Pretrial Negotiation with Multiple Defendants under Incomplete Information

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Abstract

This article analyzes the pretrial settlement process among an uninformed plaintiff and multiple defendants who share information about the winning chances of their cases. We obtain two results. If the chances are positively correlated, there always exists the no-distortion equilibrium in which defendants make settlement offers as if under complete information and it is the unique separating outcome of a refined equilibrium concept. However, if the chances are negatively correlated, *cross-type subsidization* occurs to circumvent the possibility of signal jamming, in other words, the settlement offer of a strong defendant (a weak defendant respectively) is distorted upward (downward respectively), as far as the no-distortion equilibrium is not viable. In both cases, the plaintiff settles with defendants with probability one. We discuss a policy implication on the effect of a reform from the rule of joint and several liability into the nonjoint liability rule.

1 Introduction

In many instances, harms are caused by more than one injurer. Examples abound. Water and ground pollution in a certain district may be attributed to several factories emitting

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toxic chemicals. Firms may fix their sales prices collusively to extract consumers' surpluses. A consumer may be injured by a product manufactured unsafely by the contractor itself or its subcontractor. A driver may be killed by a chain of collisions with more than one vehicle.

If each of the defendants is found to be liable for the plaintiff's total harm, we call the defendants to be "jointly and severally liable." Under the rule of joint and several liability, the plaintiff may sue all injurers jointly or may elect only one of them for her recovery, regardless of the particular injurer's share of the liability. The rule of joint and several liability is applied when either defendants acted jointly or the plaintiff's harm is indivisible.

Depending on the apportionment rules, however, defendants who paid more than their equitable share may or may not take an action for contribution from the other defendants. Under the rule of no contribution, no one who paid more has the right to obtain any reimbursement from other defendants. On the other hand, under the rule of contribution, a defendant may obtain contribution from the other defendants called on to pay less than their share. At common law, there was no right to contribution,[1]but the contribution rule has been gradually replacing the no contribution rule from concerns that the no contribution rule may cause a serious consequence against the social justice.[2]Recently, various statutes explicitly provide for the contribution rule.[3]

As in the relationship between a single plaintiff and a single defendant, it is usual that defendants are better informed of circumstantial facts affecting the trial outcome, for example, whether they have taken due care. Furthermore, it is also common that defendants share such information. For instance, when a hunter was injured by one of his company's fires, each of the company may know who caused the harm, although the victim cannot tell. As another example, potential polluters may infer from the evidences the victims provide how much each of them has contributed to their harm. Generally, if a defendant was careful in preventing the accident, he could be sure that the accident was caused by the other defendant's negligence.

Sharing information among defendants brings about qualitative differences between multi- and single-defendant settlement models in which the defendant(s) makes an offer. Most importantly, the first-best outcome under full information is more likely to be sustained because it is hard for defendants to deviate successfully from the strategies proposed to play in equilibrium. In a settlement with a single defendant, a lower offer must be rejected with a higher

probability to deter the incentive for a weak defendant to mimic a strong defendant. Thus, trial necessarily occurs in equilibrium as long as the defendant uses a separating strategy whereby a strong defendant and a weak defendant make different amounts of the settlement offer. In the settlement with multiple defendants, however, the plaintiff does not need to use a costly screening strategy whereby she rejects a lower offer with a higher probability. This is because it is difficult for informed defendants to coordinate their deviations, so the uninformed plaintiff can usually infer from their settlement offers whether there was a deviation and even who deviated, and consequently she can punish the deviant effectively only off the equilibrium path without using a costly screening strategy.

There are some cases, though, in which the plaintiff can see if there was a deviation, but cannot tell who was the deviant. This is a consequence of so-called "signal jamming." By "signal jamming", we mean an action to prevent the other informed player from conveying information regarding the true state of the world to an uninformed player via a signal.[4]The possibility of signal jamming occurs when there is a possible state in which defendants are put into an asymmetric position, in other words, a state that is favorable to one defendant but unfavorable to the other defendant. Then, a defendant in the unfavorable situation may attempt to deviate in such a way that the plaintiff cannot tell who deviated, by taking advantage of the fact that the other defendant would deviate so were he in the unfavorable situation. For example, suppose one defendant was negligent and the other was not. Moreover, suppose the plaintiff knows that either one of them was negligent. If the negligent defendant mimics the settlement offer that the nonnegligent defendant is supposed to make, it is difficult for the plaintiff to correctly infer who was negligent.

In this paper, we investigate the settlement outcome when defendants share relevant information that a plaintiff cannot have access to. We mainly consider two extreme cases which are in a good contrast; ones in which the plaintiff's probabilities of success in litigating against two defendants are positively correlated and negatively correlated. We obtain two results. First, in the case of positive correlation, the no-distortion outcome, which is the equilibrium outcome under full information, always exists and hence no trial in equilibrium. Furthermore, it can be shown that this is, in fact, the unique unprejudiced separating equilibrium outcome.[5]Since there is no possibility of signal jamming in the case of positive correlation where both defendants are in the same situation, a unilateral deviation by a de-

fendant reveals the identity of the deviator immediately to the plaintiff. In other words, the defendants' inability to coordinate their deviations, together with the positive correlation of success probabilities, makes it unnecessary for the plaintiff to incur extra costs in order to prevent a weak defendant from mimicking a strong defendant. Second, in the case of negative correlation, which is the main focus of this paper, if the no-distortion outcome is not sustainable under incomplete information, the equilibrium offers are distorted in such a way that the offer of a weak defendant is lower and that of a strong defendant is higher than in the no-distortion outcome, that is, a strong defendant subsidizes a weak defendant, due to the possibility of signal jamming. The intuitive reason for this *cross-type subsidization* is that the attempt of a weak defendant to jam a signal can be frustrated by reducing the gain from signal jamming which is the difference between the two equilibrium offers. No trial occurs in this distorted equilibrium, either. The no trial result in both cases is contrasted with a single-defendant settlement. The case that success probabilities are independent across defendants is also discussed.

There is vast literature on the settlement with multiple defendants. Following the pioneering article by Easterbrook, Landes and Posner (1980), several authors have analyzed the issue of the multi-defendant settlement by modeling it into an extensive form game under complete information. Among others, Yi (1991) shows that the plaintiff settles with all defendants in a model where defendants make simultaneous settlement offers. This result, however, relies on the assumption that the probabilities of winning against each defendant are perfectly correlated. On the other hand, Kornhauser and Revesz (1994) obtain a surprising result that joint and several liability can discourage settlements (especially in the independence case) rather than encourage settlements in a model where a plaintiff makes final settlement offers to each of the defendants. Their analysis is more general in the sense that it covers the cases of imperfect correlation and independence as well. There are also some articles addressing the issue under asymmetric information. (e.g., Yi [1991], Spier [1994] and Feess & Muehlheusser [2000].) However, all of them are screening models in which an uninformed party (or uninformed parties) moves first. So, there is no signalling involved in those models.[6]

The organization of the paper goes as follows. In the next section, we set up the basic model. In Section 3, we provide the solution for the model under complete information as a

benchmark. We characterize equilibrium outcomes under incomplete information in Section 4. In Section 5, we discuss the consequence of some variations in the basic model. Policy implications and concluding remarks follow in Section 6.

