ECONOMIC RESEARCH REPORTS

MULTI-DEFENDANT SETTLEMENTS: THE IMPACT OF JOINT AND SEVERAL LIABILITY

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RR # 92-37 **July, 1992**

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Abstract

This article offers a simple model of settlement between a single plaintiff and multiple defendants. In the model, a plaintiff makes take-it-or-leave-it offers to two defendants. Each defendant then decides independently whether to accept the offer or to litigate. These two defendants face a rule of joint and several liability with contribution (proportional to their size). In the event one defendant settles, the non-settling defendant loses its right to contribution, but its liability is set off by the amount of the settlement. The paper analyzes the settlement game involving the defendants as well as the plaintiff's optimal strategy for the full range of transaction costs and of correlation of the plaintiff's probability of success against the defendants. It shows that, for broad sets of circumstances, joint and several liability discourages settlements.

Keywords: multi-defendant settlements, contribution, joint and several liability, hazardous waste
JEL classifications: K32, K41, Q3, C78

Draft of July 29, 1992

Multi-Defendant Settlements: The Impact of Joint and Several Liability*

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This article extends the economic analysis of settlements to the analysis of problems involving multiple defendants. The law and economics literature on settlements has focused almost exclusively on the problem of a single plaintiff settling with a single defendant and has paid little attention to the game-theoretic issues that arise where there are multiple defendants.[1] Though the analysis of settlements between a

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**Professors of Law, New York University. We acknowledge the generous financial support of the Filomen D'Agostino and Max E. Greenberg Research Fund at the New York University School of Law, and the support of the C.V. Starr Center for Applied Economics at New York University. Prior versions of this article were presented at the Conference on the Law and Economics of Environmental Policy, organized by the European Association of Law and Economics and the Geneva Association, and at workshops at the New York University School of Law and the University of North Carolina School of Law. We are grateful for the research assistance of Kent Chen, Marcel Hawiger, and Jeffrey Spear.

[1]The classic single-defendant works are John P. Gould, The Economics of Legal Conflicts, 2 J. Legal. Stud. 279 (1973); William M. Landes, An Economic Analysis of the Courts, 14 J. Law & Econ. 61 (1971); Richard A. Posner, An Economic Approach to Legal Procedure and Judicial Administration, 2 J. Legal Stud. 399 (1973).

For a recent work on settlements in litigation involving multiple, sequential plaintiffs, see Yeon Koo Che & Jong Goo Yi, Litigations with Multiple Plaintiffs: The Case of Effort Externality, Center for Economic Policy Research, Stanford University, Publication No. 200 (April 1990). This article focuses on the incentives to expend effort that would be useful to subsequent plaintiffs. Our article, instead, focuses on the non-cooperative game faced by multiple defendants in the face of a simultaneous offer of settlement.

In one chapter of his dissertation, Jong Goo Yi examines single plaintiff and a single defendant extends to the case of a single plaintiff facing multiple defendants under a rule of non-joint (several only) liability,[2] the analysis differs greatly when one considers a regime of joint and several liability. Most importanty, under broad sets of circumstances, joint and several liability discourages settlements.[3]

Section I sets forth a simple model in which the plaintiff's probabilities of success in litigating against two defendants are uncorrelated, and where the transaction costs of litigation are zero. It shows that, under joint and several liability, the plaintiff will always litigate against both defendants, whereas under non-joint (several only) liability, the plaintiff would be

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settlements in litigation with multiple defendants. Jong Goo Yi, Litigations with Multiple Defendants: How to Settle Under Different Apportionment Rules 73-96 (unpublished Ph.D. dissertation, Stanford University, February 1991). He focuses only on the case in which the plaintiff's probability of success against each of the defendants is perfectly correlated, and thus deals with only a very narrow slice of the problem examined in this article.

In a recent paper, Jeffrey Lange studies, in a multiple defendant context, possible contractual arrangements between a plaintiff and one or more defendants. Jeffrey Lange, Litigation Risk Exchange: An Economic Analysis of Sliding-Scale Settlements (manuscript). He appears to address only the case of perfectly correlated probabilities. See id. at 16.

[2]The one exception is non-joint liability constrained by a one-satisfaction rule. See text accompanying note 56 & Appendix, Proposition 4, infra.

[3]We examined the efficiency properties of joint and several liability and non-joint liability in Lewis A. Kornhauser & Richard L. Revesz, Sharing Damages Among Multiple Tortfeasors, 98 Yale L.J. 831 (1989) [hereinafter Kornhauser & Revesz, Sharing Damages], and in Lewis A. Kornhauser & Richard L. Revesz, Apportioning Damages Among Potentially Insolvent Actors, 19 J. Legal Stud. 617 (1990) [hereinafter Kornhauser & Revesz, Insolvency]. Neither article examined the problem of settlement.

indifferent between settling and litigating.

Section II extends this model to deal with partially (or totally) correlated probabilities of success in litigation and for positive transaction costs. The results, are presented in Section III, which shows that there is a range of transaction costs and of correlation of probabilities for which joint and several liability leads to litigation with both defendants. Under non-joint liability, in contrast, the defendants would settle whenever the transaction costs of litigation are positive. Section III also shows that the standard legal rules governing the responsibility of joint tortfeasors disproportionately burden the defendants with the smaller share of liability.

I. Analysis of Settlement Decisions Under Uncorrelated Probabilities and Zero Transaction Costs

A. The Basic Assumptions

We consider in this section a regime of joint and several liability with contribution in which a single plaintiff has a claim against two defendants, Row and Column. We assume that the parties are risk neutral and that the defendants are infinitely solvent.

If the plaintiff is successful in its litigation against both defendants, the damages are apportioned between Row and Column according to their relative shares of the liability. This rule is consistent with the approach of the Uniform Comparative

Fault Act (UCFA).[4] Technically, under joint and several liability, the plaintiff can recover its full damages from either of the defendants, and the defendant that must satisfy the judgment has the burden of bringing a contribution action against the other; the simplification that we make has no analytic consequence, at least when transaction costs are zero.

We assume that Row's share of the liability is r and Column's is (1-r). Without loss of generality, we may (1) assume $r \leq 1/2$ (Row is the smaller party) and (2) normalize the value of the successful claim to 1.

We assume that the probability that the plaintiff will prevail against each defendant is p, where $0 < p < 1$.[5] In this section, we assume that the plaintiff's probabilities of success are uncorrelated. Thus, for example, the plaintiff's probability of success against Column is p regardless of whether the plaintiff has prevailed against, lost to, or settled with, Row. We assume that all the parties know the value of p; thus, we do not address the problem of imperfect information.

The parties may either litigate ($\neg s$) or settle (s) the claim. Settlement negotiations have the following structure. The plaintiff makes settlement offers to the two defendants. Row and Column decide simultaneously whether to accept these offers.

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[4]See section 2.

[5]We assume that the plaintiff faces the same probability of success with respect to the two defendants. This assumption merely simplifies the analysis; it does not affect any of the results.

We assume that costs of coordinating their actions are sufficiently high that they act non-cooperatively.[6] The plaintiff then litigates against the non-settling parties, if any. We adopt the convention that, if a defendant is indifferent between settlement and litigation, it settles.

If only one defendant accepts the settlement offer, the value of the plaintiff's claim against the other defendant is reduced by the amount of the settlement (a pro tanto set-off rule). This rule is based on the Uniform Contribution Among Tortfeasors Act (UCATA);[7] in contrast the UCFA provides that the plaintiff's claim against a non-settling defendant is reduced by

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[6]Non-cooperative games are ones in which the parties are not able to coordinate their strategies through binding agreements. The analysis of a non-cooperative game requires that one state the strategies available to each player and, for every possible combination of chosen strategies, the payoff to each player. The solution to the game embodies a conception of rational action for the players--how each party best protects or promotes her interests given the strategic structure of the interaction. We shall identify the Nash equilibria of the settlement game, the standard solution concept in non-cooperative game theory.

Non-cooperative game theory can also be used to analyze contracts between non-cooperating parties. Such games, however, model contracts as a sequence of individual moves: at time t, one act available to party A is to make an offer; at time t+1, if party A has made an offer, one act available to party B is to accept the offer; at time t + 2, if party B has accepted an offer, one act available to party A is to perform her contract (and another act is not to perform); at time t + 3, in the event of non-performance, one act available to party B is to file a complaint; etc. This game will remain non-cooperative if the parties cannot make binding agreements to coordinate their strategies. A strategy is a complete plan of action for a player; i.e., a strategy plans an action for every contingency that the player may face.

[7]See section 4(a).

the settling defendant's proportional share of the liability;[8] we examine this rule in a separate article.[9] Thus, under our model, to the extent that the plaintiff settles with one party for less than this party's proportional share of liability, and then prevails in its litigation against the non-settling party, the latter will bear more than its apportioned share of liability.

Moreover, when a defendant settles, it obtains protection from contribution actions by non-settling parties. This rule is consistent with both the UCFA[10] and UCATA.[11] Thus, if a party settles for less than its proportional share of liability and the plaintiff litigates against the other party and recovers more than that party's proportional share of the liability, the settling party will nonetheless not be subject to a contribution action.

The set of rules modeled in this article is informed by the legal regime of the Comprehensive Environmental Response, Compensation, and Liability Act of (CERCLA), as amended by the Superfund Amendment and Reauthorization Act of 1986 (SARA).[12] CERCLA imposes joint and several liability on responsible parties

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[8]See section 6.

[9]See text accompanying notes 59-61, infra (discussing structure of subsequent article).

[10]See section 6.

[11]See Section 4(b).

[12]42 U.S.C. §9601 et seq.

(generators and transporters of hazardous wastes, and owners and certain prior owners of hazardous waste sites), but defendants held jointly and severally liable can bring actions for contribution against other responsible parties.[13] CERCLA provides for pro-tanto set-off in the event of partial settlements, and establishes that settling parties are protected from contribution actions.[14]

B. The Role of Joint and Several Liability in Discouraging Settlements

The simplest model of the choice between settlement and litigation considers a plaintiff and a single defendant with complete information of their respective strategic situations. Specifically, each party knows both her own and the other party's belief about her success at trial and the belief about the value of the litigation as well as the transaction costs faced by each.[15] In this model, if both parties are risk-neutral, have common beliefs about the prospect and value of success at trial,

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[13]42 U.S.C. §9613(f)(1).

[14]42 U.S.C. §9613(f)(2).

[15]This describes the models of Gould, Landes, and Posner cited in note 1, supra. In fact, none of the authors explicitly frames his analysis in game theoretic terms. Subsequent analyses of the settlement game between a single plaintiff and a single defendant have been framed explicitly in game-theoretic terms but consider much more complex strategic situations in which there is either asymmetric information or symmetric but incomplete (or imperfect) information. See, e.g., Lucian Bebchuck, Litigation and Settlement Under Imperfect Information, 15 Rand J. Econ. 404 (1984); Barry Nalebuff, Credible Pre-trial Negotiation, 18 Rand J. Econ. 198 (1987).

and face zero transaction costs, then each is indifferent between litigation and settlement for the expected value of the litigation. This model leads to the following conclusions: (1) parties that face positive transaction costs (but are risk-neutral and have common beliefs) will settle and divide the "surplus" of avoided costs of litigation; (2) parties that are risk averse (but face no transaction costs and share common beliefs) will settle to avoid the risk of litigation; and (3) risk-neutral parties that face zero transaction costs will settle when at least one has pessimistic beliefs about the prospects or value of success at trial and none has optimistic beliefs.[16]

In this section, we demonstrate that, when a plaintiff faces multiple defendants subject to a rule of joint and several liability, and the probability of prevailing against each defendant is independent of the probability of prevailing against the other (uncorrelated probabilities), the structure of choice between settlement and litigation differs in important ways from the simple one-defendant model. As indicated in the preceding

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[16]A plaintiff has pessimistic beliefs when it believes that its own prospects of success are less than its true prospects of success while a defendant has pessimistic beliefs when it believes that the plaintiff's prospects of success are greater than plaintiff's true prospects of success.

There is an alternative definition of pessimism and optimism, which does not depend on a comparison to the objective probabilities of success, but instead relies on the relative assessments of the parties. The beliefs of the parties are pessimistic when a plaintiff believes that her probability of success is lower than the defendant's belief of the plaintiff's probability of success. Conversely, the beliefs of the parties are optimistic when a plaintiff believes that her probability of success is higher than the defendant's belief of the plaintiff's probability of success.

section, our discussion focuses on the case of zero transaction costs, uncorrelated probabilities of success for the plaintiff, risk-neutrality of all parties, and common beliefs in the prospects and value of success at trial. Under these circumstances, we show that settlement will never occur. The plaintiff will strictly prefer to litigate against both defendants rather than offer terms acceptable to one or both defendants. Because this preference is strict and smooth, there will be no settlement either when transaction costs are small, probabilities of success slightly correlated, parties marginally risk-averse, or beliefs slightly pessimistic.

Joint and several liability improves the plaintiff's prospects of recovery; it needs to prevail against only one of the defendants to recover fully. If the plaintiff faces only one defendant, its expected recovery from litigation is simply the probability of prevailing times the recovery in the event that it prevails: under the notation of our model (with damages normalized to 1), the expected recovery is simply p. Similarly, if liability were non-joint, the plaintiff's expected recovery from Row would be rp and from Column $(1-r)p$ for the identical total expected recovery of p.

Under joint and several liability, in contrast, if the plaintiff litigates against both defendants, it recovers its full damages, under three different scenarios: with probability p^2 if it prevails against both defendants; with probability $p(1-p)$ if it prevails only against Row; and, similarly, with probability

$p(1-p)$ if it prevails only against Column. Let $V(\neg s,\neg s)$ be the expected value of the litigation; then

$$V(\neg s,\neg s) = [p^2 + 2p(1-p)] = p(2-p) = V$$

This expected value is higher than the expected value of litigation in the one-actor problem for any p, such that $0 < p < 1$. The surplus that the plaintiff obtains in the two-actor problem as a result of the operation of joint and several liability is given by

$$p(2-p) - p = p(1-p)$$

Any settlement must be acceptable to the plaintiff and to any other settling party. A settlement will be acceptable to the plaintiff if and only if its expected return from the settlement and any attendant litigation at least equals its expected return from litigation against both defendants. We must show that there is no settlement with both defendants of the form $(S,V-S)$, in which Row pays S and Column pays $(V-S)$, and no settlement with one defendant and litigation with the other that is acceptable to the plaintiff.

First, in equilibrium, there is no settlement with both defendants of the form $(S,V-S)$. Suppose one party, say Row, settles for the amount S. There are two possibilities: $S < p$ and $S \geq p$. We consider these in turn.

Suppose first that $S < p$. Column would then have to choose between litigation and settlement for the amount $(V-S)$. But Column would always prefer to litigate than to accept this offer because, conditional on Row's having settled, Column has an expected loss of only p(1-S) which is always less than the settlement offer (V-S) = p(2-p) - S. Put differently, the plaintiff would never make a pair of offers (S,V-S) where $S < p$ because it knows that at most one party would accept the settlement and its expected recovery from the settlement with one party and the litigation with the other would be less than $\underline{V}$, its expected recovery from litigation against both parties.

Now suppose that $S \geq p$. Column now prefers to settle rather than litigate conditional on Row's settling. For (S,V-S) to be an equilibrium, however, requires that, conditional on Column deciding to settle, Row must also prefer to settle. By an argument analogous to that about Column we see that Row will prefer to litigate (conditional on Column settling for (V-S)) rather than settle for the amount $\underline{S}$ if and only if Row's expected cost from litigation $p[1 - (V-S)] < S$, its cost of settlement. But this condition holds whenever $S > p(1-p)$, which is true by assumption. Consequently, the plaintiff knows that any pair of offers (S,V-S) will induce only one party to settle and that its own expected recovery from the settling party and the litigating party will be less than $\underline{V}$, the amount it can expect to recover if it litigates against both.[17]

The preceding argument, moreover, indicates why the plaintiff will not settle with one party and litigate with the other. We now know that the plaintiff must litigate against at least one party. From the litigating party, the plaintiff

[17]This argument is independent of the size of $\underline{r}$.

expects a recovery of $p(1 - S)$, where $\underline{S}$ is the settlement received from the settling party. Now this settlement $\underline{S}$ must be acceptable both to the plaintiff and to the settling party. To be acceptable to the settling party, say Row, $\underline{S}$ must be less than or equal to the expected value of Row litigating (conditional on Column litigating), or

$$S \leq p[pr + (1-p)] = S_R$$

That is, Row will lose the litigation with probability $\underline{p}$; if it loses, with probability $\underline{p}$, Column will also lose and Row will pay its share of $\underline{r}$, but with probability $(1-p)$, Column will prevail and Row will pay the full damages of 1.

