant incurs his litigation costs irrespective of the court's judgment, according to the American rule.[17]

The parameters W_H, W_L, α, c_p, c_d, and n are all common knowledge.

3.1. Symmetric information

Assume first that both litigants do not know J but only its expected value, EW. We analyze by backward induction.

The plaintiff's threat to proceed with litigation in the last period is credible if and only if $c_p \leq EW$. If $c_p \leq EW$ then the litigants settle before the last period for $EW+c_d$.[18] But then the plaintiff's threat to proceed in the previous period, n-1, is also credible and the litigants settle before that period for $EW+2c_d$. Reasoning similarly for all periods, the suit is filed and immediately settled for $EW+C_d$.

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[14] J can be also interpreted as the expected judgment, conditional on some element of liability that may take one of two values, H or L.

[15] This assumption is only made for notational simplicity. The model can be easily applied to other distributions of litigation costs.

[16] For simplicity we assume no discounting.

[17] The analysis can be adjusted for alternative rules of fee allocation. See Bebchuk (1984), explaining the way to make such adjustment.

[18] When $c_p=EW$ any probability of proceeding is possible. Thus, there exist multiple subgame perfect equilibria in which the plaintiff offers $p_n(S_n)(EW+c_d)$ and the defendant accepts. The plaintiff, however, can always select her most favorable equilibrium by offering to settle for $EW+c_d$, thus indicating that she intends to proceed with probability 1.

If $c_p>EW$ then the plaintiff drops the suit in the last period and the defendant therefore turns down any offer in this period. Knowing that, if her offer is turned down in the previous period, *n*-1, the plaintiff is better off dropping the suit, and hence the defendant refuses any offer in that period too. The same argument holds in all previous periods and the suit is not filed.

It is the certainty that the defendant would accept her offer in all future periods that renders the plaintiff's threat to proceed credible. Yet, it is exactly this certainty which has little appeal when the model is compared with reality. According to the symmetric information model the plaintiff's belief that the defendant would accept his next offer is not affected by the way the defendant responded to her previous demands, and it fails to rationalize histories in which the defendant turns down the plaintiff's offers. The only explanation the plaintiff can give any time her offer is rejected is that the defendant made a mistake, and that the probability that he would make a similar mistake again is independent of his previous play. In moving to a framework in which information is asymmetric we look for a more "complete" model, whose equilibrium allows for a positive probability of rejection in every period throughout litigation.

3.2. Asymmetric information

Assume that the defendant knows whether the judgment is high or low. The plaintiff only knows α, the probability that the judgment is high. The plaintiff's belief over J is updated each time the defendant turns down her settlement offer. If her offer in period t is rejected then her belief that the judgment is W_H, denoted μ_t, is a function of her belief prior to that period, μ_{t-1} (where $\mu_0=\alpha$), and the defendant's expected response to her offer. Denote the probability that a strong defendant, knowing that the judgment is low, accepts a plaintiff's offer in period t, S_t, by $a^L{}_t(S_t)$ and the respective probability when the defendant is weak by $a^H{}_t(S_t)$.

The equilibrium concept we use is that of a sequential equilibrium.[19] A combination of strategies is a sequential equilibrium if the strategies are sequentially rational[20] and beliefs that are updated according to Bayes' rule, given the equilibrium strategies and the plaintiff's prior belief.[21]

There are three possible cases, depending on whether the plaintiff's per period litigation costs are higher than the high judgment, $c_p>W_H$, lower than the low judgment, $c_p\leq W_L$, or fall between these two values, $W_L<c_p\leq W_H$. Each of these cases is analyzed below.

3.2.1. The plaintiff's litigation costs per period are higher than the high judgment, $c_p>W_H$

In the last period the plaintiff's threat to proceed is not credible, independent of her belief, since her remaining costs are higher than the highest possible payoff she can expect, $c_p>W_H$. Therefore, the defendant refuses any offer and the plaintiff drops the suit. Knowing that, the plaintiff's threat to proceed in the previous period is not credible as

[19] See Kreps and Wilson (1982). In this game the sequential equilibrium solution is equivalent to a perfect Bayesian equilibrium.

[20] A player's strategy is sequentially rational if given her information this strategy is the best response to the other player's strategy.

well. The defendant refuses any offer in that period too, and the plaintiff drops the suit. Reasoning similarly for all previous periods, the suit is not filed.

This result is not surprising. Even assuming that the plaintiff is certain that the judgment is the highest possible, W_H, and thus returning to the symmetric information model, the suit would not be filed as the plaintiff's costs per period of litigation are higher. Clearly, the possibility that the judgment is lower cannot make the plaintiff better off.

3.2.2. The plaintiff's litigation costs per period are lower than the low judgment, $c_p \leq W_L$

In the last period the plaintiff can always offer to settle for any amount slightly lower than the sum of the low judgment and the defendant's remaining costs, $W_L + c_d$ and this offer would be accepted with probability 1 by both types of defendant.[22] Therefore, she would never drop the suit in the period before. Knowing that, both types of defendant are better off accepting any offer slightly lower than $W_L + 2c_d$ in that previous period and the plaintiff would not drop the suit in the period before. Reasoning similarly for all previous periods, the suit must be filed in every sequential equilibrium of this case.

The exact settlement pattern is given and proved in Spier(1992), example 1.[23] To obtain this result it assumes that the plaintiff's total costs are lower than the expected judgment. Yet, it is sufficient that the plaintiff's litigation costs in every period are lower

[21] If the defendant rejects an offer he was supposed to accept in equilibrium independent of the actual judgment then the plaintiff's updated belief can take any value as it is not constrained by Bayes' rule.
[22] This is always true since $c_d > 0$.
[23] After the suit is filed there are exactly two possible sequential equilibria. In one, the plaintiff offers to settle for $W_L + C_d$ and the defendant accepts, independent of his liability. In the other, the plaintiff offers in each period to settle for $S_t = W_H + C^t_d$, the strong defendant always rejects and the weak defendant accepts with some positive probability that makes the plaintiff indifferent between offering $W_H + C^t_d$ and offering $W_L + C^t_d$. Which of these equilibria obtains depends on the relevant parameters of the case.

than the expected judgment to obtain the same result. Since the expected judgment is never lower than the lowest possible judgment, the plaintiff's threat to litigate is credible even when it is common knowledge that the judgment is low. The possibility that the judgment is higher cannot undermine this threat.