2 Model

A risk neutral plaintiff (P) has brought suit against two risk neutral defendants (D_1, D_2). P suffers a damage of size w which is normalized to one. The size of the damage is known to all parties. The chance that P will prevail against D_i at court, denoted by q_i, is unknown to P for $i = 1, 2$, but known to both of D_1 and D_2. For example, each defendant is informed of the other defendant's negligence as well as his own negligence. The probabilities, q_1 and q_2, are distributed over a two-dimensional set according to a certain density function which is common knowledge among all players including P. They are either correlated or independent.[7]

P, D_1 and D_2 can settle the disputes out of court prior to going to trial. Pretrial negotiations are proceeded as follows. Initially, D_1 and D_2 make their respective settlement offer s_1 and s_2 simultaneously on a take-it-or-leave-it basis, and P decides whether to accept each of them or not. If she accepts only one offer s_i, P goes to trial only with the rejected defendant. We assume the pro tanto setoff rule whereby the settlement with one defendant reduces the maximum amount that the plaintiff can be awarded from the trial against the other defendant by the amount of settlement.[8]Then, the court would enforce the payment of $1 - s_i$ in case that P wins. The monetary transfer between a settling defendant and a nonsettling defendant is not allowed.[9]If P rejects both offers, both defendants go to court and each defendant D_i pays the amount proportional to his share of the liability r_i which is common knowledge if both lose.[10]It is of course that the losing party pays the total damage if only one loses. Trial incurs additional litigation costs c_d to each D_i and c_p to P if only one defendant goes to trial but c_{pp} if both go to trial. It is reasonable to assume that $c_{pp} > c_p$. We do not exclude the possibility that P withdraws her case after rejecting an offer. However, some assumptions on c_p and c_{pp} that are made in the next section free us from the burden of this extra consideration.

3 Primer: Complete Information

It will be useful to start with the analysis of the case in which P is informed of q_1 and q_2.[11] Although the case of correlation is our main concern in the next section, we will focus more on the case of independent success probabilities, since the latter case is much more illuminating and, besides, the former case can be readily adapted from the latter case.

3.1 Case of Independent Probabilities

The plaintiff maximizes the sum of the monetary gain from the trial and the settlement amount that she can extract from both defendants. Table 1 summarizes the payoffs of P, D_1 and D_2 conditional on P's litigation decision unless P withdraws one or both of her lawsuits. In Table 1, $\overline{s}_i$ is the plaintiff's gain from the litigation only against D_i and $\overline{s}_{12}$ is her gain from the litigation against both D_1 and D_2. We assume that $q_i > c_p$ for all $i = 1, 2$, that is, each single case is meritorious. We also assume that $\overline{s}_{12} > 0$, $i = 1, 2$, so that P will not withdraw her lawsuit after rejecting both settlement offers. However, depending on the size of s_j, she may drop a case after she settles with one defendant. This possibility occurs when $q_i(1 - s_j) < c_p$, i.e., $s_j > 1 - c_p/q_i$. So, in fact, P's payoff when she accepts only s_j is $q_i(1 - s_j) - c_p + s_j$ if $s_j \leq 1 - c_p/q_i$ and s_j otherwise.

A natural solution concept for this complete information model is the SPE (Subgame Perfect Equilibrium) which can be found by backward induction.

Plaintiff's Decision

A given pair of settlement offers (s_1, s_2) belong to one of the following regions.

Region I: both accepted This region is characterized by

$$\{(s_1, s_2) \in \Re^2_+ | s_i \geq \max(\overline{s}_i, 0), s_1 + s_2 \geq \overline{s}_{12}, i = 1, 2\}. \tag{1}$$

As long as we consider nonnegative settlement offers, this can be simplified into

$$\{(s_1, s_2) \in \Re^2_+ | s_i \geq \overline{s}_i, s_1 + s_2 \geq \overline{s}_{12}, i = 1, 2\}.$$

The first condition says that accepting the settlement offer by D_i is better than litigating only against D_i. The second condition says that accepting both offers is better than litigating against both defendants. The first condition for both $i = 1, 2$ may not be sufficient for accepting both offers if litigating both cases saves trial costs significantly, i.e., $c_{pp} \ll 2c_p$.

Region II: both rejected For this region, it must be that $\overline{s}_{12} > \max\{s_i + \max(\overline{s}_j, 0), s_1 + s_2, i \neq j\}$. Thus, the region is represented by

$$\{(s_1, s_2) \in \Re^2_+ | s_i < \tilde{s}_i, s_1 + s_2 < \overline{s}_{12}\}, \tag{2}$$

where $\tilde{s}_i$ satisfying $\tilde{s}_i = \overline{s}_{12} - \overline{s}_j(\tilde{s}_i)$ is the amount of D_i's settlement offer making P indifferent between litigating against both defendants and litigating only against D_j. If $s_i > \tilde{s}_i$, s_i is accepted. Since P can increase the chance of recouping the damage at court by litigating against both, $\tilde{s}_i$ is positive, unless the litigation against both defendants is too costly, i.e., $c_{pp} \gg c_p$. If $\tilde{s}_i < 0$, P always finds it in her interest to accept s_i, consequently this region disappears.

Region III: only s_i accepted This region is represented by

$$\{(s_1, s_2) \in \Re^2_+ | (1 - q_j)s_i \geq (1 - q_i)s_j - \delta_{ij}, s_i \geq \tilde{s}_i, s_j < \overline{s}_j, i \neq j\}. \tag{3}$$

where $\delta_{ij} = q_j - q_i$. The first condition says that it is better to accept s_i than s_j if only one of the offers is to be accepted. The first condition does not exclude the possibility that both offers are accepted nor rejected. The second condition requires that it is better to accept s_i than to reject it, and the third condition says that it is better to reject s_j than to accept it. The term δ_{ij} can be called a *liability premium*. A defendant with a higher winning probability enjoys this premium. Due to this premium, his offer that is lower than the other's offer can be accepted. A lower offer can beat a higher offer if $\delta_{ij} \neq 0$, because the plaintiff is aware that she is less likely to win at court against the defendant offering a lower amount.

For tie-breaking rules, we are assuming that indifference between accepting and rejecting an offer is resolved in favor of accepting it, and that indifference between accepting s_1 and s_2 is resolved by randomizing with equal probability. Then, the four regimes (AA, AR, RA,

RR) characterizing the plaintiff's decision are illustrated in Figure 1a, b. Point A and B can be computed as follows;

$$A = (\hat{s}_1, \hat{s}_2) = \left(\frac{q_1(1-q_2) - (1-q_1)c_p}{1-q_1q_2}, \frac{q_2(1-q_1) - (1-q_2)c_p}{1-q_1q_2} \right).$$

$$B = (\tilde{s}_1, \tilde{s}_2) = \left(q_1 - \frac{c_{pp} - c_p}{1-q_2}, q_2 - \frac{c_{pp} - c_p}{1-q_1} \right).$$

Notice that the line depicted by $s_1 + s_2 = \overline{s}_{12}$ must pass through point C, so that $s_1 + s_2 = \overline{s}_{12}$ becomes unbinding if c_{pp} is high as in Figure 1a.

One important implication of the preceding analysis is that the possibility that an offer by D_i will be accepted is not determined only by s_i but also by s_j, in other words, the events that each defendant goes to trial are not independent. The incentive to reject s_i becomes weaker when s_j is rejected than when it is accepted, because litigation against one more defendant would not give much additional gain. Another salient feature is that an offer $s_i < q_i - c_p$ can be accepted, which is impossible in the case that a plaintiff faces a single defendant. If the other offer is accepted, P's opportunity cost of accepting D_i's offer is $q_i(1-s_j) - c_p$ which is smaller than $q_i - c_p$, so she can accept an offer between $q_i(1-s_j) - c_p$ and $q_i - c_p$. Also, if s_j is much lower than s_i, it may be better to reject s_j and instead accept s_i as long as s_i is not too low, because a plaintiff cannot be awarded twice the total damage even though she wins against both defendants at court.

Defendant's Decision

A defendant's offer is made based on the consideration of the other defendant's offer and the subsequent plaintiff's acceptance decision. Without loss of generality, we assume that $q_1 \geq q_2$.