In turn, for $\underline{S}$ to be acceptable to the plaintiff it must be the case that

$$S + p(1 - S) \geq p(2-p)$$

Thus,

$$S \geq p = S_P$$

But, because $S_R < S_P$, there is no settlement amount $\underline{S}$ that will be mutually acceptable to the plaintiff and to Row.

The situation is no different if the plaintiff seeks to induce Row to litigate and Column to settle. In this case Column will accept an offer S only if

$$S \leq p[p(1-r) + (1-p)] = S_C$$

Again, $S_C < S_P$. Thus, in this case, there is no settlement amount $\underline{S}$ that is mutually acceptable to the plaintiff and to Column.

The argument for why the plaintiff will not settle with either defendant also explains that, if, for some reason, the plaintiff were to make settlement offers to the defendants, the offers would be of the form (S_1, S_2), where $S_1 > S_R$, and $S_2 > S_C$. If it were to make a lower settlement offer to one of the defendants, that defendant would accept the offer and the plaintiff's total recovery (the settlement plus the expected value of the litigation against the other defendant) would be less than $\underline{V}$, the value of litigating against both defendants. This result would follow even if the two settlement offers added to more than $\underline{V}$.[18] As shown above, when the plaintiff makes settlement offers of the form (S_1, S_2), the defendants will reject them. Thus, there is little reason for the plaintiff even to make settlement offers, because any settlements that would be advantageous to it will be rejected by both defendants, and any settlements that would be accepted by at least one of the defendants would be less desirable for the plaintiff than litigating against both defendants.

The intuition behind the result that the plaintiff will not settle with either defendant is relatively straightforward. It stems both from the surplus generated by joint and several liability, and from the set-off that a non-settling party receives when the plaintiff settles with the other party. As a result of the surplus, the plaintiff will not accept from one party a settlement that is too low, even if it chooses to

[18]Note, moreover, that $S_1 + S_2 > S_R + S_C = V$. Thus, the total amount of the settlement offers that the plaintiff would make is larger than $\underline{V}$.

litigate against the other party. In the extreme case in which the plaintiff settled with one party for zero (or an infinitesimally small amount), it would lose the full benefit that it derives from litigating with two parties under a rule of joint and several liability, and would face the same expected payoff as in the one-defendant problem.

Any settlement with, for example, Row that is sufficiently attractive for the plaintiff to accept confers two types of benefits on Column. First, it reduces the amount that Column has at risk in the litigation because the plaintiff's potential recovery will be set off by the settlement amount. As a consequence, litigation becomes a less forbidding option. Concomitantly, Column will be willing to pay less in any settlement because the threat of bearing the entire liability has been eliminated. As a result of this externality, each defendant will be willing to settle only for amounts that sum to less than the plaintiff can expect through litigation against both.[19] A defendant cannot capture the full benefit of a settlement offer

[19]The benefit that accrues to the non-settling party can be defined more formally. Column's expected cost of litigation given that Row litigates is $p[p(1-r) + (1-p)]$. Column's expected cost of litigation given that Row settles is $p(1-S)$. Column will get a benefit from Row's decision to settle if

$$p(1-S) < p[p(1-r) + (1-p)]$$

This relationship will hold for

$$S > pr = S_N$$

But S_N is the amount that the plaintiff would recover in a settlement with Row under non-joint liability, and not, surprisingly, is less than the minimum settlement S_P that the plaintiff would be willing to accept under joint and several liability. For any settlement by Row for an amount higher than S_N, Column receives an external benefit from the settlement.

that is acceptable to the plaintiff, because part of that benefit will accrue to the other defendant.

The externality explains not only why both defendants do not settle but also why one defendant does not settle. Given, for example, that Column litigates, Row would have to pay in settlement an amount that is greater than Row's expected value of litigation. The additional amount is the benefit conferred on Column as a result of the settlement.

It is important to stress the generality of our result. It does not depend on the pro tanto set-off rule used to reduce the claim against the non-settling party in the event of a settlement with the other party. The structure of our argument is identical under an apportioned setoff rule, under which the claim against the non-settling party is reduced not by the amount of the settlement, but by the settling party's apportioned share of the liability.[20] In fact, from the plaintiff's perspective, settlements are relatively less desirable under the apportioned setoff rule because the plaintiff does not always recover the full value of its claim when it settles with one party and prevails in litigation with the other; it is not fully compensated when it settles with one party for less than that

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[20]The result does not extend, however, to a legal regime under which there is no set-off whatsoever. Under such conditions, the plaintiff can induce both parties to settle. In fact the plaintiff would be able to extract in settlement, from each defendant p. Its total recovery is $2p > V(\neg s,\neg s) = p(2-p)$.

party's apportioned share.[21]

The result is also independent of our assumption that the plaintiff moves first and makes a take-it-or-leave-it offer--an assumption that plays a more prominent role in the subsquent sections. If the defendants made take-it-or-leave offers, the plaintiff would simply reject them, because its expected payoff from litigating is higher than what it could obtain in settlement.

The argument also extends to situations with more than two defendants because the surplus produced by joint and several

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[21]The argument in the text assumes that the plaintiff's claim against the non-settling party is reduced by the greater of (1) the settlement, and (2) the settling party's apportioned share.

If, instead, the legal regime reduces the plaintiff's claim simply by the defendant's apportioned share, it allows the possibility that, for sufficiently high transaction costs, the plaintiff will recover more than its damages: this will occur whenever the settlement is greater than the settling defendant's apportioned share. But even under this rule, the plaintiff will not settle with both defendants when the transaction costs are zero. The maximum amount that Row will settle for given that Column settles is pr. Similarly, the maximum amount that Column will settle for given that Row settles is p(1-r). The plaintiff's total recovery is p, which is less than the expected value of litigating with both defendants.

Neither will the plaintiff settle with only one defendant. Recall from the text that given that Column chooses to litigate, the maximum settlement that Row would accept is S_R. The plaintiff will prefer to settle with Row rather than litigate against both defendants if and only if

$$S_R + p(1-r) \geq p(2-p)$$

Substituting for S_R, one shows that this condition never holds. A similar argument establishes that the plaintiff would prefer to litigate with both defendants rather than settle only with Column.

For discussion of the different versions of apportioned set-off rules, see note 60, <u>infra</u>.

liability increases with increasing numbers of defendants.[22] Thus, the settlement of one party provides an analagous (though diminishing) external benefit on all non-settling parties.[23]

As we noted at the outset, these results differ from those of the simple one-defendant model, where, in the absence of transaction costs, if the plaintiff and defendant are risk-neutral and have the same estimate of the probability that the plaintiff will prevail, the parties will be indifferent between settling and litigating. The same is true for multiple parties under a rule of non-joint liability, because, as we have already discussed, the parties face the single-defendant problem. In contrast, multiple defendants acting non-cooperatively under joint and several liability will not settle in the absence of transaction costs, even if they are risk neutral and they, as

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[22]This occurs because the probability of prevailing against at least one defendant when there are three defendants is larger than the probability of prevailing against at least one defendant when there are two defendants. Formally $[1 - (1-p)^3] - [1 - (1-p)^2] = p(1-p)^2 > 0$ for $0 < p < 1$. In general, $[1 - (1-p)^n] - [1 - (1-p)^{n-1}] = p(1-p)^{n-1} > 0$ for $0 < p < 1$.

[23]The results derived in this section do depend critically on two assumptions. First, the defendants must act non-cooperatively, that is, they must be unable to negotiate as a single unit with the plaintiff. If they acted cooperatively, even in the absence of transaction costs, they could agree to offer the plaintiff an aggregate amount equal to $\underline{V}$, the expected value for the plaintiff of litigation with both parties. We have assumed throughout that the costs of coordinating their actions are sufficiently high that the defendants act non-cooperatively. In Superfund cases, defendants often fail to agree on the allocation of their joint liability, even in the face of staggering transaction costs.

Second, we have assumed that the plaintiff faces an independent probability of prevailing against each defendant. We deal in the next section with the situation in which the probabilities are correlated.

well as the plaintiff, have the same estimate of the probability that the plaintiff will prevail.

The result that joint and several liability discourages settlements is not peculiar to the situation of zero transaction costs. For positive transaction costs, the traditional model of settlement predicts that a single defendant, or multiple defendants under non-joint liability, will always settle, provided that the parties are not risk-preferring and that they have the same estimate of the probability that the plaintiff will prevail.[24] As we show in the following sections, there is a range of transaction costs for which such parties will not settle. Similarly, we show that joint and several liability discourages settlements even if the plaintiff's probabilities of success against the defendants are somewhat correlated.

In the congressional debates surrounding the enactment of Superfund, the supporters of joint and several liability argued, contrary to the conclusion that we reach here, that this rule would promote settlements because of its tough treatment of defendants who choose to litigate.[25] We believe that this

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[24]More sophisticated models explain that, even under these conditions, settlements might not take place because of strategic behavior of the parties, as they each try to capture the bulk of the surplus that results from settlement.

[25]The Admistration argued vigorously that joint and several liability would promote settlements. See, e.g., Superfund Reauthorization: Judicial and Legal Issues, Oversight Hearings Before the Subcommittee on Administrative Law and Government Relations, Committee on the Judiciary, House of Representatives, 99th Cong., 1st Sess., July 17-18, 1985, at 5-6 (statement of Lee Thomas, Administator of EPA), id. at 45 (statement of F. Henry Habicht, II, Assistant Attorney General, Land and Natural

perception is commonly shared in the legal literature.[26]

The view that joint and several liability promotes settlements stems from a fallacy similar to, though analytically distinct from, that discussed by Professor Geoffrey Miller in his article on Federal Rule of Civil Procedure 68.[27] Rule 68 provides that a plaintiff who refuses a defendant's settlement offer and then obtains a judgment not more favorable than the offer must pay the defendant's post-offer costs.

The belief with respect to Rule 68 was that it encouraged settlements by penalizing plaintiffs who reject reasonable offers. It is obvious that there is a range of offers that a plaintiff will accept as a result of Rule 68 that it would not accept in the absence of this rule. Professor Miller showed, however, that the rule affects not only the behavior of plaintiffs but also that of defendants: it reduces the amount that a defendant will offer. Thus, the primary effect of Rule 68

Resources Division); Superfund Improvement Act of 1985, Hearings Before the Committee on the Judiciary on S. 51, United States Senate, 99th Cong., 1st Sess., June 7, 10, 1985, at 18, 22 (statement of Lee Thomas)

[26]See, e.g., Gina M. Birmingham & William D. Wilcox, A Comparison of the Superfund and Rhode Island's Hazardous Waste Legislation, 23 Suffolk U.L. Rev. 345, 385 (1989); Edward D. Cavanagh, Contribution, Claim Reduction, and Individual Treble Damage Responsibility: Which Path to Reform of Antitrust Remedies?, 40 Vand. L. Rev. 1277, 1298 (1987). Judges appear to share this view. See, e.g., United States. v. Rohm & Haas Co., 721 F.Supp. 666, 689 n. 25 (D.N.J. 1989); In re Washington Public Power Supply System Securities Litigation, 720 F.Supp. 1379, 1409 (D. Ariz. 1989), aff'd, 955 F.2d 1268 (9th Cir. 1992).

[27]Geoffrey P. Miller, An Economic Analysis of Rule 68, 15 J. Legal Stud. 93 (1986).

is to shift downward the relevant settlement range. Its effect on settlements, however, is ambiguous.

Here, joint and several liability has the effect of shifting upward the settlement range by creating a surplus for plaintiffs. As in the case of Rule 68, it appears that judges and commentators mistakenly believe that a legal rule that is unfavorable to one party will make that party more willing to accept a settlement, not realizing that such a rule also has the effect of inducing the other party to demand more.[28]

Our discussion of joint and several liability also illustrates an independent effect, not present in the Rule 68 context. As a result of the positive externality that result when one party defendant settles, joint and several liability has the unambiguous consequence of making settlements less likely.

C. Treatment of the Party with the Smaller Share of Liability

It is worth devoting some attention to the impact of the apportionment rule on the party with the smaller share of liability.

Probably the strongest reason for the adoption of UCFA was

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[28]See, e.g., United States v. Rohm & Haas Co., 721 F. Supp. 666, 689 n. 25 (D.N.J. 1989) ("Undoubtedly, the tremendous transactions costs and the possibility of joint and several liability for all response costs at a site which accompany litigating a CERCLA action through the liability stage already create a large settlement incentive for PRPs."); Cavanagh, supra note 26, at 1298 ("the very nature of joint and several liability makes potential damage exposure unpredictable; and where exposure is large, a rule of joint and several liability pushes defendants toward settlement").

the acceptance of the principle of comparative fault in contribution actions. The UCFA provides that "the basis for contribution is each person's equitable share of the obligation ...,"[29] and represents a sharp departure from the UCATA, which provided for pro rata shares in contribution actions.[30] But while the plaintiff's damages are allocated proportionately to fault in the event that both defendants lose the litigation, the party with the smaller share of the fault bears a disproportionate amount of the expected cost of litigation.

Indeed, the proportion of the total expected cost that is borne by Row, $P(r)$, is given by

$$P(r) = p[pr + (1-p)]/p(2-p) = [pr + (1-p)]/(2-p)$$

Row's proportional share of the liability is, instead, r. It is easy to see that $P(r) > r$ for $r < 1/2$ and that $P(r) = r$ only for $r = 1/2$. Most strikingly, even when r is infinitesimally small, Row faces the proportion $(1-p)/(2-p)$ of the expected liability. The reason is that both defendants, independent of their relative share, face the same component of the liability $p(1-p)$, which reflects the fact that a defendant that loses must pay the plaintiff's full damages if the other prevails.

Figure I depicts $P(r)$ as a function of r; the broken line shows Row's proportional share. The vertical lines show, for each r, the amount by which Row's share of the expected liability exceeds its proportional share.

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[29]Section 4(a).

[30]See section 2.

In Section III, we discuss in more detail the unfairness of the apportionment rule from the perspective of the party with the smaller share of liability.

II. A Model with Positive Transaction Costs and Correlated Probabilities

A. The Basic Assumptions

We now consider the situation in which the plaintiff's probabilities of success against the defendants are positively correlated and in which the costs of litigation are positive. The game has the same structure as in Section I--the plaintiff makes settlement offers to the two defendants; Row and Column, acting non-cooperatively, decide whether to accept these offers, and the plaintiff then litigates against the non-settling parties, if any.[31] Similarly, we model the same legal rules concerning contribution and settoffs.

Suppose that the probability that the plaintiff prevails in litigation against a single party is p (regardless of whether Row or Column is the defendant). Let δp^2 be the probability that the plaintiff prevails against both parties where δ is in the closed interval $[0,1/p]$. The complete joint probability distribution is then:

$$\Pr[\text{R loses and C loses}] = \delta p^2$$

[31]We assume, initially, that the transaction costs are such that the plaintiff will, in fact, litigate against any non-settling defendants. We present a detailed examination of this question in Section III(E), infra.

$\Pr[R \text{ wins and } C \text{ loses}] = p(1-\delta p)$

$\Pr[R \text{ loses and } C \text{ wins}] = p(1-\delta p)$

$\Pr[R \text{ wins and } C \text{ wins}] = 1 - 2p + \delta p^2$

Thus, $\delta = 1/p$ implies perfect (positive) correlation of the outcome of litigation: the plaintiff either wins against both defendants or loses against both defendants; it cannot prevail against one and lose against the other. In turn, $\delta = 1$ implies independence--the condition considered in the prior section. Finally, $\delta = 0$ implies perfect negative correlation; the plaintiff always prevails against one, but only one, defendant.[32] It follows that in the range $[0,1)$, the correlation is negative whereas in the range $(1,1/p]$, the correlation is positive. We focus on the latter range.

With respect to the costs of litigation, we assume that each defendant faces a litigation cost of $\underline{t}$, where $t \geq 0$; this cost is independent of the other defendant's decision whether or not to settle. We assume initially that $t < 1$--that is, each party's transaction costs are smaller than the plaintiff's total claim against both defendants. Note that, to violate this condition, transaction costs woud have to be inordinately high. Nonetheless, we relax the assumption and explore its consequences in Section III(E).