3.2.3. The plaintiff's litigation costs per period fall between the low judgment and the high judgment $W_L < c_p \leq W_H$

We restrict the set of sequential equilibria of this case by requiring the following property to hold.[24]

property 1. *If the plaintiff expects the defendant to accept her offer independent of the actual judgment, yet the offer is rejected, the plaintiff believes that the judgment is low.*

To motivate this requirement suppose that the plaintiff expects that a settlement offer he makes in some period would be accepted by both types of defendant. In case this offer is unexpectedly rejected the plaintiff's belief that the defendant is weak is not constrained by Bayes' rule, and it may therefore take any value. Thus, the plaintiff may believe that the unexpected rejection was more likely to come from a weak defendant than from a strong defendant. Yet, it is clearly the case that a weak defendant, knowing that his liability is high, has always more to lose by refusing the plaintiff's offer than a strong defendant. Whenever the plaintiff pursues the case to judgment the weak defendant's expected loss is higher than the strong defendant's loss. Interpreting a rejection to signal that the judgment is high would, therefore, seem unlikely, undermining the plausibility of

[24] This property is in the same spirit of the universal divinity refinement of Banks and Sobel (1987).

any equilibrium relying on such interpretation. Hence, we require the plaintiff to infer from any unexpected rejection that the judgment is low.

In any sequential equilibrium satisfying property 1 the probability that the plaintiff's demand is rejected is always strictly positive. Otherwise, if her offer is turned down the plaintiff would always drop the suit since she would believe the judgment is W_L, which is lower than her per-period litigation costs. Expecting that, both types of defendant would be better off refusing the plaintiff's offer, contradicting the supposition that it is always accepted in equilibrium.

In fact, as shown by Proposition 1, there exists a unique[25] sequential equilibrium satisfying property 1. In this equilibrium the defendant rejects any offer the plaintiff makes if he knows the judgment is low, and he also rejects it with some positive probability when he knows that the judgment is high. Thus, every time her equilibrium offer is turned down the plaintiff's estimate of the probability that the judgment is high is decreasing. If her remaining costs are sufficiently high her expected payoff from proceeding is negative and she therefore drops the suit. Expecting that in equilibrium the defendant declines all offers irrespective of the actual judgment, the plaintiff's payoff after filing the suit equals 0, and therefore she does not file the suit.

[25] Uniqueness obtains generically, allowing for different strategies off the equilibrium path.

Proposition 1. *Define a vector* $\mu^{*}=(\mu^{*}_{0}, \mu^{*}_{1},\ldots,\mu^{*}_{n})$ *such that:*

$$\mu^{*}_{n}=(c_{p}-W_{L})/(W_{H}-W_{L}) \tag{1}$$

$$\mu^{*}_{t}= \mu^{*}_{t+1}+ c_{p}(1-\mu^{*}_{t+1})/[W_{H}+C^{t+1}_{d}] \qquad \forall\, t<n \tag{2}$$

If $W_{L}< c_{p}\leq W_{H}$ *then there exists a unique sequential equilibrium satisfying property 1. In this equilibrium the suit is filed only if* $\alpha>\mu^{*}_{1}$. *If this condition holds then the plaintiff's expected payoff after filing the suit is* $(W_{H}+C_{d})(\alpha-\mu^{*}_{1})/(1-\mu^{*}_{1})$.

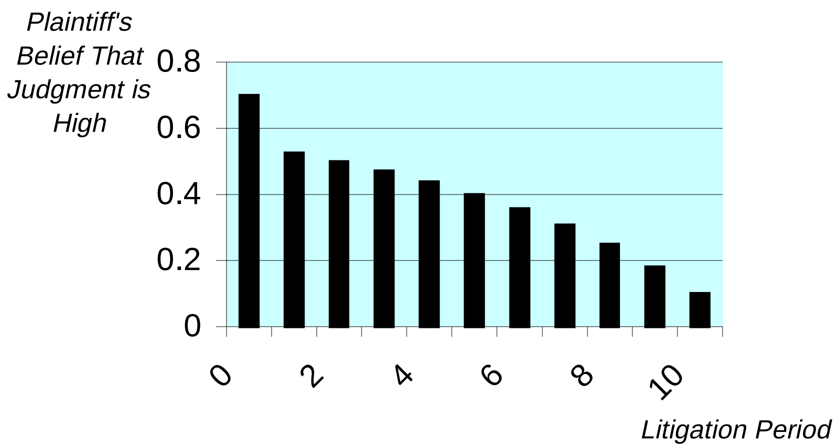
The proof is motivated by the following reasoning. The strong defendant always prefers to reject the plaintiff's offer, as his expected loss is always lower than the offer. This is true even for very low offers (made only off the equilibrium path) because such offers are followed by a high probability that the plaintiff would drop the suit. The weak defendant, however, must be indifferent between accepting the plaintiff's offer and turning it down whenever the plaintiff's threat to proceed with litigation is credible. If he preferred to accept it then rejection would signal that the defendant is strong and the plaintiff would drop the suit. But then the defendant would have been better off rejecting the offer, a contradiction. Similarly, if the weak defendant preferred to reject the plaintiff's offer then the plaintiff would proceed to the next period and the weak defendant would have been better off accepting it, given that it is not higher than his expected loss. Since the plaintiff can save some of her litigation costs by settling earlier, she would always be willing to shade down her offers so that the weak defendant would accept them.