Suppose Figure 1a is the case. Let us consider D_1's best response function. As the first case, suppose $s_2 < \tilde{s}_2$. This settlement offer by D_2 will be rejected at any event. Then, s_1 will be accepted if and only if $s_1 \geq \tilde{s}_1$. Since any offer $s_1 > \tilde{s}_1$ is dominated by $s_1 = \tilde{s}_1$, his best response is $\tilde{s}_1$ if the loss he must bear were his offer rejected exceeds the settlement offer, that is, $q_1(1-q_2) + q_1q_2r_1 + c_d > \tilde{s}_1$, or equivalently, $r_1 > 1 - \frac{1}{q_1q_2}(c_d + \frac{c_{pp}-c_p}{1-q_2})$. As the second case, if $s_2 \geq \hat{s}_2$, the offer is always accepted regardless of s_1. Since D_1's

offer s_1 is accepted in this case if and only if $s_1 \geq \overline{s}_1(s_2)$, his best response will be $\overline{s}_1(s_2)$. For a loss incurred by a lower offer would be $q_1 + c_d (> \overline{s}_1 = q_1(1 - s_2) - c_p)$. Finally, if $\tilde{s}_2 < s_2 < \hat{s}_2$, it is optimal for P to accept only one of s_1 and s_2. Thus, D_1 offers $s_1 = \frac{1}{1-q_2}[(1 - q_1)s_2 - \delta_{12}] + \epsilon$ to beat D_2's offer marginally, provided that it is less costly than the trial. Since $s_1 \approx \frac{1}{1-q_2}[(1-q_1)s_2 - \delta_{12}] < \hat{s}_1 = q_1(1-s_2) - c_p < q_1 + c_d$ for all $\tilde{s}_2 < s_2$, s_1 could not be more costly than the trial.

The best response functions of defendants and the Nash equilibrium offers are illustrated in Figure 1. Figure 1a is the case in which there is a unique Nash equilibrium, denoted by (s_1^N, s_2^N), while Figure 1b represents the set of continuum Nash equilibria.

Discussions above suggest sufficient conditions for the uniqueness of the equilibrium as follows;

[C1] $\hat{s}_i \geq \tilde{s}_i$ for all $i = 1, 2$.

[C2] $r_i \geq 1 - \frac{1}{q_1 q_2}\left(c_d + \frac{c_{pp} - c_p}{1-q_j}\right)$ for one or both of $i = 1, 2$.

However, it can be shown that [C2] is implied by [C1].[12]

If [C1] is not satisfied, it is indeed that [C2] may fail to hold, implying the possibility of multiple equilibria involving an outcome in which both offers are rejected.[13]Intuitively, if, for example, c_{pp} is so small that [C1] is violated, the region in which both offers are rejected is enlarged, and then both defendants may prefer going to trial by giving up making such a high offer that could be accepted. This outcome is in sharp contrast with the results of Easterbrook *et al.* (1980) and Yi (1991) that at least one offer must be accepted in the complete information case. This difference comes from the assumption of independence between q_1 and q_2. If q_1 and q_2 are perfectly correlated, P's payoff when accepting only one offer always exceeds her payoff when she rejects both offers, since $s_i + q(1 - s_i) - c_p = q - c_p + (1 - q)s_i > q - c_{pp}$. Intuitively, this is because accepting an offer does not reduce the probability of recovering the total damage at all in the correlated case, implying that the plaintiff is more likely to accept an offer than in the independence case. Since the probability is reduced by accepting one offer in the independence case, it is plausible that both offers are rejected.

If q_2 is so small relative to q_1 that $\hat{s}_2 \leq 0$, the unique Nash equilibrium involves a zero settlement offer by D_2. Clearly an extremely low winning probability against D_2 implies

that P prefers accepting any s_2. This possibility is illustrated in Figure 1c.

3.2 Case of Correlated Probabilities

We consider only two extreme cases of correlation, perfectly positive correlation and perfectly negative correlation.

If q_1 and q_2 are positively correlated, a high (or low resp.) probability of winning against one defendant implies a high (low resp.) probability of winning against the other defendant. In particular, if their correlation is perfect, it is impossible for P to win against D_1 but lose against D_2. In this case, we can save notation by using $q_1 = q_2 = q$. If they are negatively correlated, a high (or low resp.) probability of winning against one defendant implies a low (high resp.) probability of winning against the other. In particular, if the negative correlation is perfect, P wins against either one of the two defendants for sure, but not against both. Thus, $q_1 + q_2 = 1$.

If they are correlated rather than independent, the payoffs of each player are affected only when both offers are rejected. In the case of perfectly positive correlation, the payoffs of P and D_i when both cases are litigated are $q - c_{pp}$ and $-qr_i - c_d$ respectively. Thus, the counterpart for $\tilde{s}_i$ in this case is $\tilde{s}_i^p = \frac{c_p - c_{pp}}{1-q} < 0$, while the counterpart for $\hat{s}_i$ remains the same as the one in the independent case which is reduced to $\frac{q-c_p}{1+q} > 0$. This implies that the RR region disappears and that there is a unique equilibrium unconditionally. Again, observe that each equilibrium settlement offer $\frac{q-c_p}{1+q}$ is smaller than the equilibrium offer in the single defendant case, $q - c_p$. Note, however, that P's total recovery, $\frac{2(q-c_p)}{1+q}$, exceeds her recovery in the single defendant case, $q - c_p$. This is due to the bidding competition between defendants who want to avoid costly litigation. This result accords with the one provided by Easterbrook *et al.* (1980), Polinsky & Shavell (1981) and Yi (1991). On the other hand, in the case of perfectly negative correlation, the payoffs of P and D_i when both cases go to trial are $1 - c_{pp}$ and $-q_i - c_d$ respectively. The counterpart for $\tilde{s}_i$ in this case can be computed as $\tilde{s}_i^n = 1 - \frac{c_{pp} - c_p}{1-q_j}$. Then, the unique equilibrium can be ensured if both [CN1] and [CN2] hold where

[CN1] $\hat{s}_i \geq \tilde{s}_i^n$ for all $i = 1, 2$,

[CN2] $\tilde{s}_i^n \leq q_i + c_d$, or equivalently, $q_j \leq \frac{c_{pp}-c_p}{q_i} + c_d$ for one or both of $i = 1, 2$.

Again, it is easy to see that [CN1] implies [CN2].[14]Thus, [CN1] is a sufficient condition for the unique equilibrium.

To summarize, we have the following proposition.

Proposition 1 *(i) In the case of independence, there is a unique equilibrium under [C1]. (ii) In the case of perfectly positive correlation, there is always a unique equilibrium. (iii) In the case of perfectly negative correlation, there is a unique equilibrium under [CN1]. In all of these unique equilibria, the plaintiff settles with both defendants with probability one.*

4 Incomplete Information

To simplify the possible complexity arising in the pretrial negotiation involving multiple informed defendants, we assume that the probability of winning against each defendant is simply either high (H) or low (L). The prior probability that $q_1 = H$ is λ which is common knowledge. Also, we assume that q_1 and q_2 are correlated (either positively or negatively). The case that q_1 and q_2 are independent will be discussed in the next section.

Before we start the analysis, let us define formally the structure of information that each defendant possesses. Let Ω be the set of states of the world. A state of the world, denoted by ω, represents the probability of winning against each defendant. For example, $\Omega = \{\omega = (q_1, q_2) \mid (H, L), (L, H)\}$ in the case of negative correlation. The information partition of D_i is denoted by Ω_i which is, in this case, $\{\{(H, L)\}, \{(L, H)\}\} = \Omega$. The interpretation is that D_i cannot distinguish among elements in the same information set which is an element of the information partition. Since all information set consists of a singleton in this case, both defendants know the true state of the world. Then, hereafter, D_i with private information ω will be denoted by $D_i(\omega)$. Analogously, the information partition of the plaintiff can be represented by $\Omega_p = \{\{(H, L), (L, H)\}\}$. That is, she cannot tell against which defendant she is more likely to win.