The plaintiff's litigation cost is a function of the number of non-settling parties: it is $\underline{t}$ if only one defendant declines

[32]Note that $\delta = 0$ and the symmetry (with respect to litigation prospects) of Row and Column implies that $p = 1/2$.

the offer of settlement,[33] and ut if both defendants decline the offer, where $1 \leq u$. This assumption excludes the possibility that the total cost of litigation against two parties is less than the cost of litigation against one. When $u < 2$, the plaintiff faces economies of scale in litigation; its total cost of litigation against both parties is less than the cost of litigating against each separately. When $u > 2$, the plaintiff faces diseconomies of scale--perhaps a less plausible condition.

In Section II(B), we solve the defendants' settlement game conditional on the plaintiff making a pair of offers. In Section II(C), we determine the plaintiff's optimal settlement offers.

B. The Defendants' Settlement Game

Consider a pair of settlement offers (σ_R, σ_C). One party, say Row, will accept σ_R conditional on Column accepting σ_C if and only if

$$(1) \qquad \sigma_R \leq p(1-\sigma_C) + t \qquad \text{for } \sigma_C < 1$$
$$= 0 \qquad \text{for } \sigma_C \geq 1$$

The right-hand side of the top expression in (1) is the cost to Row of litigating given that Column settles for σ_C: Row faces a probability p of losing the litigation and, if it loses, it must pay the total damages of 1 reduced by Column's settlement of σ_C; in addition, it must bear its litigation costs t. Row will

[33]We thus assume that when the plaintiff litigates against only one party, its litigation costs equal those of the defendant. A different assumption merely complicates the algebra.

accept a settlement offer that is no more than its cost of litigation.

If the plaintiff's settlement with Column is for 1 or more, the plaintiff could not recover any further damages from litigation with Row. It is true that, were the plaintiff to sue, the defendant would have to expend $\underline{t}$ in transaction costs. We assume, however, that in the case of frivolous litigation, the defendant could recover its transaction costs through a sanction mechanism such as that provided in federal courts by Rule 11 of the Federal Rules of Civil Procedure.

Similarly, Column will accept σ_C conditional on Row accepting σ_R if and only if

$$(2) \qquad \sigma_C \le p(1-\sigma_R) + t \qquad \text{for } \sigma_C < 1$$
$$= 0 \qquad \text{for } \sigma_C \ge 1$$

Conversely, Row will settle for σ_R conditional on Column's litigating if and only if

$$(3) \qquad \sigma_R \le rp^2\delta + p(1-\delta p) + t$$

Here, the right-hand side is the cost to Row of litigating given that Column litigates: with probability $p^2\delta$ both defendants lose the litigation and Row must pay its share $\underline{r}$ of the total damages of 1; with probability $p(1-\delta p)$ Row loses but Column prevails and therefore Row must pay the total damages of 1; in addition, Row must bear its litigation costs $\underline{t}$. Row will accept a settlement offer that is no more than its cost of litigation. Similarly, Column will settle for σ_C conditional on Row litigating if and only if

(4) $$\sigma_C \leq (1-r)p^2\delta + p(1-\delta p) + t$$

Setting (3) and (4) as equalities, we define the largest settlement $S_i(\delta,t)$ that party i will accept conditional on the other party litigating:

(5) $$S_R(\delta,t) = rp^2\delta + p(1-\delta p) + t = p + t - \delta p^2(1-r)$$

(6) $$S_C(\delta,t) = (1-r)p^2\delta + p(1-\delta p) + t = p + t - \delta p^2 r$$

Note that $S_i(\delta,t)$ is also party i's expected cost of litigation conditional on the other party's litigating. Given our assumption that if a defendant is indifferent between settlement and litigation, an offer of $S_i(\delta,t)$ will induce party i to settle, conditional on party j litigating.

It is useful to substitute (5) and (6) into (1) and (2) to define $\Theta_i(\delta,t)$ as i's expected loss from litigation conditional on j's settling for $S_j(\delta,t)$. We therefore have:

(7) $$\Theta_R(\delta,t) = p[1-S_C(\delta,t)] + t = (p+t)(1-p) + \delta p^3 r \quad \text{for } S_C < 1$$
$$= 0 \quad \text{for } S_C \geq 1$$

(8) $$\Theta_C(\delta,t) = p[1-S_R(\delta,t)] + t = (p+t)(1-p) + \delta p^3(1-r) \quad \text{for } S_R < 1$$
$$= 0 \quad \text{for } S_R \geq 1$$

Equations (1), (2), (5), and (6) define the regions of (σ_R,σ_C)-space in which (s,s), (s,¬s), (¬s,s), and (¬s,¬s) are equilibria.[34] Depending on the various parameters δ, p, r, u,

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[34]Call these $O_{\delta,t}(s,s)$, $O_{\delta,t}(s,\neg s)$, $O_{\delta,t}(\neg s,\neg s)$, and $O_{\delta,t}(\neg s,\neg s)$, respectively. Then,

$$O_{\delta,t}(s,s) = (\sigma_R,\sigma_C) \mid \quad \sigma_R \leq p(1-\sigma_C)+t \text{ for } \sigma_C < 1$$
$$= 0 \quad \text{for } \sigma_C \geq 1$$
$$\text{and } \sigma_C \leq p(1-\sigma_R)+t \text{ for } \sigma_R < 1$$

and $\underline{t}$, there is either a region in which both (s,¬s) and (¬s,s) are equilibria, or a region in which both (s,s) and (¬s,¬s) are equilibria.[35] In the latter case, the intersection of the lines $\sigma_R = p[1-\sigma_C] + t$, and $\sigma_C = p[1-\sigma_R] + t$, which occurs at $[(p+t)/(1+p), (p+t)/(1+p)]$, a point that we denote as $\underline{A}$, can either be outside or inside the region of multiple equilibria. These alternatives are depicted in Figures II-IV.[36]

In the three figures, the diagonal shading of positive slope indicates the region of (s,s) equilibrium,[37] the diagonal

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$= 0 \qquad \text{for } \sigma_R \geq 1$

$O_{\delta,t}(s,\neg s) = (\sigma_R,\sigma_C) \mid \sigma_R \leq S_R(\delta,t) \text{ and } \sigma_C > p(1-\sigma_R)+t$

$O_{\delta,t}(\neg s,s) = (\sigma_R,\sigma_C) \mid \sigma_R > p(1-\sigma_C)+t \text{ and } \sigma_C \leq S_C(\delta,t)$

$O_{\delta,t}(\neg s,\neg s) = (\sigma_R,\sigma_C) \mid \sigma_R > S_R(\delta,t) \text{ and } \sigma_C > S_C(\delta,t)$

[35]See Appendix, Lemma 3, corollary 4.

[36]The figures are drawn for $S_C < 1 < p + t$.

There are also regions in which there is no equilibrium in pure strategies. One region is defined by $\sigma_R > S_R$, $1 + t/p - \sigma_C/p < \sigma_R \leq p(1-\sigma_C) + t$, and $\sigma_C \leq S_C$. Given that $\sigma_C > p(1-\sigma_R) + t$, (s,s) is not an equilibrium in pure strategies. Given that $\sigma_C \leq S_C$, (¬s,¬s) is not an equilibrium in pure strategies. Given that $\sigma_R > S_R$, (s,¬s) is not an equilibrium in pure strategies. Finally, given that $\sigma_R \leq p(1-\sigma_C) + t$, (¬s,s) is not an equilibrium in pure strategies. The conditions for the existence of this region are $S_R < (p+t)/(1+p)$ and $S_C > (p+t)/(1+p)$. The region is illustrated in Figure II.

Another region is defined by $1 \leq \sigma_R \leq p(1-\sigma_C) + t$ and $\sigma_C > 0$. (A similar region exists for σ_C.) Given that $\sigma_R \geq 1$ and $\sigma_C > 0$, (s,s) is not an equilibrium in pure strategies. Given that $\sigma_C \leq S_C$, (¬s,¬s) is not an equilibrium in pure strategies. Given that $\sigma_R > S_R$, (s,¬s) is not an equilibrium in pure strategies. Finally, given that $\sigma_R \leq p(1-\sigma_C) + t$, (¬s,s) is not an equilibrium in pure strategies.

[37]Note that the (s,s) region includes the segments $(0, 1 \leq \sigma_C \leq p+t)$ and $(1 \leq \sigma_R \leq p+t, 0)$. These segments are indicated with a thick line in Figures II-IV.

shading of negative slope indicates the region of $(\neg s, \neg s)$ equilibrium, the horizontal shading indicates the region of $(s, \neg s)$ equilibrium and the vertical shading indicates the region of $(\neg s, s)$ equilibrium. As explained below, the existence of multiple equilibria can have an effect on the plaintiff's optimal strategy, so it is important to define these regions with precision.

Table I indicates, for $\delta = 1$ (uncorrelated probabilities) and $\delta = 1/p$ (perfectly correlated probabilities), the range of transaction costs for which the various multiple equilibria exist. Formal proofs are presented in Lemmata 1-3.

Table I: Regions of Multiple Equilibria

	A ϵ Region of (s,s) & $(\neg s, \neg s)$ Equilibria	Region of (s,s) & $(\neg s, \neg s)$ Equilibria	Region of $(s, \neg s)$ & $(\neg s, s)$ Equilibria
$\delta = 1$	Never	Empty	$t \geq 0$
$\delta = 1/p$ $r \leq p/(1+p)$	Never	$t < r(1-p)$	$t \geq r(1-p)$
$\delta = 1/p$ $r > p/(1+p)$	$t < r-(1-r)p$	$t < r(1-p)$	$t \geq r(1-p)$

Thus, for $\delta = 1$ there are never multiple (s,s) and $(\neg s, \neg s)$ equilibria, but there are multiple $(s, \neg s)$ and $(\neg s, s)$ equilibria for the all _t_. In the case of $\delta = 1/p$, there are multiple (s,s) and $(\neg s, \neg s)$ equilibria for sufficiently low _t_ and multiple $(s, \neg s)$ and $(\neg s, s)$ equilibria for sufficiently large _t_; Point _A_ is never inside the region of multiple (s,s) and $(\neg s, \neg s)$ equilibria if _r_ is sufficiently small, and for larger _r_ is inside this region only if $\underline{t}$ is sufficiently small.

C. <u>The Plaintiff's Strategy</u>

We now seek to identify the plaintiff's optimal offers as a function of $\underline{\delta}$, $\underline{p}$, $\underline{r}$, $\underline{u}$, and $\underline{t}$. As a first step, we calculate the plaintiff's maximal return (and hence its optimal offers) conditional on the equilibrium induced. Of these four values, plaintiff's expected value $V_{\delta,t}(\neg s,\neg s)$ of litigation against both parties is easiest to determine because it is independent of the offers plaintiff makes as long as those offers induce both parties to litigate. It is given by

$$V_{\delta,t}(\neg s,\neg s) = p(2-\delta p) - ut \tag{9}$$

We assume for this part of the discussion that $V(\neg s,\neg s) \geq 0$. In Section III(E), we explain the implications of this assumption.

In each of the other three equilibria, the plaintiff's return varies with its offers. If the plaintiff settles with only one party, its recovery is given by

$$S + p(1 - S) - t,$$

where $\underline{S}$ is the amount received from the settling party. This expression is maximized when the plaintiff maximizes the settlement received. It then follows from (5)-(8) that if the plaintiff settles with Row and litigates with Column, it will obtain S_R from Row, $(\theta_C - t)$ from Column and expend $\underline{t}$ in litigation costs. That is,

$$\begin{aligned} V_{\delta,t}(s,\neg s) &= S_R(\delta,t) + \theta_C(\delta,t) - 2t \\ &= p - t + (1 - p)S_R \end{aligned} \tag{10}$$

Similarly,

$$(11) \qquad V_{\delta,t}(\neg s,s) = S_C(\delta,t) + \Theta_R(\delta,t) - 2t$$
$$= p - t + (1 - p)S_C{}^{38}$$

Recall the assumption that $r \leq 1/2$, that is, that Row is the smaller party. It then follows from (5) and (6) that $S_R \leq S_C$, and, in turn, from (10) and (11) that, conditional on settling with only one defendant, the plaintiff would always prefer to settle with Column than with Row. As a consequence, to determine plaintiff's optimal strategy we need not consider the $(s,\neg s)$ equilibrium, as it is dominated by the $(\neg s,s)$ equilibrium.

To calculate plaintiff's maximal return from settling with both defendant we must determine which settlement maximizes its return $(\sigma_R + \sigma_C)$. Consider Figures II-IV. The optimal settlement must be on the boundary of the (s,s) region. On that boundary, as σ_R increases from 0 to $(p+t)/(1+p)$, an increase of one unit in the settlement demanded of Row leads to a decrease of only p units (by definition an amount smaller than one) in the settlement that can be extracted from Column. Beyond $(p+t)/(1+p)$, an increase in one unit in the settlement demanded

[38]To be precise, this expression should be written (and (10) should be modified accordingly) as

$$V_{\delta,t}(\neg s,s) = \text{Max}\{S_C(\delta,t),\ S_C(\delta,t) + \Theta_R(\delta,t) - 2t\}$$

Indeed, if the plaintiff receives a settlement S_C from Column, it will proceed with litigation against Row only if the expected value of such litigation is positive, that is, if $\Theta_R - 2t > 0$.

Figures II-IV show that $(0, S_C)$ is within the zone of (s,s) equilibrium. We show below that, for this equilibrium, the plaintiff's recovery is maximized elsewhere. Thus, $V(\neg s,s) = S_C$ is always dominated by $V(s,s)$. Since we are interested only in the range in which $V(\neg s,s)$ is the plaintiff's preferred strategy, we can simplify the expressions as we did in (10) and (11).

of Row leads to a decrease of 1/p units (an amount larger than one) in the settlement that can be extracted from Column. Thus, conditional on settling with both defendants, the plaintiff's optimal pair of offers is $[(p+t)/(1+p), (p+t)/(1+p)]$. Thus,

$$V_{\delta,t}(s,s) = 2(p+t)/(1+p) \tag{12}$$

We can now compare the values to the plaintiff of the $(\neg s,\neg s)$, $(\neg s,s)$ and (s,s) equilibria. The plaintiff will prefer to settle with both defendants rather than to settle only with Column if and only if (12) ≥ (11) which, after rearrangment, holds if and only if

$$t \geq p^2\{(1-p)[1-\delta r(1+p)]\}/[2+p(1+p)] \tag{13}$$

Let us now compare the value to the plaintiff of settling with both parties to litigating against both parties. Again, the plaintiff will prefer to settle with both if and only if (12) ≥ (9), which, after rearrangement, holds if and only if

$$t \geq p^2[2-\delta(1+p)]/[2+u(1+p)] \tag{14}$$

Finally, we compare the value to plaintiff of litigating against Row and settling with Column to the value of litigating against both parties. The plaintiff will prefer to litigate against Row and settle with Column if and only if (11) ≥ (9), which, after rearrangement, holds if and only if

$$t \geq p^2\{1-\delta[1-r(1-p)\}/(u-p) \tag{15}$$

Before determining the plaintiff's optimal strategy, we need to consider with the complication caused by the existence of regions of multiple equilibria. In these regions, the plaintiff may prefer one equilibrium over the other, but, in response to a given pair of offers, the defendants might pick the other equilibrium. This possibility, if it exists, would lead the plaintiff to reassess its strategy.

Multiple equilibria do not complicate the plaintiff's strategy in two of the three scenarios set forth in Table I. In the region of multiple (s,¬s) and (¬s,s) equilibria (Figure II) we have already indicated that the plaintiff prefers the (¬s,s) equilibrium. The plaintiff need not worry that its pair of offers will yield, instead the (s,¬s) equilibrium. As long as it offers to Row is greater than S_R (and its offer to Column is S_C), it will achieve its desired objective of litigating with Row and settling with Column.

Similarly, in the region of multiple (s,s) and (¬s,¬s) equilibria, where A is outside the region of multiple equilibria, (Figure III) if the plaintiff prefers to settle with both defendants it will make offers of [(p+t)/(1+p), (p+t)/(1+p)] and will obtain the settlements. If it prefers to litigate with both defendants, it ought not make offers in the region of multiple settlement because the defendants might choose to both settle rather than both litigate. The plaintiff, however, can avoid the problem quite easily by making settlement offers anywhere in the region where (¬s,¬s) is the only equilibrium.