In the last period, if the plaintiff's demand is rejected then she has to spend her remaining costs to get a payoff equal to the expected judgment according to her belief. To proceed the plaintiff must believe that the probability the defendant is weak conditional on the last period's offer being rejected is sufficiently high. This constrains the probability that the weak defendant accepts the plaintiff's offer in equilibrium. Similarly, in every period the plaintiff's demand must be accepted with a probability that would leave her optimistic enough in case her demand is rejected. Hence, the plaintiff faces n credibility constraints, expressed by the vector μ^*, restricting the probability of settlement in each period of litigation. Her payoff is maximized when all these constraints are binding. However, when the prior probability that the defendant is liable is too low, not all constraints can be satisfied. The weak defendant rejects any offer in the first i-1 periods, where i is the first period in which the plaintiff's threat to proceed is credible assuming her belief prior to that period is α. When the plaintiff's threat to proceed in the first period is not credible (i>1) she does not file the suit.

When the plaintiff's total litigation costs are sufficiently low she files the suit and then offers to settle for the sum of the defendant's litigation costs and the higher judgment. If this offer is refused the plaintiff proceeds to the next period, in which she offers, again, the sum of the defendant's remaining litigation costs and the higher judgment. In each period the plaintiff maintains the same strategic pattern. Since the strong defendant rejects every such offer and the weak defendant accepts it with a probability that is less than 1, the probability that the case would be litigated to judgment is always positive.[26] In this equilibrium the defendant's expected loss equals the sum of the true judgment, and his total litigation costs.

Figure 2 depicts the plaintiff's belief that the judgment is high when n=10, C_p=C_d=100, W_H=100, W_L=0, and α=0.7. In this case the suit is filed and litigated to judgment with some positive probability. Notice that although the plaintiff's prior belief is 0.7, as litigation proceeds she becomes less optimistic, and if her offer in the last period is rejected then she believes the probability the defendant is liable equals c_p/W_H=0.1.

Figure 2



[26] The probability of settlement in each period, conditional on reaching that period, equals $(\mu_{n-1}-\mu^*_n)/(1-\mu^*_n)$.

4. Cost Divisibility, Information Asymmetry, and The Plaintiff's Threat to Sue

Based on Proposition 1 we can now analyze the effects of cost divisibility and information asymmetry on the plaintiff's expected payoff, and the way these variables interact. We begin by defining the levels of cost divisibility and information asymmetry.

Cost Divisibility. Cost divisibility is measured by the number of periods to which litigation is divided. It is important to emphasize that the mere divisibility of litigation costs does not, by itself, facilitate the divisibility that is relevant to the plaintiff's payoff. For divisibility to increase the plaintiff's expected value from the suit it is necessary that the litigants will be able to bargain for a settlement between each two consecutive litigation periods. Thus, even if the plaintiff's lawyer charges his fee by the hour it would seem unreasonable to assume that the parties discuss a settlement after each and every such hour. A practical measure of cost divisibility would therefore be the number of possible settlement sessions that the litigants believe they will conduct. Introducing the possibility of holding an additional settlement session, thus dividing one litigation stage into two would increase the level of divisibility.

Information Asymmetry. The level of information asymmetry is correlated with the judgment's variance. To analyze the effect of changes in the judgment's variance while keeping its mean constant we examine the spread of the possible judgments, (W_H-W_L).[27] We "spread out" this range while keeping the expected judgment and the probability of a high judgment constant and then investigate how the plaintiff's expected payoff changes.

[27] The judgment's spread is proportional to its variance in this model, $\alpha(1-\alpha)(W_H-W_L)^2$. By changing the spread we are able to check for the effect of the judgment's variance on the plaintiff's payoff, while controlling for the expected judgment.

It is simple to confirm whether the plaintiff's threat is credible when the costs per period fall outside the support of the judgment's distribution. It is never credible when these costs are above the highest possible judgment, and it is always credible when they are below the lowest possible judgment. It is when these costs fall between the two values that the answer becomes less obvious. The following corollaries demonstrate the interaction among the relevant variables, namely, total costs, level of divisibility and the judgment's spread, and their effects on the plaintiff's threat to sue when $W_L < c_p \leq W_H$.[28]

4.1. Plaintiff's Litigation Costs

Corollary 1. *If $W_L < c_p \leq W_H$ then in the sequential equilibrium satisfying property 1:*

a) *Increasing the plaintiff's total litigation costs while keeping c_p and c_d constant (weakly) reduces the plaintiff's expected payoff.*

b) *Dividing any litigation period to two or more periods (weakly) increases the plaintiff's expected payoff.*

Under symmetric information, when the plaintiff's *per-period* costs are kept constant the expected judgment required for the suit to be filed depends on the plaintiff's total costs only if the defendant has some bargaining power and is therefore able to extract part of the plaintiff's costs in settlement. With information asymmetry, however, this minimum expected judgment increases with the plaintiff's *total* litigation costs as well,

[28] Although the following discussion is based on the assumption that the plaintiff has full bargaining power

even if the defendant has no bargaining power. This effect may be demonstrated by assuming, for example, that the rules of procedure are changed so that all cases have to be submitted it a non-binding ADR procedure before going to trial.[29] Using the terminology of our model, litigants now face an additional litigation stage, involving additional litigation costs. If these costs are not higher than litigation costs in each of the other stages, this change would not affect the credibility of the plaintiff's threat to sue when information is symmetric and the plaintiff has all the bargaining power. Yet, under information asymmetry this change would reduce the plaintiff's expected payoff, and would therefore result in less suits being filed. The reason is that the plaintiff knows that she would have to incur the additional costs with some positive probability, and that after incurring it, since this happens only if her settlement offer is rejected, her belief with respect to the expected judgment would be lowered.

Part *b)* of the corollary shows that divisibility encourages the filing of more suits even under asymmetric information, as the plaintiff's payoff increases with the level of divisibility.[30] Notice that this holds true irrespective of how the litigants' litigation costs in the period that is divided are allocated among the new "sub-periods".

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its main points carry over to a more general bargaining framework.

[29] To fit in our model it must be the case that the defendant's information is not revealed in the ADR procedure. For a similar argument in the context of the classic litigation and settlement model see Shavell (1995).

[30] If the suit is not filed under lower divisibility, it may not be filed even after divisibility is increased. This is the only case where increased divisibility does not affect the plaintiff's payoff.