We begin the analysis by defining strategies and beliefs. A strategy for D_i is a map from his information partition to the possible choices of his settlement offer i.e., $s_i : \Omega_i \to \Re_+$. A (behavioral) strategy for P is a map from $\Re_+^2$ into $\Delta(A)^2$, $a : \Re_+^2 \to [0, 1]^2$, where

$A = \{0, 1\}$ and 1 indicates "accept", 0 indicates "reject", and $\Delta(A)$ is the set of all the probability distributions over A. Here, $a(s_1, s_2) = (a_i(s_1, s_2), i = 1, 2)$ can be interpreted as the probability that s_i is accepted when settlement offers are s_1 and s_2. Also, P's posterior belief over winning probabilities on her information set, denoted by $\hat{\lambda}$, will be defined as a map from the set of possible past observations to $[0, 1]$, i.e., $\hat{\lambda} : \Re^2_+ \to [0, 1]$. So, $\hat{\lambda}(s_1, s_2)$ is the probability that $q_1 = H$ after observing the settlement offers (s_1, s_2).

Given the strategies and beliefs, we can compute D_i's expected loss and P's expected gain which will be denoted by π_i and π_p respectively.

The basic solution concept that will be employed is the weak Perfect Bayesian equilibrium (wPBE) of Mas-Colell, Whinston and Green (1995). We focus only on separating wPBE (SPBE) in which the type of defendants is revealed by their settlement offers. The formal definition of SPBE follows.

Definition 1 *A tuple of strategies and beliefs* $\{s_1^*(\omega), s_2^*(\omega), a^*(s_1, s_2), \hat{\lambda}(s_1, s_2)\}$ *constitutes a separating wPBE (SPBE) of the litigation game under incomplete information, if it satisfies the following conditions.*

Condition 1: separation

$s^*(\omega_1) \neq s^*(\omega_2)$ *for all* ω_1, ω_2 *with* $\omega_1 \neq \omega_2$, *where* $s^* = (s_1^*, s_2^*)$.

Condition 2: sequential rationality

(i) for all ω, $s_i^*(\omega) \in \arg\min_{s_i} \pi_i(s_i, s_j^*(\omega), a^*(s), \omega)$, *for all* $i = 1, 2$.

(ii) for all s, $a_i^* \in \arg\max_{a_i} E[\pi_p(s, a(s), \omega); \hat{\lambda}]$, *for all* $i = 1, 2$.

Condition 3: consistency

(i) $\hat{\lambda}(s) = 1$ *if* $s = (s_1^*(H, \cdot), s_2^*(H, \cdot))$.

(ii) $\hat{\lambda}(s) = 0$ *if* $s = (s_1^*(L, \cdot), s_2^*(L, \cdot))$.

(iii) $\hat{\lambda} \in [0, 1]$ *if* $s \neq (s_1^*(\omega), s_2^*(\omega))$ *for some* ω.

In words, Condition 1 is merely the requirement that at least one defendant plays a separating strategy. Conditions 2-(i) requires that each defendant choose a loss-minimizing offer given the other's strategy, anticipating the plaintiff's probability of acceptance. Condition 2-(ii) requires that the plaintiff make the optimal acceptance decision maximizing her expected gain given the posterior beliefs on the equilibrium path and off the equilibrium path as well. Condition 3 requires the plaintiff's posterior beliefs about ω to be updated from

her prior beliefs by Bayes' rule together with the defendants' equilibrium strategies on the equilibrium path.

4.1 Positive Correlation

No-Distortion Equilibrium

As a reference point, we define a no-distortion equilibrium by $s_i^*(\omega) = s_i^N(\omega)$ for all possible $\omega \in \Omega = \{(H, H), (L, L)\}$ or simply $\{H, L\}$, where $(s_1^N(\omega), s_2^N(\omega))$ is the Nash equilibrium when the state of the world is ω. In a no-distortion equilibrium, defendants make their equilibrium settlement offers under full information in each state of the world. Now, we have

Proposition 2 *There exists the no-distortion equilibrium. In this equilibrium, both settlement offers are accepted with probability one.*

Proof. See the appendix.

This proposition implies that in the case of positive correlation all the multi-defendant lawsuits are settled and moreover the settlement offers are not distorted from the first-best ones, even if there is incomplete information about winning probabilities. The intuitive reason for the no-distortion result is that informed defendants cannot coordinate their mimicry of strong types. Defendants whose cases are weak (H) may want to pretend to be strong (L) by making the equilibrium offer of L type. This mimicry would be successful only if the other defendant also defected. However, such coordination in defection is not possible as long as defendants make settlement offers in a noncooperative fashion. The presence of another informed defendant makes it impossible for each informed defendant to deviate from his equilibrium settlement offer successfully, thus results in more settlements than in the single-defendant case. Furthermore, their inability to coordinate deviations enables strong types to signal the strength of their own cases without sacrificing payoffs through distortions in their settlement offers.

Distortion Equilibria and Refinements

Indeed, the no-distortion equilibrium is not the only possible outcome. The following lemma will be helpful to characterize the set of SPBE.

Lemma 1 *In any SPBE,* $s_i^*(H) = s_i^N(H)$ *for all* $i = 1, 2$.

Proof. See the appendix.

This lemma says that the settlement offers of H type defendants are never distorted. Intuitively, this is because if a defendant's equilibrium offer is not a best response to the other's offer, there would be no way to punish a defendant who deviates to the best response.

Due to Lemma 1, we have only to find the equilibrium values for $s_i^*(L)$. As illustrated in Figure 2a, there are continuum of equilibrium values. This is not surprising. The reason why the no-distortion outcome was sustainable was that $D_i(L)$ preferred $s_i^*(L)$ being accepted to being litigated because $s_i^*(L) < L + c_d$. Thus, any offer close to $s_i^*(L)$ in the interior of AA region in state L could be an equilibrium offer. The detailed proof will be provided in the Appendix.

Bagwell and Ramey (1991) proposed the concept of "unprejudicedness" to pare down unintuitive equilibria in a signalling game with multiple senders. This can be defined as the minimality rule such that when P observes an off-the-equilibrium message s, she must believe that $\omega = \omega_1$ if $N(\omega_1; s) < N(\omega_2; s)$ for some ω_1, ω_2. Here, $N(\omega; s)$ denotes the number of deviations required for the defendants with type ω to generate s. In this model, it turns out that the unprejudicedness can single out the unique equilibrium outcome. Consider, for example, a small deviation C' from equilibrium point C in Figure 2a. Since $N(H) = 2$ but $N(L) = 1$ for such a deviation, the unprejudiced belief must be $\hat{\lambda} = 0$. This belief destroys the equilibrium associated with point C. From Figure 2a, we can easily see that $(s_1^N(L), s_2^N(L))$ is the only unprejudiced SPBE. Proposition 3 summarizes the discussion hitherto.

Proposition 3 *There always exists a continuum of SPBE, but the no-distortion equilibrium is the unique unprejudiced SPBE.*

Proof. See the appendix.

Discussion on Pooling Equilibria

We will briefly discuss the possibility of pooling equilibria. A pooling equilibrium occurs when $s_i^*(L) = s_i^*(H)$ for $i = 1, 2$. We will focus only on a symmetric equilibrium.

Let s be a symmetric pooling offer. We will identify the condition for s to be an equilibrium offer. Since the loss from a deviation is less severe to L type than to H type in a pooling equilibrium, we have only to check the incentive compatibility condition for L type.

The posterior belief is preserved after observing the pooling offer s. To obtain the maximal set of pooling offers, we impose the most pessimistic belief $\hat{\lambda} = 1$ off the equilibrium path.

Suppose (s, s) is down below point B in Figure 2b. Each of the offers is accepted with probability equal to one half. If a defendant deviates to a slightly lower offer, it will be rejected and his loss will be $L + c_d$. So, s must be less than $L + c_d$. However, it cannot be an equilibrium because a slightly higher offer, $s + \epsilon$, can be accepted with certainty and clearly $s + \epsilon < s/2 + (L + c_d)/2$ if $s < L + c_d$. On the other hand, suppose (s, s) is above point A. This offer cannot be an equilibrium, either, because a slightly lower offer can be accepted for any posterior belief. Finally, suppose s is between point A and B. If a defendant deviates by making a slightly lower offer, it will be rejected. Thus, s can be an equilibrium offer if $s < L + c_d$. The equilibrium set of pooling equilibrium offers are drawn in Figure 2b. Note that none of them are eliminated by the unprejudicedness because both types of defendants use the same strategy in a pooling equilibrium, i.e., $N(L) = N(H)$ for any deviation from the pooling offers.