In contrast, where A is inside the region of multiple (s,s) and (¬s,¬s) equilibria (Figure IV), if the plaintiff makes offers of [(p+t)/(1+p), (p+t)/(1+p)], it must worry about the possibility that the defendants might both litigate rather than both settle. Indeed, by definition, in the region of multiple (s,s) and (¬s,¬s) equilibria, $\sigma_R > S_R$ and $\sigma_C > S_C$. Because S_R is the cost to Row of litigating given that Column litigates (and conversely S_C is the cost to Column of litigating given that Row litigates), everywhere in the region of multiple equilibria, both Row and Column prefer the (¬s,¬s) equilibrium to the (s,s) equilibrium. We assume that in response to a pair of settlement offers, the defendants will choose a Pareto dominating equilibrium, if one exists; thus, Row and Column would both choose to litigate.

To avoid litigation, the plaintiff will choose settlement offers in the boundary of the region of multiple equilibria, either (S_R, θ_C) or (θ_R, S_C). (10) and (11) reveal that the latter pair maximizes the plaintiff's expected payoff. Finally, (11) shows that a settlement with both defendants at (θ_R, S_C) is preferable for the plaintiff, by an amount 2t, to the (¬s,s) equilibrium. In summary, when $\underline{A}$ is in the region of multiple (s,s) and (¬s,¬s) equilibria, the plaintiff makes settlement offers of (θ_R, S_C). We denote the expected payoff as

(16) $$V'_{\delta,t}(s,s) = (\theta_R, S_C)$$

Note that the presence of $\underline{A}$ in the region of multiple (s,s) and (¬s,¬s) equilibria does not affect the plaintiff's choice among equilibria, it merely changes the offers that it makes in order to obtain a settlement with both defendants.

III. Outcomes of the Game

From the inequalites (13)-(15), we can determine the plaintiff's optimal pair of offers for any $\underline{\delta}$, $\underline{p}$, $\underline{r}$, $\underline{t}$, and $\underline{u}$. We first solve the problem in full for the cases in which the probabilities of success against the defendants are uncorrelated ($\delta = 1$), and perfectly correlated ($\delta = 1/p$). We then study the plaintiff's optimal behavior for the full range of correlations $\underline{\delta}$. Finally, we consider the allocation of costs among the defendants, the impact of high transaction costs, and the differences between joint and several liability on the one hand and non-joint (several only) liability on the other.

A. Uncorrelated Probabilities

The plaintiff's optimal strategies, for different ranges of litigation costs can be determined easily by plotting the plaintiff's expected payoff under the three relevant equilibria as a function of transaction costs. The values are obtained simply by substituting $\delta = 1$ into (9)-(11). Moreover, recall from Table I that there are no multiple (s,s) and (¬s,¬s) equilibria when $\delta = 1$; thus, for the (s,s) equilibrium, the plaintiff obtains the payoff V(s,s) rather than V'(s,s).

Examination of (9)-(11) reveals that the plaintiff's expected payoffs under for the three equilibria is linear in $\underline{t}$. Table II presents the intercepts (at $t = 0$) and the slopes of the respective functions.

Table II: Plaintiff's Payoffs for Uncorrelated Probabilities as a Function of Litigation Costs

Payoff	Intercept	Slope
V(¬s,¬s)	p(2-p)	-u
V(¬s,s)	p[(2-p) - pr(1-p)]	-p
V(s,s)	2p/(1+p)	2/(1+p)

First, Table II reveals that the intercept is largest for V(¬s,¬s). Thus, when the costs of litigation are zero, the plaintiff will prefer to litigate with both parties. This result confirms the conclusion of Section I.

Second, the slope of the payoffs is negative for V(¬s,¬s) and V(-s,s) and positive only for V(s,s). Thus, when the costs of litigation are sufficiently high, the plaintiff will settle with both defendants. This result is consistent with the single-defendant case: transaction costs create a surplus that parties can appropriate by settling rather than litigating. The slope is negative for V(¬s,¬s) because the plaintiff must bear, under the American rule, its own costs of litigation. In contrast, for V(s,s), the slope is positive because, given our assumption that the plaintiff makes a take-it-or-leave it offer, it is able to appropriate, from each defendant, the surplus that they receive from settling rather than litigating. For V(¬s,s), there are two countervailing effects. On the one hand, the plaintiff litigates against Row, so its expected payoff from the litigation decreases as the costs of litigation increase. On the other hand, as these costs increase, the plaintiff can extract a higher settlement from Column.

Third, $V(\neg s,\neg s)$ and $V(s,s)$ are independent of r. For $V(\neg s,s)$, in contrast, the slope is independent of r but the intercept decreases as r increases.

The three payoffs are plotted in Figure V. The intersections among these payoffs occur at the following values of t:

t_1: intersection between $V(\neg s,\neg s)$ and $V(\neg s,s)$;

t_2: intersection between $V(\neg s,\neg s)$ and $V(s,s)$; and

t_3: intersection between $V(\neg s,s)$ and $V(s,s)$.

The figure illustrates the payoff function under the two relevant scenarios: low r (case 1) and high r (case 2). The thick line indicates the strategy that maximizes the plaintiff's payoff. When r is sufficiently low, the plaintiff chooses $(\neg s,\neg s)$ for $0 \leq t < t_1$, $(\neg s,s)$ for $t_1 \leq t < t_3$, and (s,s) for $t \geq t_3$. As r increases, $V(\neg s,s)$ shifts downward; for sufficiently large r, its intersection with $V(s,s)$ occurs at lower t than its intersection with $V(\neg s,\neg s)$. Thus, as Figure V indicates, there is no longer range of values of t for which the plaintiff would choose $(\neg s,s)$. The plaintiff now seeks $(\neg s,\neg s)$ for $0 < t < t_2$ and (s,s) for $t \geq t_2$.[39]

Figure V shows that the plaintiff is better off when r is small because there is then a range in which $V(\neg s,s)$ is greater than both alternatives. Furthermore, as r becomes smaller the surplus produced by $V(\neg s,s)$ gets larger.

Table II also makes it possible to analyze the impact of u

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[39]A full proof is in Proposition 1 in the Appendix.

on the plaintiff's strategy. Only V(¬s,¬s) is dependent on u. As u increases, the slope becomes more negative resulting in a lower payoff to the plaintiff from litigating with both parties, and producing a switch to one of the other strategies at a lower t. The reason, of course, is that, as u increases, the plaintiff's costs of litigation with both parties for a given level of t increase, and litigation with both therefore becomes less attractive.

B. Perfectly Correlated Probabilities

Table I shows that for a sufficiently large r and a sufficiently small t the point A is in the region of multiple (s,s) and (¬s,¬s) equilibria. When that is the case, the plaintiff's payoff from settling is V'(s,s) rather than V(s,s). We proceed as in Section III(A), this time substituting $\delta = 1/p$ into (9)-(11) and (16). Once again, the plaintiff's expected payoffs under the various equilibria is linear in t. Table III presents the intercepts (at t = 0) and the slopes of the respective functions.

Table III: Plaintiff's Payoffs for Perfectly Correlated Probabilities as a Function of Litigation Costs

Payoff	Intercept	Slope
V(¬s,¬s)	p	-u
V(¬s,s)	p[(2-p) - r(1-p)]	-p
V(s,s)	2p/(1+p)	2/(1+p)
V'(s,s)	p[(2-p) - r(1-p)]	2-p

First, Table III reveals that the intercept is smallest for

V(¬s,¬s). When r is low, the intercept is largest for V(¬s,s);[40] in contrast, when r is high, the intercept is largest for V(s,s).

Second, as in the case of uncorrelated probabilities, the slope of the payoffs is negative for V(¬s,¬s) and V(-s,s) and positive for V(s,s) (and for V′(s,s)). Thus, when the costs of litigation are sufficiently high, the plaintiff will settle with both defendants. This result, once again, is consistent with the single-defendant case.

Third, V(¬s,¬s) and V(s,s) are independent of r. For V(¬s,s), in contrast, the slope is independent of r but the intercept decreases as r increases.

Fourth, V(¬s,¬s) has a lower intercept and more negative slope than the alternative strategies. Thus, when the probabilities are perfectly correlated, the plaintiff will never choose to litigate with both defendants. The intuition is straightforward. A consequence of perfect correlation under a rule of joint and several liability is that the expected value of litigating against two defendant is no higher than that of litigating against one. Perfect correlation implies that the plaintiff either prevails against both or against neither; thus, additional defendants do not increase the probability of the plaintiff's success in litigation. Moreover, because of joint and several liability, the plaintiff recovers its full damage

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[40] V(¬s,s) and V′(s,s) have the same intercept, but V′(s,s) is not an equilibrium solution for low r.

regardless of the number of defendants against which it prevails.

The various payoffs are plotted in Figure VI under the two relevant scenarios: low r (case 1) and high r (case 2). The thick line indicates the strategy that maximizes the plaintiff's payoff. When r is sufficiently low, the plaintiff chooses (¬s,s) for $0 \leq t < \tau_3$, and (s,s) for $t \geq \tau_3$. As r increases, V(¬s,s) shifts downward and, for sufficiently large r, the plaintiff settles with both defendants for every value of t. At low t, however, there are multiple (s,s) and (¬s,¬s) equilibria, so the plaintiff obtains only V′(s,s) rather than V(s,s) from the settlement.[41]

Figure VI shows that, like in the case of uncorrelated probabilities, the plaintiff is better off when r is small because there is then a range in which V(¬s,s) is greater than both alternatives. Furthermore, as r becomes smaller the surplus produced by V(¬s,s) gets larger.

For perfectly correlated probabilities, u is irrelevant to the plaintiff's strategy and payoff because the plaintiff never chooses V(¬s,¬s), the only payoff function dependent on u.

C. The Impact of the Correlation of Probabilities

Here, we seek to determine the impact on the plaintiff's strategy and payoff of the correlation of probabilities by plotting the plaintiff's expected payoff under the various equilibria as a function of the level of correlation of its

[41]A full proof is in Proposition 2 in the Appendix.

probabilities of success in litigation. (9)-(11) and (16) show that, for all the strategies the relationship is linear. Recall that in this article we are analyzing $\underline{\delta}$ in the closed interval [1,1/p]. Table IV presents the intercepts (at $\delta = 1$) and the slopes of the respective functions.

Table IV: Plaintiff's Payoffs as a Function of the Correlation of Its Probabilities of Success

Payoff	Intercept	Slope
V(¬s,¬s)	p(2-p) - ut	$-p^2$
V(¬s,s)	p[(2-p) - pr(1-p)] - pt	$-p^2r(1-p)$
V(s,s)	2(p+t)/(1+p)	0
V'(s,s)	p[(2-p) - pr(1-p)] + (2-p)t	$-p^2r(1-p)$

First, Table IV shows that the value of the intercept (at $\delta = 1$) is largest for V(¬s,¬s) when $\underline{t}$ is small, for V(s,s) when $\underline{t}$ is large, and for V(¬s,s) when $\underline{t}$ is in an intermediate range and $\underline{r}$ is small. The conclusions are consistent with Figure V, which looked at the payoffs as functions of $\underline{t}$ for $\delta = 1$.

Second, the slope of the payoffs is zero for V(s,s) and negative for the other equilibria. V(¬s,¬s) has the largest negative slope. The reason is that as $\underline{\delta}$ increases, the surplus that the plaintiff obtains from litigating with two defendants rather than one decreases.

Third, V(¬s,¬s) and V(s,s) are independent of $\underline{r}$. In contrast, over the full range of $\underline{\delta}$, V(¬s,s) decreases as $\underline{r}$ increases.

The various payoffs are plotted in Figure VII for t = 0 under the two relevant scenarios: low $\underline{r}$ (case 1) and high $\underline{r}$ (case

2). In both cases, the plaintiff chooses $(\neg s, \neg s)$ for $1 \leq \delta < \delta_1$. For low r, the plaintiff chooses $(\neg s, s)$ for $\delta \geq \delta_1$. For high r, it chooses $(\neg s, s)$ for $\delta_1 \leq \delta < \delta_3$. For $\delta \geq \delta_3$, the plaintiff's payoff is maximized with $V(s,s)$, but because for that range of δ (and $t = 0$) there is are multiple (s,s) and $(\neg s, \neg s)$ equilibria,[42] it must choose $V'(s,s)$ instead; note, moreover, that for $t = 0$, $V'(s,s) = V(\neg s, s)$.[43]

Figure VIII shows the relationship between payoffs and level of correlation for two other scenarios: intermediate t and low r (case 1) and high t (case 2). For the first case, the plaintiff chooses $(\neg s, s)$ for $1 \leq \delta < \delta_3$, and (s,s) for $\delta \geq \delta_3$. In the second case, the plaintiff chooses (s,s) for all δ and its recovery is independent of the level of correlation.

D. <u>Allocation of Costs Among the Defendants</u>

We indicated in Part I that, under zero transaction costs, Row, the defendant with the smaller share of liability, must bear a disproportionate share of the liability. This effect is exacerbated for positive transaction costs.

First, when both parties litigate, they must each bear their own transaction costs. If the transaction costs are independent of the relative liability of the parties, as we assume, the total amount expended (damages paid to the plaintiff plus transaction costs) will be even more disproportionate than when transaction

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[42]See Appendix, Lemma 1.

[43]A full proof is in Proposition 3 in the Appendix.

costs are zero.

Second, the unfairness is even more striking in the case of the (s,s) equilibrium. Where each defendant settles for $(p+t)/(1+p)$, Row bears half the settlement costs, even if its share of liability is far smaller than Column's.

Moreover, in the case of the region of multiple (s,s) and $(\neg s,\neg s)$ equilibria, when this region contains $\underline{A}$, Row's settlement of θ_R is actually larger than Column's settlement of S_C. Examine Figure IV. It follows from the definition of the region that $S_C < (p+t)/(1+p)$. The geometry of the figure reveals that $\theta_R > (p+t)/(1+p)$.

Finally, in the case of a $(\neg s,s)$ equilibrium, Row will pay a disproportionate share of liability if

$$\theta_R/S_C > r/(1-r) \qquad (16)$$

Substitution into (6) and (7) reveals that this expression holds for all $\underline{\delta}$, $\underline{p}$, $\underline{r}$, and $\underline{t}$.[44] It is noteworthy that this effect occurs even where $t = 0$; thus, it does not stem solely from the fact that under our assumptions, the smaller defendant pays a disproportionate amount of the total transaction costs paid by the defendants. In summary, under all the equilibria, the smaller defendant pays a disproportionate amount of the transaction costs.

This conclusion, and particularly the fact that when both

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[44] (16) can be rewritten as

$$t > -p(1 + \{\delta pr[p(1-r) + r]/[(1-2r) - p(1-r)]\})$$

Note that $0 < \delta p \leq 1$ and $r[p(1-r) + r]/[(1-2r) - p(1-r)] > -1$ for $r < 1$. Thus, (16) holds for the parameter ranges in our model.

defendants settle they generally pay the same amount, regardless of their relative sizes is paradoxical given that we have modeled a rule in which, if both defendants litigate, they pay in proportion to their degree of fault. If, however, they both are induced to settle because of the high transaction costs of litigation, their share of the liability becomes irrelevant.

The UCATA, most recently revised in 1955, provides that in contribution actions, the defendants will divide their aggregate liability in pro rata shares, rather than by reference to their relative degrees of fault.[45] The UCFA), adopted in 1977, departs from this approach and provides that damages should be divided among defendants by reference to their comparative fault.[46] The preceding discussion reveals, that at least with the set-off rule used in our model, in which the plaintiff's claim against the non-settling defendant is reduced by the amount of the settlement with the other defendant, the move toward principles of comparative fault has no effect in cases of high transaction costs.[47]

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[45]See sections 1 and 2.

[46]Section 2.

[47]The federal Superfund statute provides for comparative fault in the case of contribution actions and the set-off rule used in our model. See text accompanying notes 12-14, <u>supra</u>. The UCFA provides for a different set-off rule, under which the plaintiff's claim against the non-settling defendant would be reduced by the settling defendant's equitable share of the obligation. See section 6. We provide a full analysis of this rule in a separate article, discussed at text accompanying notes 61-62, <u>infra</u>.