4.2. Information Asymmetry and Cost Divisibility

Corollary 2. *If* $W_L < c_p \leq W_H$ *then in the sequential equilibrium satisfying property 1, increasing the spread of the possible judgments,* $(W_H - W_L)$, *while keeping EJ and* α *constant (weakly) decreases the plaintiff's expected payoff.*

As Corollary 2 demonstrates, the level of information asymmetry, which is a function of the judgment's spread, is negatively correlated with the plaintiff's payoff. Thus, a higher level of divisibility is required to maintain the credibility of the plaintiff's threat to sue when his information becomes less accurate.

For a given expected judgment and probability of high judgment, the highest variance is obtained if the lower judgment is zero – the defendant may be found not liable. When this is the case, there is always a minimum probability of high judgment, strictly lower than 1, below which the suit is not filed. Such a minimum probability exists even if the plaintiff's litigation costs are infinitely divided.[31] This result is summarized in the following Corollary.

Corollary 3. *If* $c_p > W_L = 0$ *then in the sequential equilibrium satisfying property 1 the plaintiff does not file the suit if* $C_p/(W_H + C_d) \geq \ln(1/(1-\alpha))$.

[31] Corollary 1 only gives a conservative lower bound on the probability of high judgment required for the suit to be filed. Hence, although it is necessary for the probability of high judgment to be higher than this lower bound, it is not sufficient to make the plaintiff's threat to sue credible.

Corollaries 2 and 3 imply that we should observe higher level of divisibility within cases that are filed when the defendant may be found not liable, as compared to cases where his liability is known and he is only informed about the level of the expected damages. We can apply this insight to the comparison between negligence and strict liability. Since under a negligence regime the defendant's private information may concern whether he satisfied the standard of care, the variance of possible judgments would usually be higher than in a strict liability regime, where the scope of litigation is often limited to the level of damages. We therefore predict that if the level of litigation divisibility is the same under both regimes, the expected judgment required for negligence suits to be filed would be higher than the respective expected judgment required for filing under strict liability.[32]

Corollary 3 also suggests that when the plaintiff's probability of success in trial is low and the defendant holds private information concerning whether he is liable or not, the effect of cost divisibility is limited. Only when the probability that the defendant is liable is sufficiently high does divisibility bring about a substantial improvement in the plaintiff's position. Thus, for low probability suits, the classic assumption that the suit is filed only when its expected litigation value is positive, is approximated by the results under the multi-period, asymmetric information model.

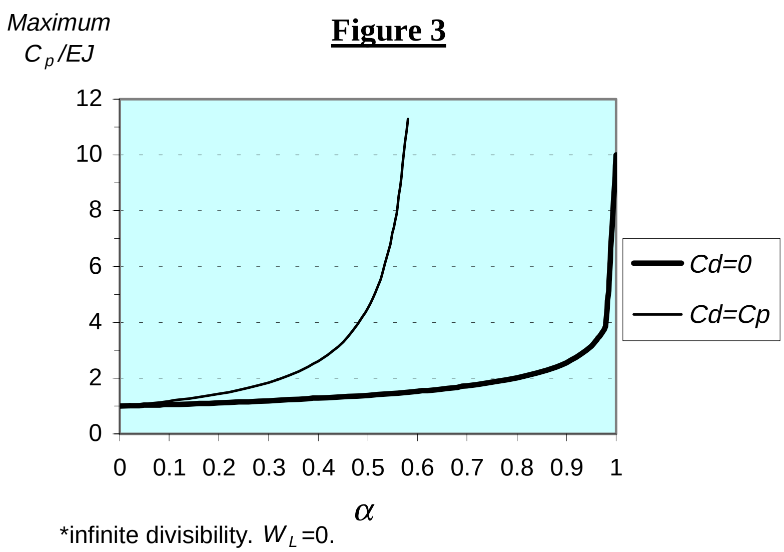
Figure 3 plots the maximum ratio of plaintiff's total costs to her expected judgment, C_p/EJ, beyond which the suit may not be filed, as a function of her probability of success,

[32] This should not be confused with the distributional effects of the different regimes. It is evident that the plaintiff's expected judgment for the *same* claim would be higher under strict liability. Our analysis shows that even if we control for this distributional effect, more suits would still be filed under strict liability, because of its lower judgment variance.

α, where W_L=0. We demonstrate this function for the two cases where C_d=0,[33] and C_d=C_p, under infinite cost divisibility.

The graph for C_d=0 reflects the case where the plaintiff is unable to extract the defendant's costs in bargaining. As for the case where C_d=C_p, notice that since Corollary 3 only obtains a loose upper bound on the maximum ratio $C_p/(W_H+C_d)$ above which the suit is not filed, there is a range of suits below this graph that would not be filed *even* under infinite divisibility. Note also that when information is symmetric the maximum ratio, C_p/EJ, for which a suit would be filed if there is only one litigation period is 1 and that under infinite divisibility *all* suits would be filed, independent of α and C_d.

Figure 3



[33] The model assumed C_d>0 only for expository simplicity. Its results continue to hold when C_d=0.

Figure 3 clearly shows that only when α is in its upper range does divisibility kick in and significantly increase the range of suits that are filed. In the lower ranges, divisibility is much less significant. This points to a screening process that relies not only on the expected judgment, but more specifically, on the probability of plaintiff's success. In cases where the defendant holds superior information and costs are divisible a low probability suit involving large stakes would be able to extract a positive settlement less often than a high probability suit with low stakes, assuming both have the same expected judgment.

5. Conclusion

Defendants who want to deter small value suits often engage in a stonewalling strategy. One expects that a plaintiff facing high litigation costs would be reluctant to file the suit if she believes the defendant would refuse to settle it. Yet, when information is assumed to be symmetric and costs are sufficiently divisible the suit is expected to be settled immediately after it is filed, and the plaintiff cannot explain rejections of her settlement offers but as mistakes the defendant made. She would therefore always be willing to pursue the suit further, convinced that the case would immediately settle. Such is the case even if these "mistakes" are repeated throughout the litigation. According to the symmetric information model, every time the plaintiff has to decide whether to keep litigating she should assume that there is no correlation among these "mistakes" and she should expect that they would not be repeated in the future. She should be certain that her next offer *would* be accepted.