4.2 Negative Correlation

If q_1 and q_2 are negatively correlated, P cannot win against both defendants. We assume that (q_1, q_2) is either (H, L) or (L, H) with $q_1 + q_2 = 1$. Also, we confine ourselves to the case that the Nash equilibrium under full information is unique.

Possibility of Signal Jamming

The no-distortion outcome is illustrated in Figure 3. Not as in the case of positive correlation, each defendant's wish to pretend to be of L type generates the possibility of signal jamming.

To see the possibility of signal jamming, consider two points, A and B in Figure 3, where $s_H = s_1^N(H, L) = s_2^N(L, H)$, $s_L = s_1^N(L, H) = s_2^N(H, L)$. If information is complete, $D_1(H, L)$ who is more likely to lose his case must offer a higher settlement amount than

$D_2(H, L)$ as in point A. On the other hand, the settlement offer of $D_2(L, H)$ must be higher than that of $D_1(L, H)$ as in point B. Thus, if he could fool P into believing that he is L type, $D_1(H, L)$ (or $D_2(L, H)$ respectively) might deviate to a lower settlement offer at the point A (or point B respectively). However, the incentive for an H-type defendant to lower his offer can be eliminated by pessimistic off-the-equilibrium beliefs. For example, $D_1(H, L)$'s incentive to deviate to s_1 is prevented by imposing $\hat{\lambda}(s_1, s_L)$ close to one for all $s_1 \neq s_H$, while $D_2(L, H)$'s incentive is eliminated by $\hat{\lambda}(s_L, s_2)$ close to zero for all $s_2 \neq s_H$. However, a difficulty occurs when either $D_1(H, L)$ or $D_2(L, H)$ deviates to the point C. Then, what belief should be assigned to this point? If $\hat{\lambda}$ were too high, $D_1(H, L)$ could profitably deviate to C and if $\hat{\lambda}$ were too low, $D_2(L, H)$ could. So, it should not be too high nor too low to prevent both incentives. If there is no such $\hat{\lambda}$, a H-type defendant would be able to succeed in keeping the plaintiff from processing accurate information on the strength of each defendant by jamming a signal of an L-type defendant. Therefore, in this case, a deviation to the point C can be interpreted as successful "signal jamming".

No-Distortion Equilibrium

Given the belief $\hat{\lambda}$, the partition of the space (s_1, s_2) into four regions representing P's decision is determined by the counterparts for $\overline{s}_1$, $\overline{s}_2$, $\tilde{s}_1$ and $\tilde{s}_2$. Note that

$$\tilde{s}_1(H, L) = 1 - (c_{pp} - c_p)/H,$$
$$\tilde{s}_2(H, L) = 1 - (c_{pp} - c_p)/L,$$
$$\overline{s}_{12}(\hat{\lambda}) = 1 - c_{pp}.$$

Then, we have

$$\overline{s}_1(\hat{\lambda}) = \frac{M(\hat{\lambda}) - M(1 - \hat{\lambda})c_p - (1 - c_p)LH}{1 - LH}, \tag{4}$$

$$\overline{s}_2(\hat{\lambda}) = \frac{M(1 - \hat{\lambda}) - M(\hat{\lambda})c_p - (1 - c_p)LH}{1 - LH}, \tag{5}$$

$$\tilde{s}_2(\hat{\lambda}) = 1 - \left(\frac{\hat{\lambda}}{H} + \frac{1 - \hat{\lambda}}{L}\right)(c_{pp} - c_p), \tag{6}$$

$$\tilde{s}_1(\hat{\lambda}) = 1 - \left(\frac{\hat{\lambda}}{L} + \frac{1-\hat{\lambda}}{H}\right)(c_{pp} - c_p), \tag{7}$$

where $M(\mu) = \mu H + (1-\mu)L$.

We can see that neither $D_1(H, L)$ nor $D_2(L, H)$ will deviate to C if $s_L \equiv \hat{s}_2(H, L) < \min\{\tilde{s}_1(\hat{\lambda}), \tilde{s}_2(\hat{\lambda})\}$, because these offers would be rejected then. Hence, the no-distortion equilibrium. If s_L is larger than one or both of $\tilde{s}_1(\hat{\lambda})$ and $\tilde{s}_2(\hat{\lambda})$, P will accept at least one offer of (s_L, s_L), thus one of the defendant can succeed in signal jamming, thereby subverting the no-distortion equilibrium. Since $\min\{\tilde{s}_1(\hat{\lambda}), \tilde{s}_2(\hat{\lambda})\}$ is maximized at $\hat{\lambda} = 1/2$, the no-distortion equilibrium can exist if $\frac{\tilde{s}_1(1/2)+\tilde{s}_2(1/2)}{2} > s_L$, that is

$$1 - \frac{1}{2}\left(\frac{1}{L} + \frac{1}{H}\right)(c_{pp} - c_p) > \frac{L^2 - Hc_p}{1 - LH}. \tag{ND1}$$

Proposition 4 *In the case of negative correlation, the no-distortion equilibrium exists under [ND1].*

Proof. See the appendix.

Under [ND1], the cost of litigating against both defendants is relatively small so that either defendant's attempt to jam a signal is frustrated by the plaintiff's balanced posterior belief and the concommitant decision to reject both settlement offers.

Figure 3 illustrates both possibilities. Figure 3a corresponds to a situation where the no-distortion equilibrium is sustained by the posterior belief $\hat{\lambda}(s_L, s_L) = 1/2$. In Figure 3b, the no-distortion equilibrium is unsustainable for any belief. Also, Figure 3c shows the possibility that an extreme value of belief can destroy the no-distortion equilibrium even in the case that the no-distortion equilibrium could be viable.

Distorted Separating Equilibria

Even if [ND1] condition is violated, the no-distortion equilibrium may exist if the following condition is met;

$$s_H - \frac{1}{2}s_L \leq \frac{1}{2}(H + c_d). \tag{ND2}$$

The signal jamming point is symmetric in the sense that both defendants make the same amount of offers. So, such a deviant offer is accepted with equal probability by the

assumption. [ND2] says that a deviation to a signal-jamming point one of whom must be accepted with equal probability is not profitable. The left hand side of inequality [ND2] represents the gain of a H-type defendant from a deviation to s_L and the right hand side represents his loss from the deviation.

If both [ND1] and [ND2] fail to hold, at least one equilibrium pair of settlement offers must be distorted. We will consider only symmetric equilibria in which $s_1^*(H, L) = s_2^*(L, H) \equiv s_h$ and $s_1^*(L, H) = s_2^*(H, L) \equiv s_l$.

First, it should be noted that (s_h, s_l) must stay in the boundary of the AA region given the belief $\hat{\lambda} = 1$. If they were in the interior, a defendant could deviate profitably by moving inward or downward while remaining in the interior of the AA region. Second, clearly, (s_h, s_l) must satisfy [ND1] or [ND2].