E. The Case of High Transaction Costs

Our analysis of the settlement game between the defendants assumed that transaction costs t did not exceed 1, the plaintiff's full damages. In addition, our analysis of plaintiff's optimal offers assumed that $V(\neg s, \neg s)$, the plaintiff's return from litigating against both parties, was non-negative.[48] We made these assumptions temporarily to avoid a question concerning the structure of our model. Recall that we have modelled the interaction between plaintiff and defendants as a two-stage game. In stage 1, plaintiff makes simultaneous take-it-or-leave-it offers to the two defendants. In stage 2, each defendant independently decides to accept or to reject plaintiff's offer. If both defendants accept the offers, the game ends; if one or more rejects the offers, litigation occurs against those parties and the game ends.

An alternative model would add a third stage to the analysis. In the third stage, if one or more of the defendants rejected its offer, plaintiff would decide whether to file suit or not. These two models differ in their assumption concerning plaintiff's ability to commit itself at stage 1 to litigation in stage 3. Call the model of sections I and II, the model with commitment and the alternative model, introduced here, the "model without commitment".

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[48] Of these two assumptions, the second is more restrictive. From (9), it follows that $V(\neg s, \neg s) \geq 0$ if and only if $t \leq p(2-\delta p)/u < 1$.

Our assumptions on transaction costs were meant to make more plausible that, in the event an offer were rejected, plaintiff would indeed litigate as the model with commitment requires.[49] The assumptions on transaction costs thus raise three sets of questions. First, and most straightforward, how does the analysis of the game with commitment alter when we relax these assumptions? Second, how greatly will an analysis of the model without commitment differ from the analysis of the model here? Third, how do we choose between a model with commitment and a model without commitment? We briefly address each of these questions in turn.

1. <u>High Transaction Costs in a Model with Commitment</u>

Consider first the second-stage game between the defendants. Recall that, in general, when the plaintiff settles with both defendants, it makes offers of $\sigma_R = \sigma_C = (p+t)/(1+p)$ for σ_R, $\sigma_C < 1$; this latter conditions hold only for $t < 1$. For $t \geq 1$, the (s,s) region is instead depicted in Figure IX. It consists of the square defined by $\sigma_R < 1$, $\sigma_C < 1$ and two additional regions. In one $\sigma_R = 0$ and $1 \leq \sigma_C \leq p + t$, and in the other $\sigma_C = 0$ and $1 \leq \sigma_R \leq p + t$. Thus, the plaintiff's optimal set of offers is either (1-e,1-e), where <u>e</u> is infinitesimally small or, alternatively, (0,p+t) or (p+t,0). It will choose one of the

[49]As we point out at greater length below, the assumptions two assumption made in Section II are not sufficient to insure that litigation occurs in the third stage.

latter options over the former for $t \geq 2-p$. It is interesting that in this range, the plaintiff's optimal settlement strategy is to give a release to one defendant and obtain its full payoff from the other.

Consider now how high transaction costs affect the plaintiff's choice of strategy. As (9) reveals, $V(\neg s,\neg s) > 0$ for $t < p(2-\delta p)/u$. This quantity is labeled as t_0 in Figures V and VI, and δ_0 in Figures VII and VIII. These figures show that all of the results discussed in this paper occur in the range in which $V(\neg s,\neg s) > 0$.[50] Thus, our restrictive assumptions on transaction costs have no effect on the analysis of the model with commitment.

More importantly, however, in a model with commitment, it does not matter if $V(\neg s,\neg s)$ is non-positive. Because the plaintiff is committed to litigating in the third stage, the defendants would respond to the plaintiff's settlement offer as if the threat of litigation were real. Thus, the plaintiff would never find itself in a situation in which its settlement offers were rejected but then had to face litigation with negative expected value. Thus, in a model with commitment, the assumption that $V(\neg s,\neg s) > 0$ is actually unnecessary.

2. <u>High Transaction Costs in a Model without Commitment</u>

[50]We define $t_0 = p(2-\delta p)/u$ and $\delta_0 = (2p-ut)/p^2$. With respect to Figure V, $t_0 > t_2$, and $u \leq 2$ is a sufficient condition for $t_0 > t_3$. With respect to Figure VI, $u \leq 2$ is a sufficient condition for $t_0 > \tau_3$. With respect to Figure VII, $\delta 0 > \delta 2$. Finally, in Figure VIII, for certain parameters $\delta_0 > \delta_3$.

The analysis becomes considerably more complex if plaintiff cannot commit itself at stage 1 to litigation, if necessary, in stage 3. Most obviously, the largest offer a defendant, say Row, would accept in stage 2 conditional on Column's accepting a specified offer σ_C will depend on whether plaintiff's threat of litigation for the residual $(1-\sigma_C)$ is credible, that is, if the litigation has a positive expected value for the plaintiff. As a consequence, the functions $\Theta_i(\delta,t)$ will be step functions rather than constants and the set of (s,s) equilibria attainable by plaintiff will be greatly altered.

We may easily calculate a limit on transaction costs which leaves plaintiff's strategic options concerning (s,s) equilibria unchanged. The point A generally optimizes plaintiff's return from an equilibrium in which both defendants settle. In a model without commitment, A is only attainable if plaintiff's threat to sue a non-settling party is credible when the other party settles. This requires

$$p[1 - (p+t)/(1+p)] > t$$

or, equivalently,

$$t < p/(2p + 1) \qquad (17)$$

Note that when p is close to 1, the upper bound on transaction costs is close to 1/3. Under this more severe restriction, the analyses of the models with and without commitment should largely coincide.

A second difference between the models merits attention. Note that $t > p$ implies that plaintiff will not litigate against only one defendant because costs of litigation exceed the expected gross benefit from litigation. In a single-plaintiff-single-defendant model without commitment, a plaintiff would then be unable to recover anything in settlement from the lone defendant.

If plaintiff's probabilities of success are not perfectly correlated, however, the expected gross benefit from litigation against both parties $p(2-\delta p)$ exceeds p. Hence, if there are sufficiently great economies to scale of litigation against two parties (i.e., u is sufficiently close to 1), then the plaintiff may have a credible threat of litigation when two defendants are present, even though its threat would not be credible if there were only one defendant. As a result, one defendant might settle for some positive amount.

Conversely, if u and δ are sufficiently large and $t < p$, the plaintiff will not have a credible threat to litigate against both parties though it will have a credible threat to litigate against one party (when both reject its offers). This possibility also alters the structure of the analysis. Given that one defendant, say Row, chooses to litigate, then Column's expected cost of litigation is the probability that the plaintiff will sue Column rather than Row times the plaintiff's expected recovery; hence the largest settlement Column would accept conditional on Row's litigating will differ from S_C.[51]

[51]The text ignores problems concerning contribution because it does not focus on whether a losing defendant has a credible threat of litigation against a non-settling, non-sued defendant.

These brief remarks suggest that, for high transaction costs, our conclusions in the prior sections may be suspect if plaintiff's cannot commit itself, at stage 1, to litigation at stage 3.

3. The Choice Between the Models

The size of transaction costs often prevents injured parties from seeking relief. Indeed, a variety of institutional devices have arisen to reduce the transaction costs to injured parties. Contingent fee schemes and class action suits both increase the expected value of a claim by reducing the transaction costs to a single injured party. Thus, a model without commitment will captures phenomena that a model with commitment does not.

A model with commitment, however, serves several functions. First, it analytically more tractable and many of the results will carry over to the model without commitment. Thus, our conclusion that, in the presence of zero or low transaction costs, joint and several liability reduces the likelihood of settlement also holds in a model without commitment. Indeed, equation (17) in the previous section defines a reasonable range of transaction costs over which our conclusions should be independent of the commitment assumption. So for p as low as 1/2, t may be as high as .25. As t is the per defendant cost, total transaction costs expended can be as high as .5 the amount of the claim if plaintiff sues only one party and and as high as (.5 + .25u) the amount of the claim if plaintiff sues both. For u = 2, total transaction costs can be equal the amount of the claim and the two models with still yield identical results.

Second, commitment, coupled with the structure of plaintiff making take-it-or-leave-it offers, places an upper bound on the settlement range between plaintiff and defendants. We could define other bounds using models with commitment that allowed first Row and then Column to make take-it-or-leave-it offers to the other two parties.

Third, the assumption of take-it-or-leave-it bargaining already embodies a commitment assumption. If a defendant rejects the plaintiff's initial offer, the plaintiff would generally be better off making a second offer rather than litigating immediately. Any model of settlement and litigation sufficiently well-specified to permit precise prediction of equilibria will similarly require a defense of the particular commitment assumptions it makes and avoids.

F. Comparison with Non-Joint (Several Only) Liability

In Section I, we showed that, for transaction costs of zero and uncorrelated probabilities, a plaintiff always recovers more under joint and several liability than under non-joint (several only) liability. This conclusion extends, still for zero transaction costs, through the full range of correlation of probabilites, except in the case of perfectly correlated probabilities. Indeed, the plaintiff's expected value of litigation under non-joint liability in the face of zero transaction costs is given by

(18) $V_{\delta,0,NJ}(\neg s,\neg s) = \delta p^2 + rp(1-\delta p) + (1-r)p(1-\delta p) = p$

Note that this value is independent of the correlation of probabilities.

The comparison of (9) and (18) reveals that the expected value of litigation under joint and several liability is greater than under non-joint liability for $\delta < 1/p$ and that both values are equal for $\delta = 1/p$ (perfectly correlated probabilities).

Under non-joint liability, however, the plaintiff will always settle with both defendants when the transaction costs are positive.[52] The elimination of joint and several liability has the effect of uncoupling the game, and therefore results in a situation akin to the simple single-actor problem, which produces settlements in cases in which the parties are both risk-neutral and have the same assessment of the plaintiff's probability of success.[53] Row and Column face expected costs of litigation of $rp + t$ and $(1-r)p + t$, respectively.

We can thus write the maximum settlements that Row and Column, respectively, would pay as

(19) $$\sigma_{R,NJ} = rp + t$$

(20) $$\sigma_{C,NJ} = (1-r)p + t$$

Note that, unlike the case of joint and several liability, here

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[52]When transaction costs are zero, the defendants will be indifferent between settling and litigating; under our assumption, they will settle.

[53]See text accompanying notes 15-16, supra.

independent of whether the other defendant litigates or settles, and, in the latter event, of the amount of the settlement.

The plaintiff will make take-it-or-leave-it offers for the amounts in (19) and (20), totaling p + 2t, and those offers will be accepted. We thus write

$$(21) \qquad V_{\delta,t,NJ}(s,s) = p + 2t$$

The comparison of (12) and (21) shows that $V(s,s) > V_{NJ}(s,s)$ if and only if $t < (1-p)/2$. For larger values of t, the plaintiff recovers more in the absence of joint and several liability. Note that the range of transaction costs for which non-joint liability is preferable increases as p increases.

While this result--that the seemingly more pro-plaintiff rule would, under a plausible set of conditions in fact be detrimental to the plaintiff--might seem paradoxical. Indeed, this possibility, seems to have completely escaped the advocates of the tort reform movement, who argued for the abolition of joint and several liability as a way of protecting defendants.[54]

The explanation is relatively straightforward. Under joint and several liability, we have modeled a set-off rule that, in cases in which one defendant settles and the other litigates, reduces, by the amount of the settlement, the plaintiff's recovery from the non-settling defendant. Thus, where the plaintiff settles with one defendant and litigates with the other, it can never recover more than the full amount of its

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[54]See Kornhauser & Revesz, Sharing Damages, supra note 3.

damages. In contrast, the prevailing rule under non-joint liability, which is reflected in (19) and (20), does not constrain the plaintiff's recovery in this manner. Thus, if the plaintiff settles with one defendant for more than this defendant's share, it can obtain from the non-settling defendant its share, thereby obtaining a total recovery that is larger than its damages.[55]

There are therefore two factors pulling in opposite directions. On the one hand, non-joint liability is less desirable to the plaintiff because the expected value of litigation against both defendants is lower; this effect lowers the amount that the plaintiff can obtain from settling with both defendants. On the other hand, non-joint liability is more desirable because the total recovery from litigating with one defendant and settling with the other is not bounded by the total amount of damages; this effect raises the amount that the plaintiff can obtain from settling with both defendants. The first effect dominates for low transaction costs, and the second for high transaction costs.

Interestingly, however, even if the recovery under non-joint liability were constrained to prevent the plaintiff from recovering more than its full damages when it settles with one

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[55]See, e.g., Roland v. Bernstein, 828 P.2d 1237 (Ariz. Ct. App. 1991); Stratton v. Parker, 793 S.W.2d 817 (Ky. 1990); Glenn v. Fleming, 732 P.2d 750 (Kan. 1987); Wilson v. Galt, 668 P.2d 1104, 1107-10 (N.M. Ct. App. 1983), cert. quashed, 668 P.2d 308 (N.M. 1983). The basic rationale of these decisions is that the plaintiff, rather than the non-settling defendant, should benefit from an advantageous settlement.

defendant and litigates with the other (a one-satisfaction rule), joint and several liability would not always lead to larger settlements. The largest settlement that Row and Column would offer under the constrained version of non-joint liability is given by

$$(22)\quad \sigma_{R,NJ}' = p\{1 - \text{Max}\{(1-r),\sigma_C\} + t \qquad \text{for } \sigma_C < 1$$
$$= 0 \qquad \text{for } \sigma_C \geq 1$$

$$(23)\quad \sigma_{C,NJ}' = p\{1 - \text{Max}\{r,\sigma_R\} + t \qquad \text{for } \sigma_R < 1$$
$$= 0 \qquad \text{for } \sigma_R \geq 1$$

Equations (22) and (23) reveal that when $\underline{t}$ is sufficiently large, the expressions for the largest settlement offers that Row and Column would offer become identical to those in equations (1) and (2), the maximum settlement offers under joint and several liability.[56] Note, moreover, that under the one-satisfaction version of non-joint liability, as under joint and several liability, the defendants' decisions are linked; the amount of one defendant's settlement influences the other's maximum offer.

Conclusion

The analysis in this article extends our prior work on the differences between joint and several liability and non-joint (several only) liability. Our work on infinitely solvent tortfeasors concluded that negligence rules are efficient under joint and several liability as long as the standards of care for

[56] A full proof is presented in Proposition 4 in the Appendix.

each of the actors are set at the socially optimal level but that negligence rules are not generally efficient in the absence of joint and several liability. We also determined that strict liability rules are not efficient regardless of whether there is joint and several liability.[57]

In our article on potential insolvency among joint tortfeasors, we determined that it is not possible to draw any general conclusion about whether, on efficiency grounds, joint and several liability is preferable to non-joint liability. This conclusion is applicable both to negligence and strict liability.[58]

Here, we show that joint and several liability has the effect of discouraging settlements. When settlements do occur, however, it generally, but not always, increases the amount that the plaintiff can recover.

Another central finding of this article concerns the treatment of party with the smaller share of liability. We show that this party bears a disproportionate share of the expected liability. We will explore in a separate article the effects of three different attempts by the legal regime to redress this unfairness: (1) allowing the non-settling defendant to challenge the plaintiff's settlement with the other defendant;[59] (2)

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[57]Kornhauser & Revesz, Sharing Damages, supra note 3.

[58]Kornhauser & Revesz, Insolvency, supra note 3.

[59]In general, courts can entertain a non-settling defendant's challenge to a settlement on the ground that it was not entered in "good faith." In Tech-Bilt, Inc. v. Woodward-

employing a set-off rule that reduces the plaintiff's claim against a non-settling defendant by the settling defendant's apportioned share of liability;[60] and (3) requiring the plaintiff

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Clyde & Assoc., 698 P.2d 159 (Calif. 1985), held that the good-faith inquiry "would enable the trial court to inquire, among other things, whether the amount of the settlement is within the reasonable range of the settling tortfeasor's proportional share of comparative liability for the plaintiff's injuries." Id. at 166. In a strong dissent, Chief Justice Bird argued that "a settlement satisfies the good faith requirement if it is free of corrupt intent, i.e., free of intent to injure the interests of the nonsettling tortfeasors. A settlement is made in bad faith only if it is collusive, fraudulent, dishonest, or involves tortious conduct. Id. at 168 (Bird., C.J., dissenting). Under her approach, the actual amount of the settlement would not be relevant to the good-faith inquiry.