This paper demonstrated that there is an alternative reasoning the plaintiff may employ; The defendant's settlement strategy may signal his private information. As litigation proceeds and more of her settlement offers are declined the plaintiff would be forced to reason that the expected judgment is lower than she previously thought. Although divisibility of her costs makes the plaintiff's cost of proceeding in each stage of the litigation lower, it also increases the number of such stages, and with it, the number of possible rejections of her offers. If this number is too high, the plaintiff would prefer not to take the risk of running high costs for a low expected judgment, and would therefore not file her suit. The effect of divisibility is thus undermined when the plaintiff cannot be certain of the defendant's next move. Although divisibility is expected to increase the set of suits that are filed, this effect would become less significant as the level of information asymmetry increases.

While it was the assumption that the defendant's private information concerns the court's judgment, other sources of information asymmetry would produce similar results. Thus, the defendant may hold private information with respect to his per period litigation costs, his risk aversion, his reputational concerns, his constrained calculation ability or other unobservable variables that affect his willingness to settle at each point during the litigation. In the presence of such unobservable variables the plaintiff cannot be confident when filing a suit that the defendant would indeed settle it early. Every time the defendant declines to settle, the plaintiff would interpret it to signal an increased probability that the defendant would decline future settlement offers as well.[34] The

[34] A previous version of this paper has modeled the defendant as having some probability, α, of being 'crazy' and refusing any settlement. This assumption, although less conventional in the literature on litigation and settlement, actually makes the analysis much simpler, and the unique equilibrium that emerges is similar to the one described in Proposition 1.

numerous sources of information asymmetry therefore support the intuition that the backward induction analysis of the symmetric information model should be modified to allow for the possibility of stonewalling defendants. The larger the number of litigation periods, the higher the level of private information held by the defendant and the higher the litigation costs involved, the more plausible it is that such stonewalling strategies would be used to deter plaintiffs from filing their suits.

The model also assumed that the defendant's private information is revealed only after the last litigation period. This assumption is obviously a simplifying one, since as litigation proceeds much of the private information held by either of the litigants is revealed through voluntary disclosure and compulsory discovery procedures. It therefore may be the case that the defendant's type would become common knowledge at an earlier stage as a consequence of the plaintiff's litigation efforts.[35] Such information revelation would improve the plaintiff's position, as she would be able to avoid part of her litigation costs. Under sufficient divisibility, once the defendant's type is revealed the plaintiff would either drop the suit, if the judgment is low, or settle immediately, if it is high. Litigation would therefore never proceed to judgment, and the point in which information is revealed (for example, after discovery is exercised) would become the last period *de facto*. The model can therefore be easily extended to this case, and its main results would continue to hold.[36]

[35] The assumption of information asymmetry implies that the defendant cannot reliably reveal his information to the plaintiff. Once information can be verified it would unravel and no further litigation would take place. See, for example, Shavell (1989) and Hay (1994).
[36] The model can be further complicated by allowing for information to be revealed with probability that is less than 1, in every period throughout the litigation. Such extension is beyond the scope of this paper, yet our main results can be shown to hold under it as well.

Our analysis produced some testable predictions that may be contrasted with those of the symmetric information model. Examining the set of suits that are filed, the judgment's variance is expected to be positively correlated both with the expected judgment and with the number of litigation periods. Also, addition of litigation stages should result in more suits being screened out, even if the additional cost is not high and the plaintiff has most of the bargaining power. Finally, we expect divisibility to have insignificant effect on low probability suits, and to improve the plaintiff's position only in cases where her probability of success is sufficiently high. In a world of information asymmetry and cost divisibility suits would be screened not only by their expected judgment, but more specifically, by their probability of success.

An important question that still remains to be answered is what determines the level of divisibility in any given lawsuit. Since the level of divisibility is defined by the number of possible settlement negotiations between the plaintiff and the defendant, it is in the interest of plaintiffs to initiate more negotiations throughout the litigation. Yet, empirical evidence seems to suggest that the number of settlement conferences in ordinary litigation is generally low.[37] Whether this number is restricted by the defendant's strategic behavior or by other factors is left open for future research.

[37] For example, only 15% of all cases studied by Kritzer (1985) involved three or more exchanges of offers and counter offers. In only 20% of the cases was the time spent on settlement discussions by the lawyers more than 20% of the total time spent on the case. These figures do not vary much across stakes and case complexity. See also Kritzer (1992).

Appendix

Proposition 1. *Define a vector* $\boldsymbol{\mu}^{*}=(\mu^{*}_{0}, \mu^{*}_{1},\ldots,\mu^{*}_{n})$ *such that:*

$$\mu^{*}_{n}=(c_p-W_L)/(W_H-W_L) \tag{1}$$

$$\mu^{*}_{t}= \mu^{*}_{t+1}+ c_p(1-\mu^{*}_{t+1})/[W_H+C^{t+1}_{d}] \qquad \forall\, t<n \tag{2}$$

If $W_L< c_p\leq W_H$ *then there exists a unique sequential equilibrium satisfying property 1. In this equilibrium the suit is filed only if* $\alpha>\mu^{*}_{1}$. *If this condition holds then the plaintiff's expected payoff after filing the suit is* $(W_H+C_d)(\alpha-\mu^{*}_{1})/(1-\mu^{*}_{1})$.

Proof. We prove this proposition in two steps. First we show that there exists a sequential equilibrium that satisfies the proposition, then we show by backward induction that this sequential equilibrium is unique under property 1.