Intuitively, a defendant can succeed in signal jamming if the benefit from a deviation (paying a less settlement amount) exceeds the loss (increasing the probability of going to trial). Therefore, the signal-jamming incentive could be eliminated by either reducing the benefit from the deviation or increasing the loss. There are possibly two ways to recover SPBE. One is to increase the loss from the deviation by choosing (s_h, s_l) satisfying [ND1] condition. Then, a deviation from s_h to s_l would lead to the trial for sure. This would be possible by choosing $s_l < s_L$ and correspondingly $s_h > s_H$ so as for (s_H, s_L) to remain on the boundary of the AA region thereby inducing both to be accepted. However, this pair of offers cannot be an equilibrium because the H-type defendant always has an incentive to lower his offer slightly from s_h. The other possibility is to reduce the gain from the deviation. This is possible by agreeing (s_h, s_l) satisfying inequality [ND2]. This works as long as defendants find it in their interest to stick to these equilibrium settlement offers, that is, $s_l < L + c_d$ and $s_h < H + c_d$. To summarize, we have

Proposition 5 *Suppose [ND1] and [ND2] do not hold. Then, distorted equilibria involve (s_h, s_l) such that $s_h < s_H$ and $s_l > s_L$. In these equilibria, the plaintiff settles with both defendants with probability one.*

Proof. direct from the discussion above

This proposition says that even if the conditions for the existence of the no-distortion equilibrium do not hold, defendants circumvent the possibility of signal jamming in equilib-

rium in such a way that a stronger defendant makes a higher offer and a weaker defendant makes a lower offer than their respective offer in a no-distortion outcome, that is, a stronger defendant subsidizes a weaker defendant. Such a distortion involving a *cross-type subsidy* could reduce the gain from signal jamming. Figure 4 illustrates the set of equilibrium offers for parameter values of $L = 1/4$, $c_d = 1/8$, $c_p = 1/16$ and $c_{pp} = 1/8$.

At this moment, it is worthwhile to stress that both a low offer and a high offer can be accepted with probability one in this model as in the previous model. This is in sharp contrast with the result obtained in the case of a single defendant (e.g., Reinganum and Wilde [1986]). When there is only one informed defendant, he will always prefer a low offer if both a low offer and a high offer are accepted with certainty. However, if there are more than one defendant, $D_1(H, L)$ cannot deviate successfully to (s_l, s_h) alone, as we argued in the case of positive correlation. All he can do is to jam a signal by deviating to (s_l, s_l). Then, the plaintiff can punish him partially by assigning an appropriate posterior belief. In sum, punishing only off the equilibrium path is possible due to the presence of another informed defendant: Because of the inability to coordinate deviations, a weak defendant cannot mimic a strong type, but only attempt to jam a signal. This incentive of signal jamming can be prevented as well because another defendant can still give partial information about the true state of the world.

Discussion on Refinements

Unlike in the case of positive correlation, the unprejudicedness has no cutting power at all in this case. Any equilibrium survives the unprejudicedness. For example, consider point C in Figure 4. This point could be supported as an equilibrium outcome by the belief $\hat{\lambda}(s) = 1$ for a deviation to $s = (s_h - \epsilon, s_l)$. Since this belief satisfies the unprejudicedness, it survives the refinement.

We may also resort to refinements based on stability-like arguments by Kohlberg & Mertens (1986), Cho & Kreps (1987) and Banks & Sobel (1987). However, this turns out to be not appropriate for applying to a separating equilibrium, because a unilateral deviation to a point except the signal-jamming point would be feasible only in one state of the world, meaning that it is not even necessary to check the extra condition for reasonable beliefs like the equilibrium domination criterion.

5 Discussion

The analysis given in the previous section can be carried over to some variations of the model without any significant qualitative modifications.

Independent Winning Probabilities

The no-distortion equilibrium when q_1 and q_2 are independent is illustrated in Figure 5. Since $\Omega = \{(H,H),(H,L),(L,H),(L,L)\}$, it involves four equilibrium pair of offers and accordingly, five signal-jamming points represented by cross marks. For example, point α off the equilibrium path could be reached by a deviation of either $D_2(L,H)$ or $D_1(H,H)$. As far as one can assign a posterior probability on those five off-the-equilibrium points in an analogous way to the case of negative correlation, a SPBE can be constructed quite plausibly.

Secret Negotiation

We assumed that a settlement with a defendant would reduce the liability of the other nonsettling defendant. This is based on the "one satisfaction" rule requiring that the sum of settlement amounts and judgments cannot exceed the plaintiff's loss. Clearly, this rule provides the plaintiff the incentive to engage in her negotiation with defendants confidentially. By keeping the negotiation secret, the plaintiff could receive the total damage from a defendant at trial even if she has settled with the other defendant at a positive amount.[15]

Figure 6 illustrates the equilibrium in the secret pretrial negotiation under complete information. Two things are noteworthy. First, the line by $s_i = s_j - \delta_{ij}$ indicates that a strong defendant's offer which is less than a weak defendant's offer by the liability premium can be accepted. Second, an offer $s_i < q_i w - c_p$ can be accepted as in the case of open negotiation. This implies that the main reason why an offer $s_i < q_i w - c_p$ can be accepted is not simply because the settlement with one defendant reduces the value of the plaintiff's claim against the other nonsettling defendant as argued in Kornhauser and Revesz (1994). Even in the case that they can settle secretly so that the settlement with the other defendant does not affect the court award when P prevails, an offer less than $q_i w - c_p$ can be accepted because the plaintiff's probabilities of accepting each offer are not independent, as we discussed in

Section 3.

The possibility of signal jamming is still inherent in the secret negotiation under incomplete information. Figure 6 illustrates the possibility of signal jamming. It is crystal clear that most of the discussion in the previous section still holds except that only the lower offer is (upwardly) distorted in a distortion equilibrium.

When the Plaintiff Makes Demands

If the uninformed plaintiff makes settlement demands, it becomes a screening model, not a signalling model. Consider the case of negative correlation. P's settlement demands (s_1, s_2), belong to one of the four regions illustrated in Figure 7, depending on the acceptance decisions of defendants. Under full information, P will make settlement demands either both of which are accepted or only one of which is accepted. If she wants both demands to be accepted, the optimal pair of demands will correspond to the point A which is $(\frac{q_1^2+q_2c_d}{1-q_1q_2}, \frac{q_2^2+q_1c_d}{1-q_1q_2})$ and the resulting total payoff of P is $\frac{q_1^2+q_2^2+c_d}{1-q_1q_2}$. If she wants only one demand to be accepted, she will demand either $s_1 = q_1 + c_d$ (and $s_2 \geq q_2 + c_d$) or $s_2 = q_2 + c_d$ (and $s_1 \geq q_1 + c_d$) and, in either case, the total payoff will be $s_i + q_j - c_p = 1 + c_d - c_p$. Assume that the optimal pair of settlement demands is the point A. Under incomplete information, P will choose either point A or point B, depending on her prior belief. If her belief that $\omega = (H, L)$ is high, she will choose A, while she will choose C if the belief is low. If P's belief is rather accurate in the sense that the equilibrium choice is A when the actual type is (H, L), no trial occurs, but if her belief is inaccurate so that she chooses C, only D_1 accepts the demand and D_2 prefers going to trial.

In the case of positive correlation,[16]equilibrium settlement demands are symmetric, so both defendants either accept or reject the demand. This suggests that efficiency is enhanced when informed parties are given opportunities to make a settlement demand.

6 Policy Implication and Concluding Remarks

Recently, there has been much controversy over the joint and several liability rule in U.S. states, just as the no contribution rule has been replaced by the contribution rule in many

states. California adopted the nonjoint (several only) rule for non-economic damages. (See California Civil Code §1431.2a.) Also, Colorado entirely abrogated joint and several liability. This paper throws an interesting policy implication on the effect of a reform into the nonjoint liability rule.

Under a rule of nonjoint (several only) liability, the plaintiff's decision to accept each offer becomes independent especially when the success probabilities are independent across defendants. A multi-defendant settlement problem is then reduced to two independent single-defendant settlement problems. Under this rule, a weak type of defendant, say D_1, can imitate a strong type unless the equilibrium offer of a strong type is more likely to be rejected, because the offer made by D_2 conveys no extra information at all due to the independency in determining two settlement offers. This leads to more litigation. Under the joint and several liability rule, however, the equilibrium offer of D_2 is affected by the strength of the case against D_1, because q_1 determines s_1, in turn affecting the probability that s_2 is accepted.

To be short, the joint and several liability makes the determination of s_1 and s_2 interdependent on q_1 and q_2, which can be regarded as the main mechanism to induce more settlements. Of course, if defendants can collude so as to act as if they were a single defendant, trial may occur even under the rule of joint and several liability, but unless the collusion is perfect, joint and several liability will encourage more settlements.