Approaches similar to that of Tech-Bilt have been adopted in other jurisdictions. See, e.g., International Action Sports, Inc. v. Sabellico, 573 So. 2d 928 (Fla. Dist. Ct. App.), review denied, 583 So. 2d 1036 (Fla. 1991); Picket v. Stephens-Nielsen, Inc., 717 P.2d 277 (Wash. App. Ct. 1986). Several jurisdictions, however, have rejected the Tech-Bilt approach and sided with Chief Justice Bird. See, e.g., Pritchard v. Swedishamerican Hosp., 557 N.E.2d 988, 994 (Ill. App. Ct. 1990); Noyes v. Raymond, 548 N.E.2d 196 (Mass. App. Ct. 1990). Other courts have held that the Tech-Bilt inquiry is not required and have given the trial courts broad discretion to determine the factors that are relevant to the good-faith inquiry. See, e..g., Velsicol Chemical Corp. v. Davidson, 811 P.2d 561 (Nev. 1991).

[60]This approach is followed in the UCFA. See section 6. There are two versions of this rule. Under one, when the plaintiff settles with one defendant for more than this defendant's apportioned share of the liability, its claim against the non-settling defendant is reduced by the settling defendant's apportioned share, even though, if successful, the plaintiff can recover more than its damages. Under the other, the plaintiff's claim against the non-settling defendant is reduced by the greater of (1) the settling defendant's apportioned share of liability, and (2) the actual amount of the settlement. See note 21, supra. The former rule appears prevalent. See, e.g., Rambaum v. Swisher, 435 N.W.2d 19 (Minn. 1989); Thomas v. Solberg, 442 N.W.2d 73 (Iowa 1989); Austin v. Raymark, Indus., 841 F.2d 1184 (1st Cir. 1988) (applying Maine law); Kussman v. City of Denver, 706 P.2d 776 (Colo. 1985); Cypress Creek Utility Serv. Co. v. Muller, 640 S.W.2d 860 (Tex. 1982). The latter rule is followed by statute in New York. See N.Y. General Obligations Law §15-108 (McKinney 1992). See also Deal v. Madison 576 S.W.

to makes pairs of offers that bear a relationship to the defendants' share of liability.[61]

2d 409 (Tex. Civ. App. 1978), overruled by Cypress Creek Utility Serv. Co., 640 S.W. 2d at 865.

[61]In the Superfund context, for example, we believe that the Environmental Protection Agency (EPA) faces such a constraint as a result of representations it made in response to concerns, expressed at the time of the passage of CERCLA, about the potential unfairness that results from joint and several liability. See, e.g., Superfund Reauthorization: Judicial and Legal Issues, Oversight Hearings Before the Subcommittee on Administrative Law and Government Relations, Committee on the Judiciary, House of Representatives, 99th Cong., 1st Sess., July 17-18, 1985, at 953-54 (statement of Edmund Frost on behalf of the Chemical Manufacturers Ass'n). For the Administration's assurances, see, e.g., id. at 14-15 (statement of Lee Thomas, Administator of EPA), id. at 44-46 (statement of F. Henry Habicht, II, Assistant Attorney General, Land and Natural Resources Division). EPA's settlement offers to generators of hazardous waste are generally proportional to their volumetric contribution of waste.

Appendix

Lemma 1: The point $[(p+t)/(1+p), (p+t)/(1+p)]$ is inside the region of multiple (s,s) and (¬s,¬s) equilibria if and only if $t < p[\delta r(1 + p) - 1]$.

Proof: This point is in the region of multiple (s,s) and (¬s,¬s) equilibria if and only if $S_R < (p+t)/(1+p)$, $S_C < (p+t)/(1+p)$. But for $r \leq 1/2$, $S_R \leq S_C$; thus, if S_C satisfies the condition, S_R will as well. Substituting for S_C in (6) establishes the lemma.

Corollary 1: For $\delta = 1$ (independent probabilities), the point $[(p+t)/(1+p), (p+t)/(1+p)]$ is never inside the region of multiple (s,s) and (¬s,¬s) equilibria.

Proof: The condition in the lemma is not satisfied for any $t \geq 0$, given that $r \leq 1/2$.

Corollary 2: For $\delta = 1/p$ (perfectly correlated probabilities), the point $[(p+t)/(1+p), (p+t)/(1+p)]$ is never inside the region of multiple (s,s) and (¬s,¬s) equilibria if $r \leq p/(1+p)$.

Proof: For $r \leq p/(1+p)$, the condition in the lemma is not satisfied for any $t \geq 0$.

Corollary 3: For $\delta = 1/p$ (perfectly correlated probabilities) and $r > p/(1+p)$, the point $[(p+t)/(1+p), (p+t)/(1+p)]$ is inside the region of multiple (s,s) and (¬s,¬s) equilibria if and only if $t < r - (1-r)p$.

Proof: Follows directly from the condition in the lemma.

Lemma 2: There are multiple (s,s) and (¬s,¬s) equilibria if and only if $t < p\{\delta[r + p(1 - r)] - 1\}$.

Proof: These multiple equilibria will exist if and only if (S_R, S_C) is inside the region of (s,s) equilibria. Because $S_R \leq S_C$, this condition is never satisfied for $S_R > (p+t)/(1+p)$. For $S_R \leq (p+t)/(1+p)$, the condition becomes $S_C < p(1 - S_R) + t = \theta_C$. Substituting for S_C and θ_C in (6) and (8) establishes the lemma.

Corollary 1: For $\delta = 1$ (independent probabilities), there is no region of multiple (s,s) and (¬s,¬s) equilibria.

Proof: The condition in the lemma is not satisfied for any $t \geq 0$, given that $r \leq 1/2$.

Corollary 2: For $\delta = 1/p$ (perfectly correlated probabilities), there is a region of multiple (s,s) and (¬s,¬s) equilibria for $t < r(1-p)$.

Proof: Follows directly from the condition in the lemma.

Lemma 3: There are multiple (s,¬s) and (¬s,s) equilibria if and only if $t \geq p\{\delta[r + p(1 - r)] - 1\}$.

Proof: These multiple equilibria will exist if and only if (S_R, S_C) is not inside the region of (s,s) equilibria. Because $S_R \leq S_C$, this condition is always satisfied for $S_R > (p+t)/(1+p)$. For $S_R \leq (p+t)/(1+p)$, the condition becomes $S_C \geq p(1 - S_R) + t = \theta_C$. Substituting for S_C and θ_C in (6) and (8) establishes the lemma.

Corollary 1: For $\delta = 1$ (independent probabilities), there is a region of multiple (s,¬s) and (s,¬s) equilibria for all $t \geq 0$.

Proof: For $\delta = 1$, the condition in the lemma becomes

$$t \geq p\{[r + p(1 - r)] - 1\}$$

The right-hand side of this expression is non-positive.

Corollary 2: For $\delta = 1/p$ (perfectly correlated probabilities), there is a region of multiple $(s,\neg s)$ and $(s,\neg s)$ equilibria for $t > r(1-p)$.

Proof: Follows directly from the condition in the lemma.

Corollary 3: When a region with the two equilibria $(s,\neg s)$ and $(\neg s,s)$ exists, a region with the two equilibria (s,s) and $(\neg s,\neg s)$ does not exist.

Proof: The conditions in lemmata 2 and 3 are mutually exclusive.

Corollary 4: For all $t \geq 0$, there is either a region of multiple (s,s) and $(\neg s,\neg s)$ equilibria or a region of multiple $(s,\neg s)$ and $(\neg s,s)$ equilibria.

Proof: Follows from lemmata 2 and 3.

Proposition 1: For $\delta = 1$ (independent probabilities),

(a) if $r < (u-p)/[2+u(1+p)]$

(i) for $t < t_1$, plaintiff makes any pair of offers (σ_R, σ_C) with $\sigma_i > S_i(1,t)$ and both parties litigate;

(ii) for $t_1 \leq t < t_3$, plaintiff makes any pair of offers $(\sigma_R, S_C(1,t))$ where $\sigma_R > S_R(1,t)$ and Column settles while Row litigates; and

(iii) for $t \geq t_3$, plaintiff makes the pair of offers $([p+t]/[1+p],[p+t]/[1+p])$ and both parties settle;

(b) if $r \geq (u-p)/[2+u(1+p)]$,

(i) for $t < t_2$, plaintiff makes any pair of offers (σ_R, σ_C) with $\sigma_i > S_i(1,t)$ and both parties litigate; and

(ii) for $t \geq t_2$, plaintiff makes the pair of offers $([p+t]/[1+p],[p+t]/[1+p])$ and both parties settle;

where $t_1 = p^2r(1-p)/[u-p]$, $t_2 = p^2(1-p)/[2+u(1+p)]$ and $t_3 = p^2(1-p)[1-r(1+p)]/[2 + p(1+p)]$.

<u>Proof</u>: t_1 is the smallest <u>t</u> for which the plaintiff prefers the equilibrium $(\neg s,s)$ to the equilibrium $(\neg s,\neg s)$. We calculate t_1 by setting $\delta = 1$ in (15), treating it as an equality, and rearranging.

t_2 is the smallest <u>t</u> for which the plaintiff prefers the equilibrium (s,s) to the equilibrium $(\neg s,\neg s)$. We calculate t_2 by setting $\delta = 1$ in (14), treating it as an equality, and rearranging.

t_3 is the smallest <u>t</u> for which the plaintiff prefers the equilibrium (s,s) to the equilibrium $(\neg s,s)$. We calculate t_3 by setting $\delta = 1$ in (13), treating it as an equality, and rearranging.

Comparing the expressions for t_i shows that $t_1 < t_2 < t_3$ if and only if $r < (u-p)/[2+u(1+p)]$ and, conversely that $t_3 \leq t_2 \leq t_1$ if and only if $r \geq (u-p)/[2+u(1+p)]$. Thus, for $r < (u-p)/[2+u(1+p)]$, $t < t_1$ implies $(\neg s,\neg s)P(\neg s,s)P(s,s)$ (that is, the plaintiff prefers $(\neg s,\neg s)$ to $(\neg s,s)$ and $(\neg s,s)$ to (s,s)), establishing (a)(1); $t_1 \leq t < t_2$ implies $(\neg s,s)P(\neg s,\neg s)P(s,s)$, and $t_2 \leq t < t_3$ implies $(\neg s,s)P(s,s)P(\neg s,\neg s)$, establishing (a)(ii); and $t \geq t_3$ implies $(s,s)P(\neg s,s)P(\neg s,\neg s)$, establishing (a)(iii).

For $r \geq (u-p)/[2+u(1+p)$, $t < t_3$ implies $(\neg s,\neg s)P(\neg s,s)P(s,s)$, and $t_3 \leq t < t_2$ implies $(\neg s,\neg s)P(s,s)P(\neg s,s)$, establishing (b)(i); and $t_2 \leq t < t_1$ implies $(s,s)P(\neg s,\neg s)P(\neg s,s)$ and $t \geq t_1$ implies $(s,s)P(s,\neg s)P(\neg s,\neg s)$, establishing (b)(ii).

Corollary 1: If litigation costs $\underline{t}$ are zero (and $\delta = 1$), plaintiff makes any pair of offers (σ_R, σ_C) with $\sigma_i > S_i(1,0)$ and both parties litigate.

Proof: Follows directly from the proof of Proposition 1(a)(i) and 1(b)(i).

Proposition 2: For $\delta = 1/p$ (perfectly correlated probabilities),

(a) If $r = p/(1+p)$, plaintiff makes the pair of offers $([p+t]/[1+p],[p+t]/[1+p])$ and both parties settle;

(b) If $r > p/(1+p)$, then

(i) for $t < r - p(1-r)$, plaintiff makes the pair of offers (Θ_R, S_C) and both parties settle; and

(ii) for $t \geq r - p(1-r)$, plaintiff makes the pair of offers $([p+t]/[1+p],[p+t]/[1+p])$ and both parties settle;

(c) If $r < p/(1+p)$, then,

(i) for $t < \tau_3$, plaintiff makes any pair of offers $(\sigma_R, S_C(1/p,t))$ with $\sigma_R > S_R$ and Column settles while Row litigates; and

(ii) for $t \geq \tau_3$, in equilibrium, plaintiff makes the pair of offers $([p+t]/[1+p],[p+t]/[1+p])$ and both parties settle;

where $\tau_3 = p(1-p)[p - r(1+p)]/[2+p(1+p)]$.

<u>Proof</u>: We may calculate τ_1, τ_2, and τ_3 corresponding to t_1, t_2, and t_3 in Proposition 1. τ_1 and τ_2 are always negative. $\tau_3 > 0$ if and only if $r < p/(1+p)$. Lemma 1, Corollary 3 shows that the point $([p+t]/[1+p],[p+t]/[1+p])$ is in the region of multiple (s,s) and $(\neg s,\neg s)$ equilibria for $r > p/(1+p)$, and $t < r - p(1-r)$.

Consider first the regions in which the point $([p+t]/[1+p],[p+t]/[1+p])$ is not in the region of multiple (s,s) and $(\neg s,\neg s)$ equilibria. For $r = p/(1+p)$, $(s,s)P(\neg s,s)P(\neg s,\neg s)$, establishing (a). For $r < p/(1+p)$ if $t < \tau_3$, $(\neg s,s)P(s,s)P(\neg s,\neg s)$, but if $t \geq \tau_3$, $(s,s)P(\neg s,s)P(\neg s,\neg s)$, establishing (c).

For $r > p/(1+p)$, $(s,s)P(\neg s,s)P(\neg s,\neg s)$. For $t \geq r - p(1-r)$, the point $([p+t]/[1+p],[p+t]/[1+p])$ is not in the region of multiple (s,s), $(\neg s,\neg s)$ equilibria, establishing (b)(ii). But for $t < r - p(1-r)$, the point $([p+t]/[1+p],[p+t]/[1+p])$ is in the region of multiple (s,s) and $(\neg s,\neg s)$ equilibria. Lemma 5 then establishes (b)(i).

<u>Corollary 1</u>: If litigation costs <u>t</u> are zero (and $\delta = 1/p$),

(a) If $r = p/(1+p)$, plaintiff makes the pair of offers $(p/(1+p), p/(1+p))$ and both parties settle;

(b) If $r > p/(1+p)$, plaintiff makes the pair of offers $(\Theta_R(1/p,0), S_C(1/p,0))$ and both parties settle;

(c) If $r < p/(1+p)$, plaintiff makes any pair of offers $(\sigma_R, S_C(1/p,0))$ with $\sigma_R > S_R(1/p,0)$ and Column settles while Row litigates.

<u>Proof</u>: Follows directly from the proof of Proposition 2(a), 2(b)(i) and 2(c)(i).

<u>Proposition 3</u>: If the costs of litigation <u>t</u> are zero,

(a) For $r > p/(1+p)$,

(i) if $\delta < \delta_1$, plaintiff makes any pair of offers (σ_R, σ_C) with $\sigma_i > S_i(\delta,0)$ and both parties litigate;

(ii) if $\delta_1 \leq \delta < \delta_3$, plaintiff makes any pair of offers $(\sigma_R, S_C(\delta,0))$ where $\sigma_R > S_R(\delta,0)$ and Column settles while Row litigates;

(iii) if $\delta = \delta_3$, plaintiff makes the pair of offers $(p/[1+p], p/[1+p])$ and both parties settle; and

(iv) if $\delta_3 < \delta \leq 1/p$, plaintiff makes the pair of offers $(\Theta_R(\delta,0), S_C(\delta,0))$ and both parties settle;

(b) For $r = p/(1+p)$,

(i) if $\delta < \delta_1$, plaintiff makes any pair of offers (σ_R, σ_C) with $\sigma_i > S_i(\delta,0)$ and both parties litigate;

(ii) if $\delta_1 \leq \delta < \delta_3$, plaintiff makes any pair of offers $(\sigma_R, S_C(\delta,0))$ where $\sigma_R > S_R(\delta,0)$ and Column settles while Row litigates; and

(iii) if $\delta = \delta_3$, plaintiff makes the pair of offers $(p/[1+p], p/[1+p])$ and both parties settle; and

(c) For $r < p/(1+p)$,

(i) if $\delta < \delta_1$, plaintiff makes any pair of offers (σ_R, σ_C) with $\sigma_i > S_i(\delta,0)$ and both parties litigate; and

(ii) if $\delta_1 \leq \delta < 1/p$, plaintiff makes any pair of offers $(\sigma_R, S_C(\delta,0))$ where $\sigma_R > S_R(\delta,0)$ and Column settles while Row litigates;

where $\delta_1 = 1/[1-r(1-p)]$, $\delta_2 = 2/(1+p)$ and $\delta_3 = 1/[r(1+p)]$.