Step 1. The following is a sequential equilibrium satisfying property 1. In every period the strong defendant rejects every offer the plaintiff makes. Also, in every period t, if $\mu^{*}_{t}<\alpha$ then the weak defendant rejects every offer, and the plaintiff drops the suit if her offer is rejected. Let $t=i$ be the first period where $\mu^{*}_{t}\geq\alpha$. In all periods $t\geq i$ the weak defendant accepts every offer that is not higher than the sum of the judgment and his remaining litigation costs, $W_H+C^{t}_{D}$, with probability $a^{H}_{t}(S_t)$. In period $t=i$ this probability equals $(\alpha-\mu^{*}_{i})/\alpha(1-\mu^{*}_{i})$, and in all the following periods $t>i$ it equals $(\mu^{*}_{t-1}-\mu^{*}_{t})/\mu^{*}_{t-1}(1-\mu^{*}_{t})$ (notice that this probability does not depend on S_t as long as $S_t\leq W_H+C^{t}_{D}$). The probability $a^{H}_{t}(S_t)$ is well defined since $1>\mu^{*}_{t-1}>\mu^{*}_{t}>0$ for all $t>1$. In all periods $t\geq i$ the plaintiff offers $S_t=W_H+C^{t}_{d}$. In case this offer is rejected the plaintiff proceeds with probability 1. If the plaintiff deviates and offers $S_t<W_H+C^{t}_{d}$ and her offer is rejected then she proceeds to the next period with probability $p_t(S_t)=S_t/(W_H+C^{t}_{D})$. If she deviates and offers $S_t>W_H+C^{t}_{d}$ her offer is rejected and she proceeds with probability 1. The plaintiff's beliefs are always updated according to Bayes' rule and the above equilibrium strategies.

It can be easily verified that the litigants' strategies are sequentially rational. In particular, when $\alpha \geq \mu^*_t$ the plaintiff is indifferent between dropping the suit and proceeding and the weak defendant is indifferent between accepting the plaintiff's equilibrium offer and rejecting it. Hence, conditional on reaching period *t*, the plaintiff's payoff equals $(W_H+C^t_d)(\mu_{t-1}-\mu^*_t)/(1-\mu^*_t)$ if $\mu_{t-1} \geq \mu^*_t$ and 0 otherwise. Since the filing cost is positive the suit is filed only if the plaintiff's prior belief, α, is strictly higher than μ^*_1, and after it is filed the plaintiff's expected payoff is $(W_H+C_d)(\alpha-\mu^*_1)/(1-\mu^*_1)$.

Step 2. We show that the sequential equilibrium described in step 1 is unique. We begin by proving the following Lemma:

Lemma 1. *Fix a sequential equilibrium satisfying property 1. In every period t and for every offer S_t, if the defendant's expected loss following a rejection of S_t is $p_t(S_t)(J+C^t_D)$ then the strong defendant rejects S_t with probability 1.*

Proof. We prove this by contradiction. Suppose the strong defendant accepts the plaintiff's offer S_t with a positive probability. Then it must be that his expected loss if he rejects the offer is not lower than the offer, $p_t(S_t)(W_L+C^t_d) \geq S_t$. Since $S_t>0$, it must also be that $p_t(S_t)>0$. Hence, the weak defendant strictly prefers to accept S_t, as his loss if he rejects it is higher, $p_t(S_t)(W_H+c_d)>S_t$, and he therefore accepts it with probability 1. Suppose the strong defendant accepts S_t with a positive probability that is less than 1. Then, if the offer is rejected the plaintiff must conclude that the judgment is low, and she should drop the suit, as $c_p>W_L$. Expecting that in equilibrium the strong defendant is better off rejecting the offer, a contradiction. Now suppose that the strong defendant accepts the plaintiff's offer with probability 1. Under property 1 if the plaintiff's offer is rejected she must conclude that the judgment is low and drop the suit. The strong defendant is therefore better off rejecting the offer, a contradiction.

Next we prove uniqueness in the last period, $t=n$. The plaintiff is indifferent between proceeding and dropping the suit in the last period if her expected payoff from proceeding equals her remaining costs, $\mu_n W_H+(1-\mu_n)W_L=c_p$. This is equivalent to $\mu_n=(c_p-W_L)/(W_H-W_L)=\mu^*_n>0$. If the defendant rejects the plaintiff's offer S_n, and the plaintiff proceeds with probability $p_n(S_n)$ then the defendant's expected loss is $p_n(S_n)(J+c_d)$. By Lemma 1 the strong defendant rejects every offer in the last period. Therefore the plaintiff's belief that the judgment is high if the defendant rejects an offer cannot be greater than her belief prior to making the offer, $\mu_n\leq\mu_{n-1}$.

If the plaintiff's belief that the judgment is high, prior to the last period, μ_{n-1}, is weakly lower than μ^*_n, then the plaintiff drops the suit in period n-1; If $\mu_{n-1}<\mu^*_n$ then the plaintiff drops the suit if her offer is rejected, $p_n(S_n)=0$. The defendant's expected loss if he rejects this offer is therefore 0, and he does not accept it, independent of his liability. Similarly, if $\mu_{n-1}=\mu^*_n$ then the plaintiff proceeds in case her offer is rejected only if her belief after such rejection equals μ^*_n, and therefore in equilibrium the defendant refuses this offer independent of his liability. Since the plaintiff is indifferent between proceeding and dropping the suit, her expected payoff if the offer is rejected is always 0. Hence, if $\mu_{n-1}\leq\mu^*_n$ then the plaintiff's expected payoff in the last period is 0, and she drops the suit in the previous period to save the costs of proceeding to the last period.