Sharing information between defendants is crucial to fostering settlements. If they do not share information, their settlement offers can be rejected with positive probability due to the uncertainty about the probability of winning against the other defendant. The upshot is that the effective way of fostering settlements in multi-defendant cases is to allow defendants to cooperate in sharing information but to prohibit them from cooperating in making settlement offers.

To elucidate the effect of information sharing and signal jamming between defendants on the settlement outcome, which is our main concern, we admittedly neglected to incorporate some important institutional details into the model, for example, the effect of alternative rules such as no contribution rule, proportionate rule etc. However, we believe that the qualitative nature of the outcome will remain unaffected by introducing the features.

Appendix

Proof of Proposition 2: Impose $\hat{\lambda}(s_1^N(H), s_2^N(H)) = 1$ and $\hat{\lambda}(s_1^N(L), s_2^N(L)) = 0$. The beliefs obviously satisfy Condition 3 of Definition 1. Next, for the given beliefs, the plaintiff's decision rule, $a(s_1, s_2)$, is defined to satisfy Condition 2-(ii) as specified in Figure 2a. Then, P accepts both offers no matter which pair of equilibrium offers is observed, because they belong to the AA region for the respective state. Finally, we have only to show that the proposed settlement offers satisfy Condition 2-(i). $D_i(L)$ clearly has no incentive to deviate in order to mimic H type. Now, let $\hat{\lambda}(s_1', s_2^N(H)) = 1$ for any $s_1' \neq s_1^N(H)$. Since $s_i^N(H)$ is the best response $s_j^N(H)$ for H type given that $\omega = H$ is known, it clearly satisfies Condition 2-(i) and the proof is complete.

Proof of Lemma 1: Suppose $s_i^*(H) \neq s_i^N(H)$, or equivalently, $s_i^*(H) \neq s_i^{BR}(s_j^*(H), H)$ for some i. Consider a deviation of $D_i(H)$ to $s_i^{BR}(s_j^*(H), H)$. This deviation would be clearly more profitable even if the most pessimistic belief $\hat{\lambda} = 1$ is imposed. Thus, the proof is complete.

Proof of Proposition 3: It suffices to prove the first part of the proposition. Denote the interior, boundary and exterior of $\cdot\cdot$ region given the belief $\hat{\lambda}$ by $\text{Int}(\cdot\cdot; \hat{\lambda})$, $\text{Bod}(\cdot\cdot; \hat{\lambda})$ and $\text{Ext}(\cdot\cdot; \hat{\lambda})$.

Suppose $s^*(L) \in \text{Ext}(AA; 0)$. We know that $s^*(L) \notin \text{Int}(RA; 0)$ because $D_1(L)$ would profitably deviate to his best response to $D_2(L)$ then. Similarly, $s^*(L) \notin \text{Int}(AR; 0)$. Also, $s^*(L) \notin \text{Bod}(RA; 0) \cap \text{Bod}(AR; 0)$ i.e. $s_1^*(L) \neq s_2^*(L)$. If $s_1^*(L) = s_2^*(L)$, both offers are accepted with equal probability. Thus, it is always profitable for $D_i(L)$ to choose $s_i = s_i^*(L) + \epsilon$ whatever $\hat{\lambda}(s_i)$ may be, because it will be accepted with certainty.

Suppose $s^*(L) \in \text{Bod}(AA; 0)$. If $s^*(L) \in \text{Bod}(RA; 0)$, it will be profitable for $D_i(L)$ to deviate to $s_i = s_i^*(L) - \epsilon$ because P will still accept the offer, implying that it cannot be an equilibrium. Similarly, $s^*(L) \notin \text{Bod}(AR; 0)$.

Finally, suppose $s^*(L) \in \text{Int}(AA; 0)$. It is clear that $s^*(L) \notin \text{Int}(AA; 1)$. Now, suppose $s^*(L) \in \text{Ext}(AA; 1)$. Given the most pessimistic belief, making an offer $s_i = s_i^*(L) - \epsilon$ will yield the loss of $L + c_d$ by being rejected. Thus, it can be an equilibrium as long as $s^*(L) \leq L + c_d$. Since $L + c_d > \frac{L - c_p}{1 + L}$, there are always a continuum of SPBE. (See Figure

2a.)

Proof of Proposition 4: Impose the following posterior belief

$$\hat{\lambda}(s) = \begin{cases} 1 & \text{if } s = (s_1, s_L) \text{ for } s_1 \neq s_H, s_L \\ 0 & \text{if } s = (s_L, s_2) \text{ for } s_2 \neq s_H, s_L \\ 1/2 & \text{if } s = (s_L, s_L) \\ r \in [0,1] & \text{otherwise.} \end{cases}$$

It is obvious that $D_1(H, L)$ has no incentive to deviate to $s_1 \neq s_L$. If he deviates to $s_1 = s_L$, the offer is rejected under [ND1], which incurs $H + c_d$ to him. Since $s_H < H + c_d$, the result is immediate.

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Endnotes

1. The no contribution rule originated from the case of *Merryweather v. Nixan*, 8 Term. Rep. 186, 101 Eng. Rep. 1337 (K.B. 1799).

2. The contribution rule has been adopted in the area of antitrust law and securities law. For example, see the Securities Act of 1993 (Section 11) and the Securities Exchange Act of 1934 (Section 9).

3. See Landes and Posner (1987) and Epstein (2000).

4. This possibility was pointed out by Kim (2003). The term of "signal-jamming" defined in this paper is distinguished from the notion of "signal jamming" that appears in other literature (Holmström [1982], Fudenberg and Tirole [1986], Riordan [1985]), although the two notions have the common feature that a player interferes with another's inference from a signal. In the latter notion, the signal is usually generated by an uninformed player.

5. See Bagwell and Ramey (1991) for details of unprejudicedness.

6. The literature on pretrial negotiation under asymmetric information in the context of a single defendant is extensive. To name a few, see Bebchuck (1984) for a screening model and Reinganum & Wilde (1986), Schweizer (1989), Daughety & Reinganum (1994) for signalling models.

7. Strictly speaking, the events that P wins against D_i for $i = 1, 2$ are either correlated or independent.

8. There is an alternative rule, so-called the proportionate rule whereby each defendant pays his share of liability regardless of whether the other defendant settled or not. See Feess and Muehlheusser (2000) for comparison of the two rules.

9. See Section 4(b) and 6 of the Uniform Comparative Fault Act.

10. We are implicitly assuming that contribution between nonsettling defendants is allowed.

11. See Yi (1991) for a precedent analysis of the complete information model in which each defendant makes a final offer. His analysis is, however, limited to the case that the plaintiff's

winning probabilities against defendants are perfectly correlated. Earlier, Easterbrook *et al.* (1980) and Polinsky & Shavell (1981) also considered a similar situation.