<u>Proof</u>: δ_1 is the smallest $\underline{\delta}$ for which the plaintiff prefers the equilibrium (¬s,s) to the equilibrium (¬s,¬s). We calculate δ_1 by setting t = 0 in (15), treating it as an equality, and rearranging.

δ_2 is the smallest $\underline{\delta}$ for which the plaintiff prefers the equilibrium (s,s) to the equilibrium (¬s,¬s). We calculate δ_2 by setting t = 0 in (14), treating it as an equality, and rearranging.

δ_3 is the smallest $\underline{\delta}$ for which the plaintiff prefers the equilibrium (s,s) to the equilibrium (¬s,s). We calculate δ_3 by setting t = 0 in (13), treating it as an equality, and rearranging.

Comparing the expressions for δ_i shows that, for $r \le 1/2$, $\delta_1 \le \delta_2 \le \delta_3$. Note, moreover, that $\delta_2 \le 1/p$ for $r \le 1/2$ and that $\delta_3 \le 1/p$ if and only if $r \ge p/(1+p)$.

Consider first the case of $r > p/(1+p)$. $\delta < \delta_1$ implies (¬s,¬s)P(¬s,s)P(s,s), establishing (a)(i); $\delta_1 \le \delta < \delta_2$ implies (¬s,s)P(¬s,¬s)P(s,s), and $\delta_2 \le \delta < \delta_3$ implies (¬s,s)P(s,s)P(¬s,¬s), establishing (a)(ii); and $\delta = \delta_3$ implies (s,s)P(¬s,s)P(¬s,¬s), establishing (a)(iii).

Finally $\delta_3 < \delta < 1/p$ also implies (s,s)P(¬s,s)P(¬s,¬s). But Lemma 1 establishes that for $\delta > \delta_3$, there are multiple (s,s) and (¬s,¬s) equilibria. Lemma 5 establishes that the settlement will occur at (Θ_R, S_C) rather than at (p/[1+p], p/[1+p]), establishing (a)(iv).

The proof for (b) is identical to the proof for (a)(i)-(iii) and the proof for (c) is identical to the proof for (a)(i)-(ii).

<u>Corollary 1</u>: For $\delta = 1$ (independent probabilities), plaintiff makes any pair of offers (σ_R, σ_C) with $\sigma_i > S_i(\delta,0)$ and both parties litigate.

<u>Proof</u>: Follows directly from the proof of Proposition 3(a)(i), because $1 < \delta_1$. This result confirms Proposition 1, Corollary 1.

<u>Corollary 2</u>: For $\delta = 1/p$ (perfectly correlated probabilities),

(a) If r = p/(1+p), plaintiff makes the pair of offers (p/(1+p), p/(1+p)) and both parties settle;

(b) If r > p/(1+p), plaintiff makes the pair of offers ($\Theta_R(1/p,0)$, $S_C(1/p,0)$) and both parties settle;

(c) If r < p/(1+p), plaintiff makes any pair of offers (σ_R, $S_C(1/p,0)$) with $\sigma_R > S_R(1/p,0)$ and Column settles while Row litigates.

<u>Proof</u>: Note that $\delta_1 < 1/p$ for all r < 1. In turn, r = p/(1+p) implies that $\delta_3 = 1/p$; Proposition thus 3(b)(iii) establishes (a). r > p/(1+p) implies that $\delta_3 < 1/p$; Proposition 3(a)(iv) thus establishes (b). r < p/(1+p) implies that $1/p < \delta_3$; Proposition 3(c)(ii) thus establishes (c). These results confirm Proposition 2, Corollary 1.

<u>Proposition 4</u>: A plaintiff's expected recovery under the

one-satisfaction version of non-joint (several only) liability (Section III(F)) is lower than under joint and several liability for $t < 1 - r(1+p)$, and the same as under joint and several liability for $t \geq 1 - r(1+p)$.

<u>Proof</u>: Equations (22) and (23) establish three different scenarios for $t < 1$. First, for $t < r(1-p)$,[62]

$$\sigma_{R,NJ}' = rp + t$$

$$\sigma_{C,NJ}' = (1-r)p + t$$

Thus,

$$V_{\delta,t,NJ}(s,s)' = p + 2t$$

Comparison with equation (12) reveals that $V_{\delta,t,NJ}(s,s)' < V_{\delta,t}(s,s)'$ if and only if $t < (1-p)/2$. For $r \leq 1/2$, $(1-p)/2 \geq r(1-p)$. Thus, for $t < r(1-p)$, the amount recovered by the plaintiff by settling with both parties under non-joint liability is less than the amount recovered by settling with both parties under joint and several liability.

Second, for $r(1-p) \leq t < 1 - r(1+p)$,

$$\sigma_{R,NJ}' = rp + t$$

$$\sigma_{C,NJ}' = p(1 - \sigma_R) + t$$

Thus,

$$V_{\delta,t,NJ}(s,s)' = p + (2 - p)t$$

Comparison with (12) reveals that, for <u>t</u> in this range, the plaintiff recovers less under non-joint liability.

Third, for $1 - r(1+p) \leq t < 1$,

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[62]The two conditions that must be satisfied are $rp + t \leq r$ and $(1-r)p + t \leq 1-r$. Because $r \leq 1/2$, whenever the first condition is satisfied, the second is satisfied as well.

$$\sigma_{R,NJ}' = p(1 - \sigma_C) + t$$

$$\sigma_{C,NJ}' = p(1 - \sigma_R) + t$$

Thus,

$$V_{\delta,t,NJ}(s,s)' = 2(p+t)/(1+p) = V_{\delta,t,}(s,s)$$

For transaction costs in this range, joint and several liability and the constrained version of non-joint liability yield the same settlements.

For $t \geq 1$, the analysis under the constrained non-joint liability rule is identical to that presented in the prior section for joint and several liability. Thus, for sufficiently high transaction costs, non-joint liability is no worse for the plaintiff than joint and several liability.

Figure I: Proportion of the Liability Borne by Row
If the Outcomes of Litigation Are Uncorrelated
and the Costs of Litigation Are Zero

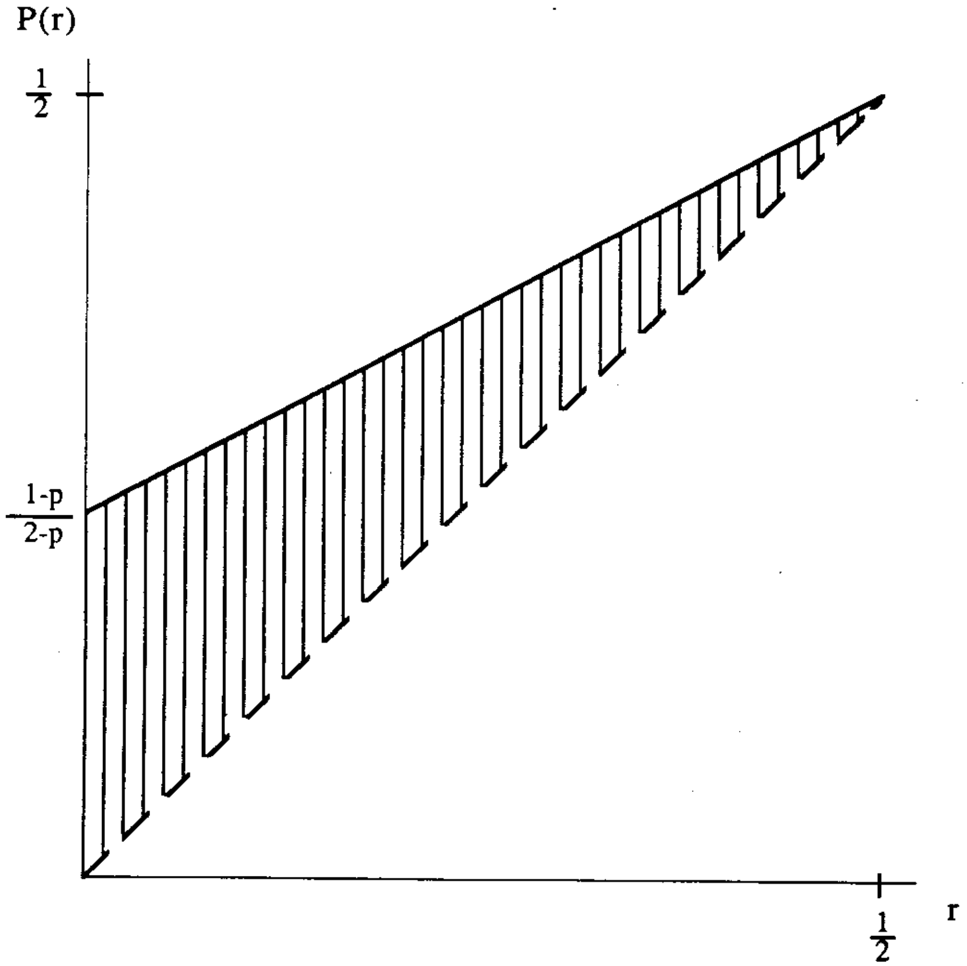


Figure II: Multiple (s,¬s) and (¬s,s) Equilibria

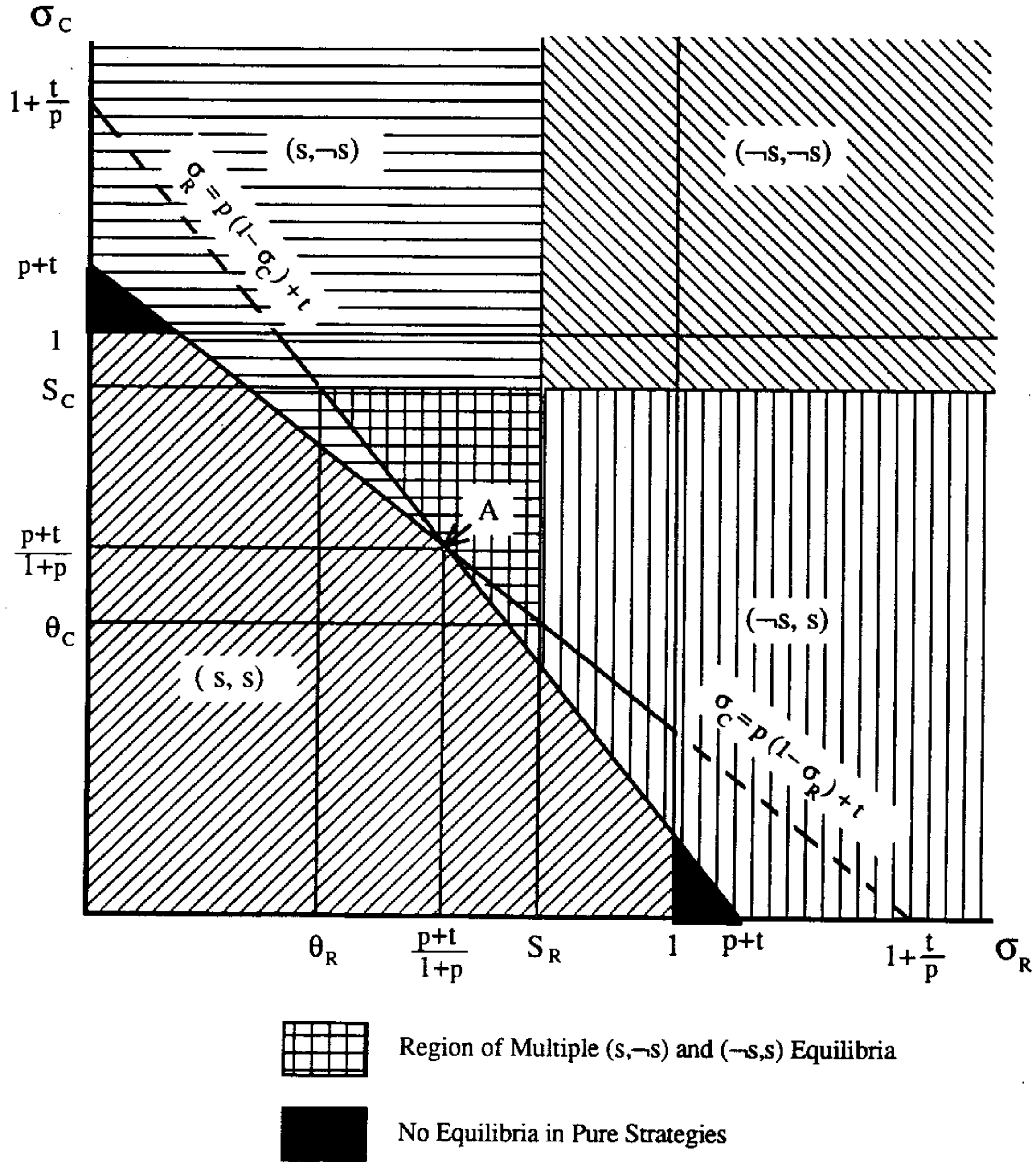


Figure III: Multiple (s,s) and (¬s,¬s) Equilibria
(A ∉ Multiple Equilibria Region)

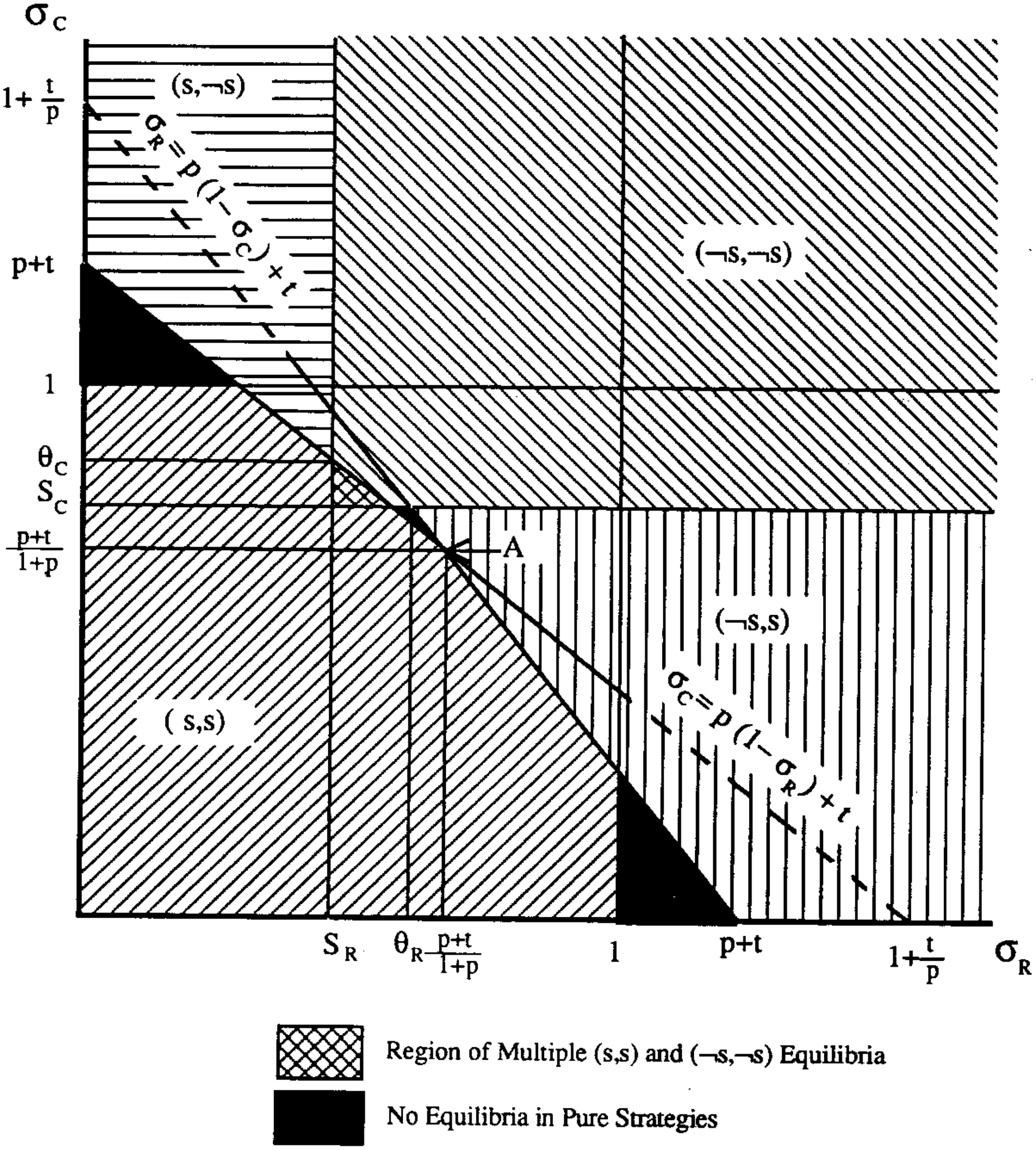


Figure IV: Multiple (s,s) and (¬s,¬s) Equilibria
($A \in$ Multiple Equilibria Region)