Suppose $\mu_{n-1}>\mu^*_n$ and the plaintiff's offer is strictly lower than the sum of the high judgment and the defendant's remaining costs, $S_n<W_H+c_d$. If this offer is rejected the plaintiff must proceed in equilibrium with probability $p_n(S_n)=S_n/(W_H+c_d)<1$. We show this by contradiction. If $p_n(S_n)>S_n/(W_H+c_d)$ then the weak defendant strictly prefers to accept the plaintiff's offer and therefore if her offer is rejected the plaintiff must reason that the judgment is low. But then she prefers to drop the suit, $p_n(S_n)=0$, which is a contradiction. If $p_n(S_n)<S_n/(W_H+c_d)$ then the weak defendant strictly prefers to reject the plaintiff's offer and therefore the plaintiff's belief after her offer is rejected equals her belief prior to making the offer, $\mu_n=\mu_{n-1}$. But then she strictly prefers to proceed, $p_n(S_n)=1$, which is, again, a contradiction. Since $p_n(S_n)=S_n/(W_H+c_d)<1$ the plaintiff must be indifferent between proceeding and dropping the suit, so $\mu_n=\mu^*_n$. By Bayes' rule $\mu_n=\mu_{n-1}(1-a^H_n(S_n))/(1-a^H_n(S_n)\mu_{n-1})$. Rearranging we get the probability that the defendant accepts the plaintiff's offer in equilibrium if he knows the judgment is high, $a^H_n(S_n)=(\mu_{n-1}-\mu^*_n)/\ \mu_{n-1}(1-\mu^*_n)$. The plaintiff's expected payoff after offering $S_n<W_H+c_d$ is therefore $S_n(\mu_{n-1}-\mu^*_n)/(1-\mu^*_n)$.

It follows that no offer $S_n<W_H+c_d$ can be made in a sequential equilibrium since the plaintiff can always get a higher expected payoff, arbitrarily close to $(W_H+c_d)(\mu_{n-1}-\mu^*_n)/(1-\mu^*_n)$, by offering $S_n=W_H+c_d-\varepsilon$ for a sufficiently small $\varepsilon>0$. Any offer $S_n>W_H+c_d$ is rejected by the defendant independent of his liability, and the plaintiff's expected payoff equals $\mu_{n-1}W_H+(1-\mu_{n-1})W_L-c_p$. It can be easily verified that this payoff is strictly lower than $(W_H+c_d)(\mu_{n-1}-\mu^*_n)/(1-\mu^*_n)$.[38] Consequently, the only possible offer in equilibrium is $S_n=W_H+c_d$. This offer is accepted by a weak defendant with probability $a^H_n(S_n)=(\mu_{n-1}-\mu^*_n)/\mu_{n-1}(1-\mu^*_n)$, and rejected by a strong defendant. The defendant's expected loss, conditional on reaching this period, is therefore $J+c_d$.

In the period before the last, n-1, the plaintiff is indifferent between proceeding and dropping the suit if her expected payoff in the last period equals her costs of proceeding to that period. This is true if and only if $(W_H+c_d)(\mu_{n-1}-\mu^*_n)/(1-\mu^*_n)=c_p$. Rearranging we get $\mu_{n-1}=\mu^*_n+c_p(1-\mu^*_n)/[W_H+c_d]=\mu^*_{n-1}>\mu^*_n$. Therefore, if the plaintiff proceeds to the last period with a positive probability $p_{n-1}(S_{n-1})>0$, then the defendant's expected loss from rejecting the offer is $p_{n-1}(S_{n-1})(J+2c_d)$. By Lemma 1 the strong defendant rejects every offer made in the period before the last, and therefore $\mu_{n-1}\leq\mu_{n-2}$. Like in the last period, if $\mu_{n-2}\leq\mu^*_{n-1}$ then the plaintiff's expected payoff in period n-1 is 0 and she drops the suit in the previous period, and if $\mu_{n-2}>\mu^*_{n-1}$ then the plaintiff offers $S_{n-1}=W_H+2c_d$, this offer is accepted by a weak defendant with probability $a^H_n(S_n)=(\mu_{n-2}-\mu^*_{n-1})/\mu_{n-2}(1-\mu^*_{n-1})$, and rejected by a strong defendant. The defendant's expected loss, conditional on reaching this period, is therefore $J+2c_d$. Reasoning similarly for every previous period the equilibrium specified in step 1 is unique.

[38] This is intuitively obvious, as the plaintiff has to always spend her last period costs if she offers a settlement that no defendant would accept. She can save some of these costs, and extract some of the defendant's costs (without losing anything) by offering to settle for $W_H+c_d-\varepsilon$.

Corollary 1. *If* $W_L < c_p \leq W_H$ *then in the sequential equilibrium satisfying property 1:*

a) Increasing the plaintiff's total litigation costs while keeping c_p *and* c_d*, constant (weakly) reduces the plaintiff's expected payoff.*

b) Dividing any litigation period to two or more periods (weakly) increases the plaintiff's expected payoff.

Proof. Part *a)* follows immediately from Proposition 1. To prove part *b)* suppose that period i is divided to two periods, $i1$ and $i2$, where the plaintiff's costs in these periods are $c_{p1}>0$ and $c_{p2}>0$, respectively. The defendant's costs in these periods are similarly defined to be c_{d1} and c_{d2}. It therefore follows that:

$$c_{p1}+c_{p2}=c_p, \tag{A1}$$

$$c_{d1}+c_{d2}=c_d. \tag{A2}$$

Suppose that before dividing period i, $\mu^{*}=(\mu^{*}_0,\ \mu^{*}_1,\ldots,\mu^{*}_n)$ is defined according to Proposition 1. Generalizing Proposition 1 we get a new vector after dividing period i, $\mu^{**}=(\mu^{**}_0,\ \mu^{**}_1,\ldots,\ \mu^{**}_{i-1},\ \mu^{**}_{i1},\ \mu^{**}_{i2},\ \mu^{**}_{i+1},\ldots,\ \mu^{**}_n)$. For all periods $t\geq i+1$ $\mu^{**}_t=\mu^{*}_t$. For periods $t< i-1$ the following must hold:

$$\mu^{**}_t= \mu^{**}_{t+1}+ c_p(1-\mu^{**}_{t+1})/[W_H+C^{t+1}_d]. \tag{A3}$$

The remaining values are determined by the following conditions:

$$\mu^{**}_{i2}= \mu^{*}_{i+1}+ c_{p2}(1-\mu^{*}_{i+1})/[W_H+C^{i+1}_d], \tag{A4}$$

$$\mu^{**}_{i1}= \mu^{**}_{i2}+ c_{p1}(1-\mu^{**}_{i2})/[W_H+C^{i+1}_d+c_{d2}], \tag{A5}$$

$$\mu^{**}_{i-1}= \mu^{**}_{i1}+ c_p(1-\mu^{**}_{i1})/[W_H+C^{i}_d]. \tag{A6}$$

It can be verified that $\mu^{**}_{i\text{-}1}<\mu^{*}_{i\text{-}1}$, and therefore $\mu^{**}_{1}<\mu^{*}_{1}$. By Proposition 1, the plaintiff's expected payoff strictly increases by the division if $\alpha>\mu^{**}_{1}$ and it remains 0 otherwise.