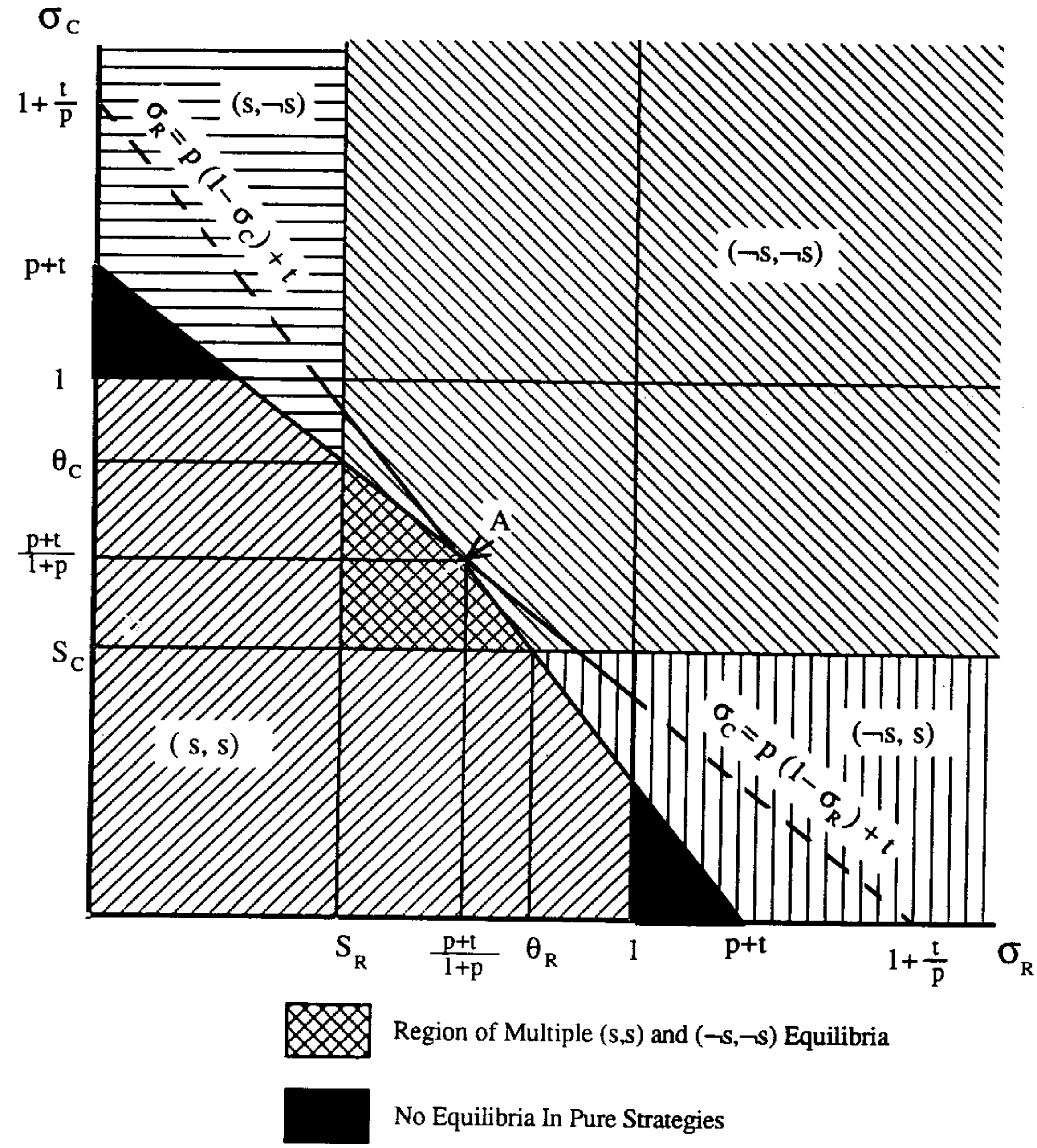
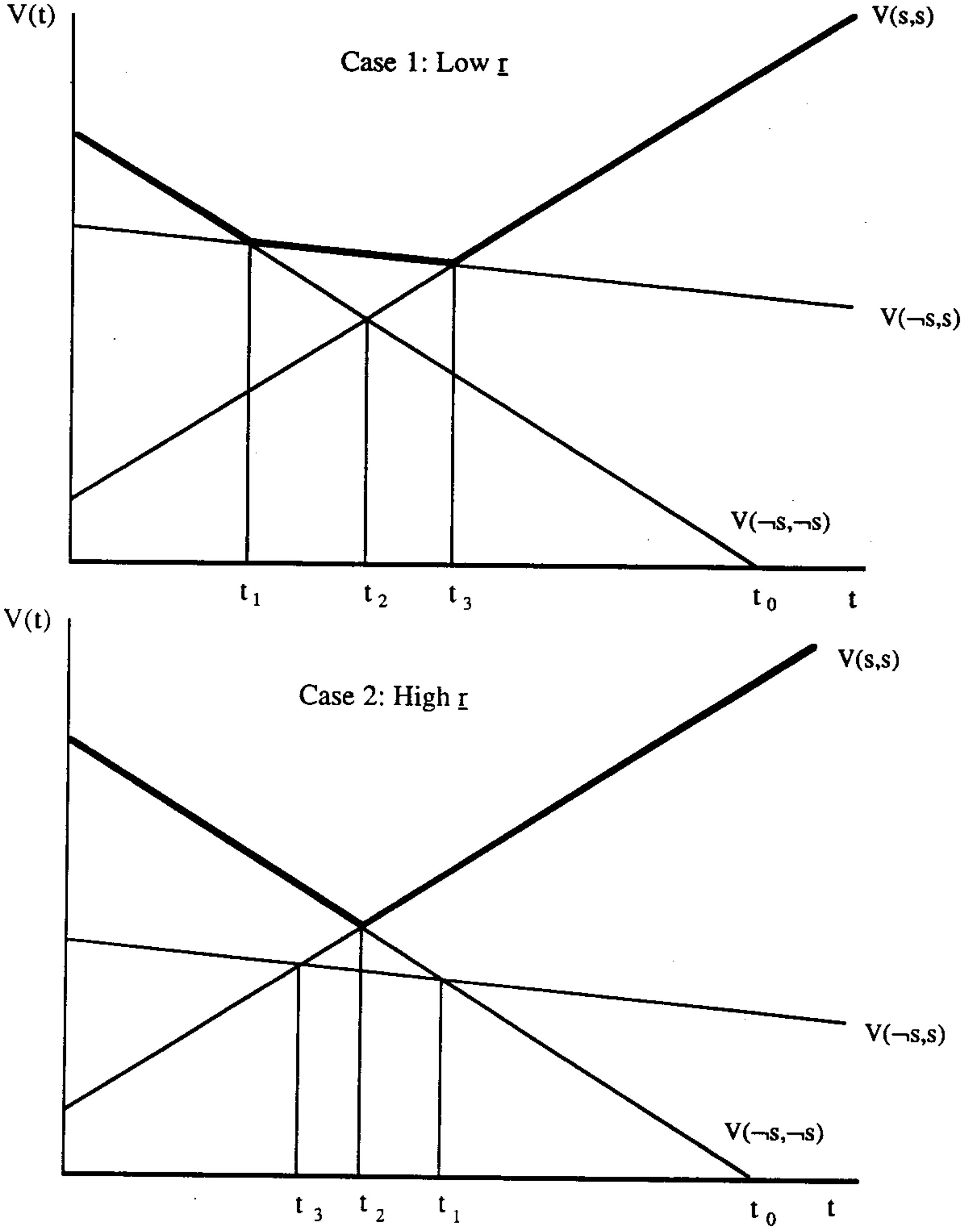
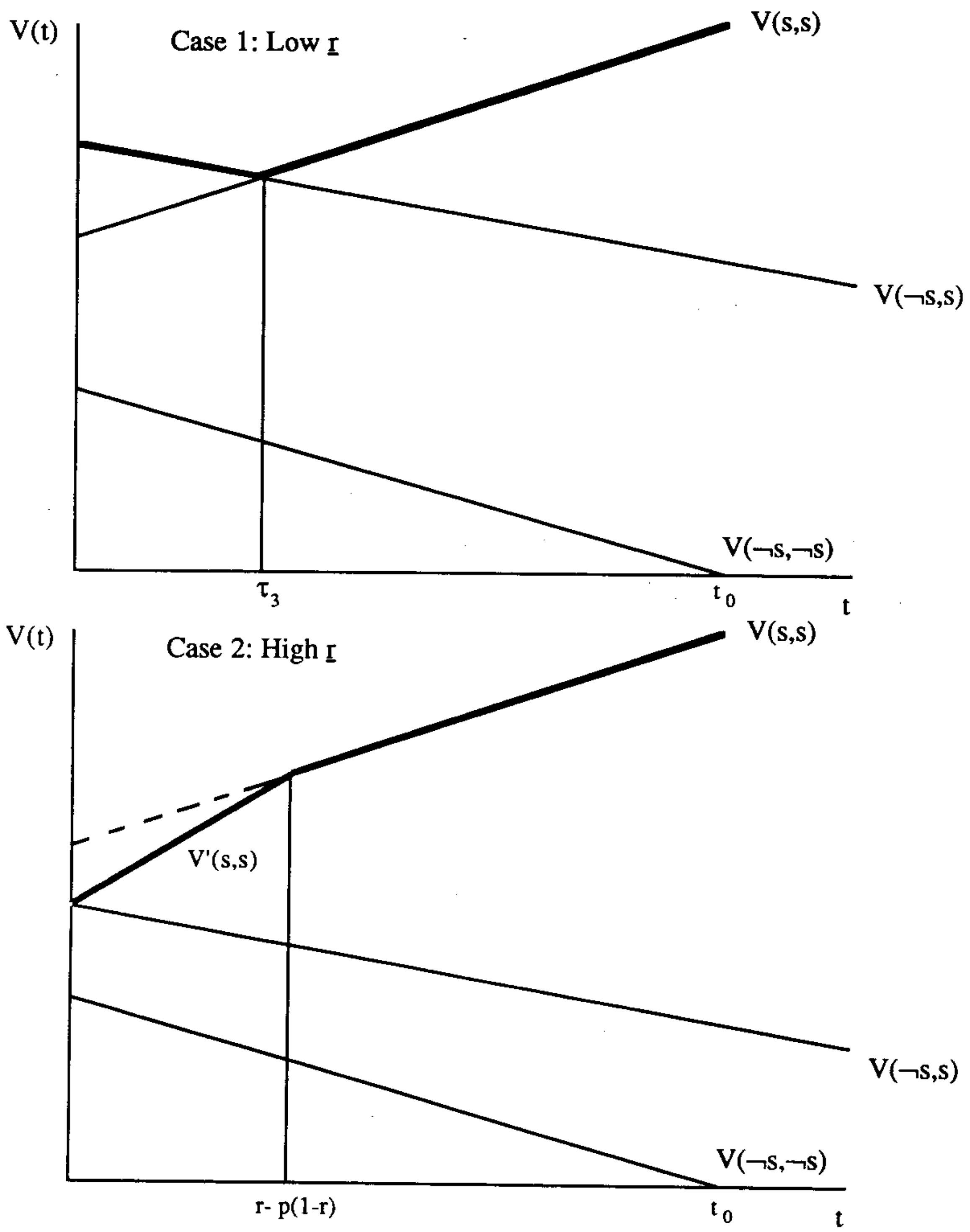


Figure V: Plaintiff's Optimal Strategy as a Function of Litigation Costs: Uncorrelated Probabilities*



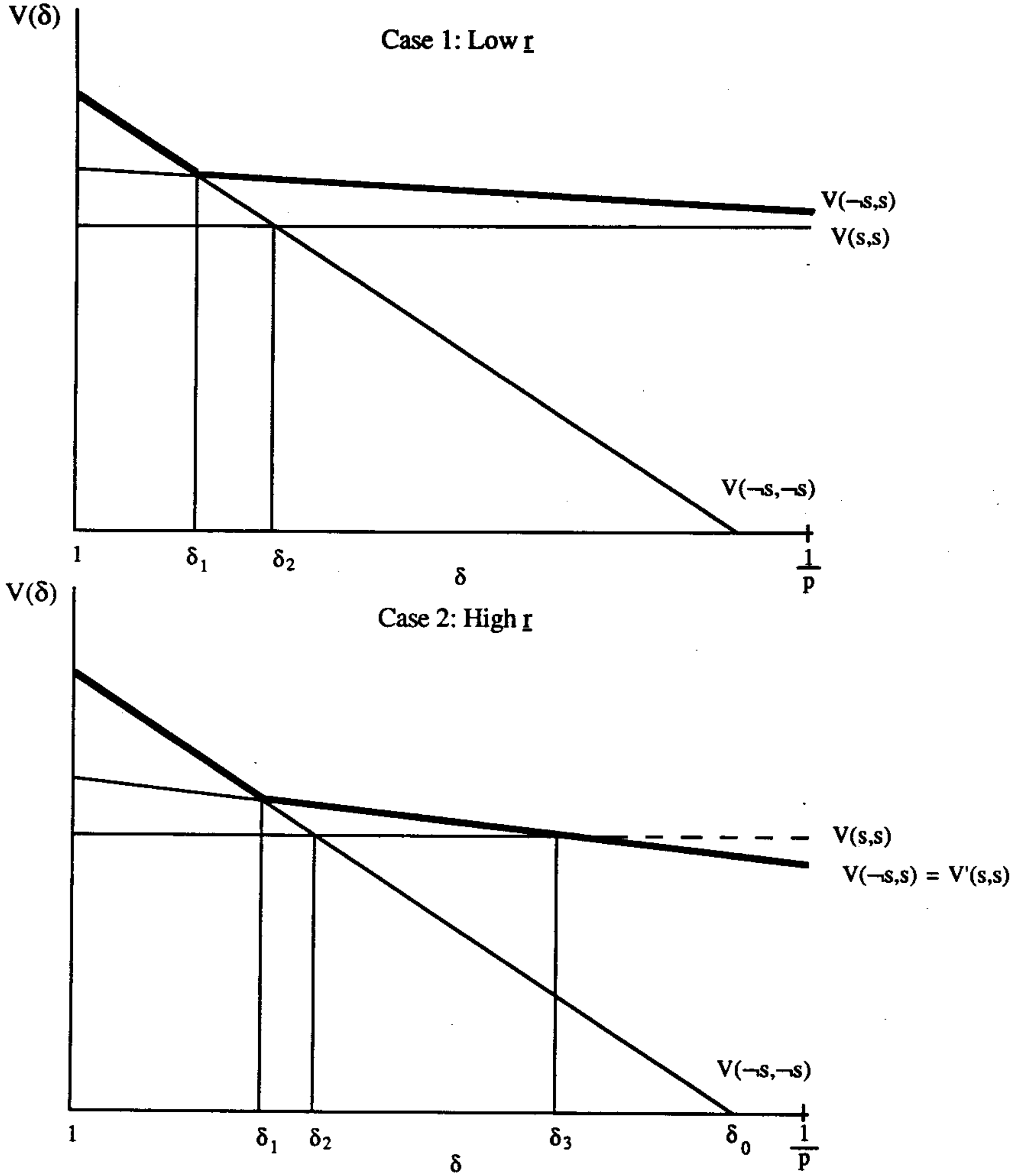
* Not drawn to scale

Figure VI: Plaintiff's Optimal Strategy as a Function of Litigation Costs: Perfectly Correlated Probabilities*



* Not drawn to scale

Figure VII: Plaintiff's Optimal Strategy as a Function of the Correlation of the Outcomes of Litigation if the Costs of Litigation are Zero.*



* Not drawn to scale

Figure IX: Region of (s,s) Equilibria for High Transaction Costs (t >1)