Corollary 2. *If* $W_L< c_p\leq W_H$ *then in the sequential equilibrium satisfying property 1, increasing the spread of the possible judgments,* $(W_H\text{-}W_L)$*, while keeping* EJ *and* α *constant (weakly) reduces the plaintiff's expected payoff.*

Proof. Assume that $W_L>0$ (otherwise the spread cannot be increased without changing α). Define W'_H and W'_L as follows:

$$W'_H=EJ+\theta(W_H\text{-}EJ), \tag{A7}$$

$$W'_L=EJ\text{-}\theta(EJ\text{-}W_L), \tag{A8}$$

where $EJ/(EJ\text{-}W_L)>\theta>1$. By construction $\alpha W'_H+(1\text{-}\alpha)W'_L=\alpha \mathrm{W}_\mathrm{H}+(1\text{-}\alpha)W_L=EJ$ and $W'_H\text{-}W'_L>W_H\text{-}W_L$.[39] Define a vector $\boldsymbol{\mu}^{*}=(\mu^{*}_{0}, \mu^{*}_{1},\ldots,\mu^{*}_{n})$ such that:

$$\mu^{*}_{n}=(c_p\text{-}W_L)/(W_H\text{-}W_L), \tag{A9}$$

$$\mu^{*}_{t}=\mu^{*}_{t+1}+ c_p(1\text{-}\mu^{*}_{t+1})/[W_H+C^{t+1}_{d}] \qquad \forall\, t<n, \tag{A10}$$

and a vector $\boldsymbol{\mu}^{**}=(\mu^{**}_{0}, \mu^{**}_{1},\ldots,\mu^{**}_{n})$ such that:

$$\mu^{**}_{n}=(c_p\text{-}W'_L)/(W'_H\text{-}W'_L), \tag{A11}$$

$$\mu^{**}_{t}= \mu^{**}_{t+1}+ c_p(1\text{-}\mu^{**}_{t+1})/[W'_H+C^{t+1}_{d}] \qquad \forall\, t> n. \tag{A12}$$

[39] Notice that keeping EJ and α constant, any change in W_L uniquely defines W_H.

We prove the corollary by induction. It can be verified that:

$$\mu^{**}_n=[\alpha(\theta\text{-}1)+\mu^{*}_n]/\theta\ . \qquad \text{(A13)}$$

Now suppose that:

$$\mu^{**}_{t+1}\geq[\alpha(\theta\text{-}1)+\mu^{*}_{t+1}]/\theta. \qquad \text{(A14)}$$

We show that $\mu^{**}_t>[\alpha(\theta\text{-}1)+\mu^{*}_t]$.

Using (A14) to substitute for μ^{**}_{t+1} in (A12) and substituting $\alpha W_H+(1\text{-}\alpha)W_L$ for EJ we get:

$$\mu^{**}_t\geq[\alpha(\theta\text{-}1)+\mu^{*}_{t+1}]/\theta + c_p\{1\text{-}[\alpha(\theta\text{-}1)+\mu^{*}_{t+1}]/\theta\}/[(1\text{-}\theta)(\alpha W_H+(1\text{-}\alpha)W_L)+\theta W_H+C^{t+1}_d]. \qquad \text{(A15)}$$

Rearranging we get:

$$\mu^{**}_t\geq\frac{\alpha(\theta\text{-}1)+\mu^{*}_{t+1}+c_p[(\theta(1\text{-}\alpha)+\alpha\text{-}\mu^{*}_{t+1}]/[W_H(\theta(1\text{-}\alpha)+\alpha)\text{-}W_L(\theta\text{-}1)(1\text{-}\alpha)+C^{t+1}_d]}{\theta}> \qquad \text{(A16)}$$

$$>\ \frac{\alpha(\theta\text{-}1)+\mu^{*}_{t+1}+c_p(1\text{-}\mu^{*}_{t+1})/(W_H+C^{t+1}_d)}{\theta}=\frac{[\alpha(\theta\text{-}1)+\mu^{*}_t]}{\theta}\ ,$$

where the second inequality holds since $\theta>1$. Therefore, $\mu^{**}_1>[\alpha(\theta\text{-}1)+\mu^{*}_1]/\theta$.

This completes the proof since if $\mu^{*}_1\geq\alpha$ then $\mu^{**}_1\geq\alpha$, and the suit is not filed either before or after spreading the range. If, however, $\mu^{*}_1<\alpha$ then $\mu^{**}_1>\mu^{*}_1$ and the Corollary follows by Proposition 1.

Corollary 3. *If* $c_p > W_L = 0$ *then in the sequential equilibrium satisfying property 1 the plaintiff does not file the suit if* $C_p/(W_H+C_d) \geq \ln(1/(1-\alpha))$.

Proof. Define a vector $\boldsymbol{\mu'}=(\mu'_0, \mu'_1,\ldots,\mu'_n)$ such that:

$$\mu'_n = c_p/W_H, \tag{A17}$$

$$\mu'_t = \mu'_{t+1} + c_p(1-\mu'_{t+1})/[W_H+C_d] \qquad \forall\, t < n. \tag{A18}$$

It can be easily verified that $\mu'_1 = 1-[1-C_p/(n(W_H+C_d))]^{n-1}[1-C_p/(nW_H)]$ and that this expression is decreasing in n. When $n\to\infty$, $c_p = C_p/n \to 0$, and $\mu'_1 \to 1-\exp(-C_p/(W_H+C_d))$. By Proposition 1 when $\alpha \leq \mu'_1$ the suit is not filed, since $\mu^*_1 \geq \mu'_1$. Rearranging we get $C_p/(W_H+C_d) \geq \ln(1/(1-\alpha))$.

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