12. See the supplementary material for the proof.

13. See the supplementary material for a numerical example.

14. See the supplementary material for the proof.

15. This possibility was first pointed out by Spier (1994).

16. Spier (1994) analyzes the positive correlation case in the context of the nonjoint liability which is equivalent to two single-defendant lawsuits.

accepted offers	s_1 and s_2	s_1	s_2	neither
D_1	-s_1	-s_1	-$q_1(1-s_2)-c_d$	$-q_1(1-q_2)-q_1q_2r_1-c_d$
D_2	-s_2	-$q_2(1-s_1)-c_d$	$-s_2$	$-q_2(1-q_1)-q_1q_2r_2-c_d$
P	s_1+s_2	$s_1+\overline{s}_2$	$\overline{s}_1+s_2$	$\overline{s}_{12}$

Table 1: Payoffs

$\overline{s}_1 \equiv q_1(1-s_2)-c_p$
$\overline{s}_2 \equiv q_2(1-s_1)-c_p$
$\overline{s}_{12} \equiv q_1+q_2(1-q_1)-c_{pp}$
$r_i =$ relative liability of D_i

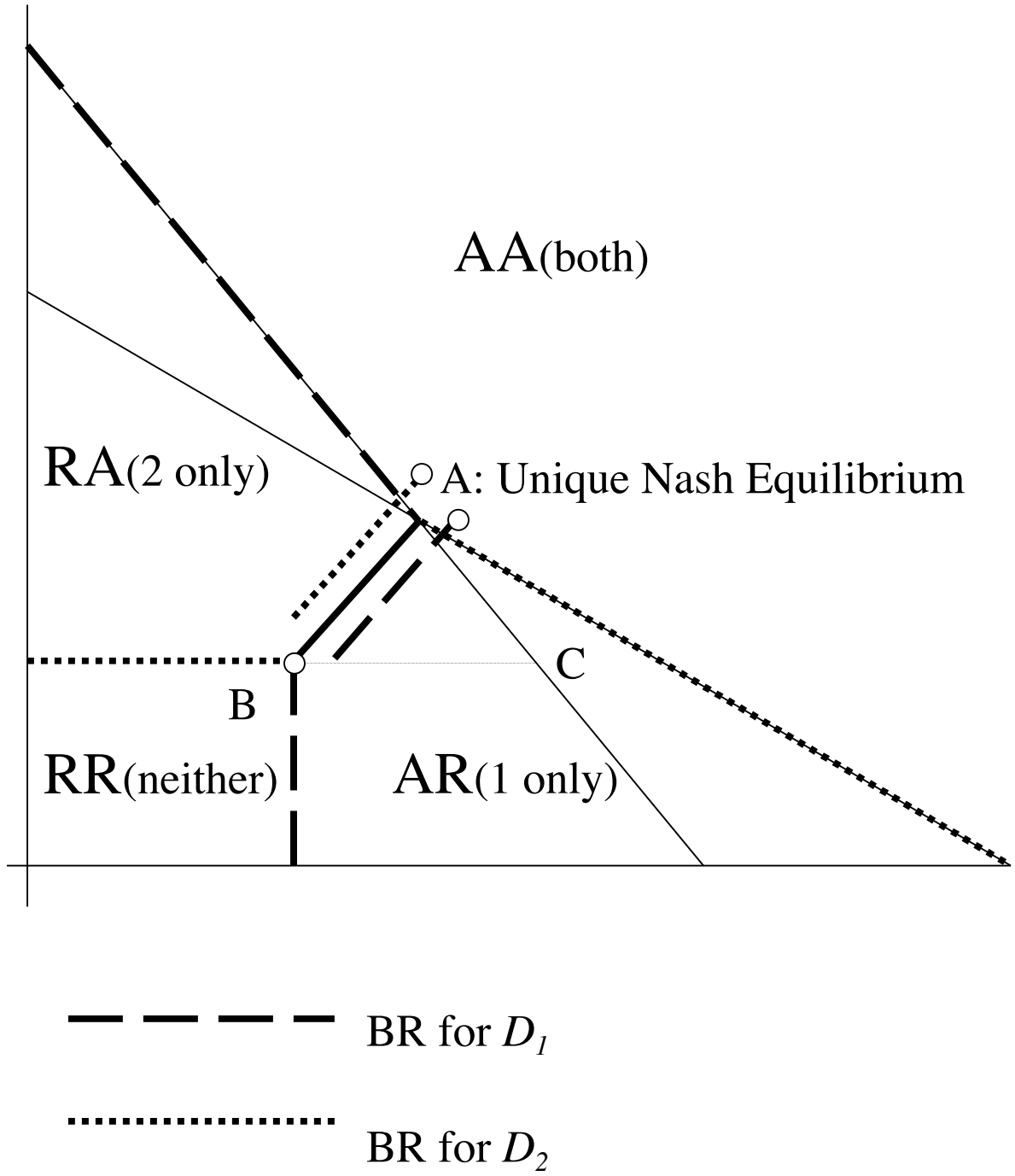


Fig 1.a Unique Nash Equilibrium (c_{pp} is large)

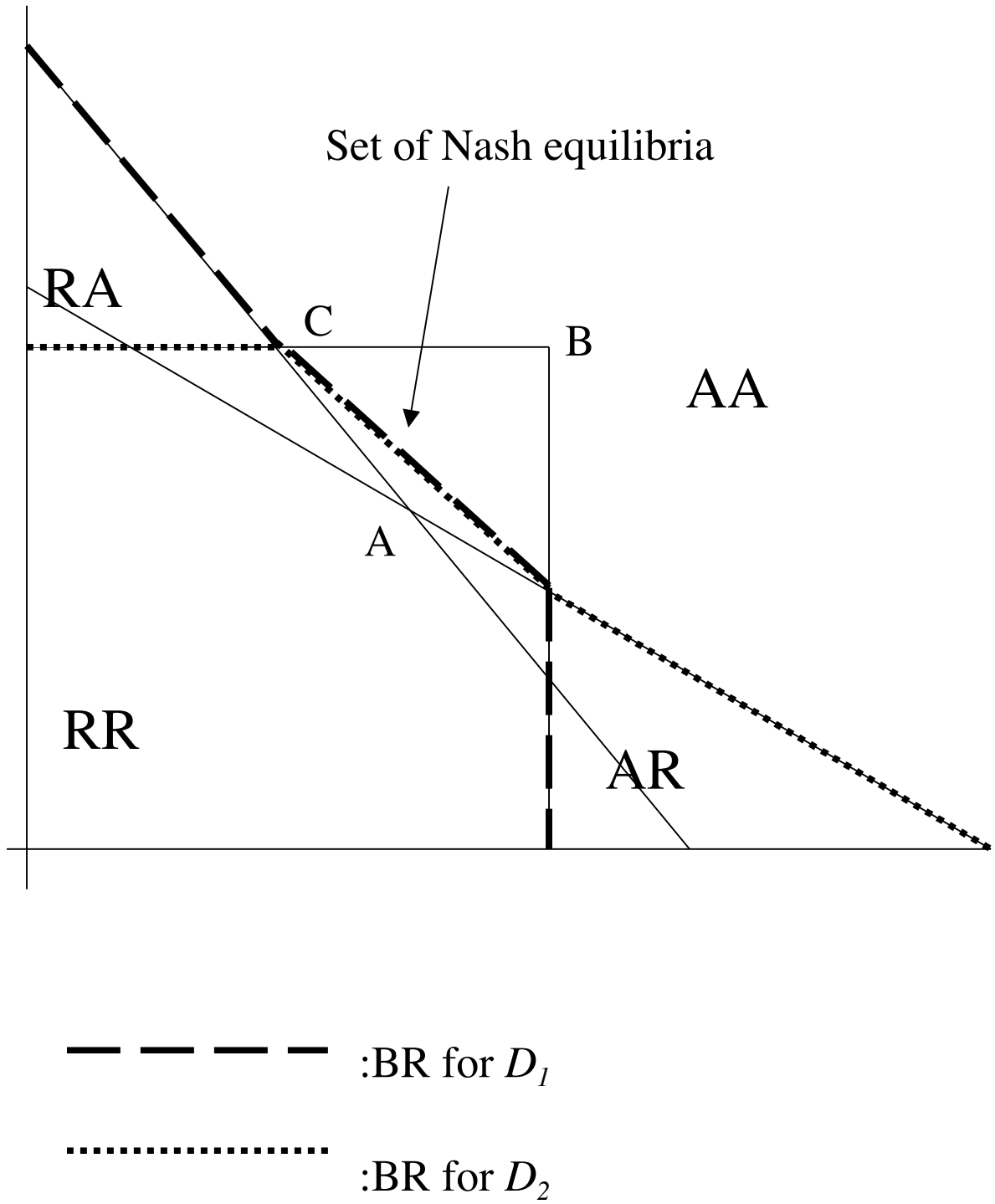


Fig 1.b Set of Nash Equilibria (c_{pp} is small)

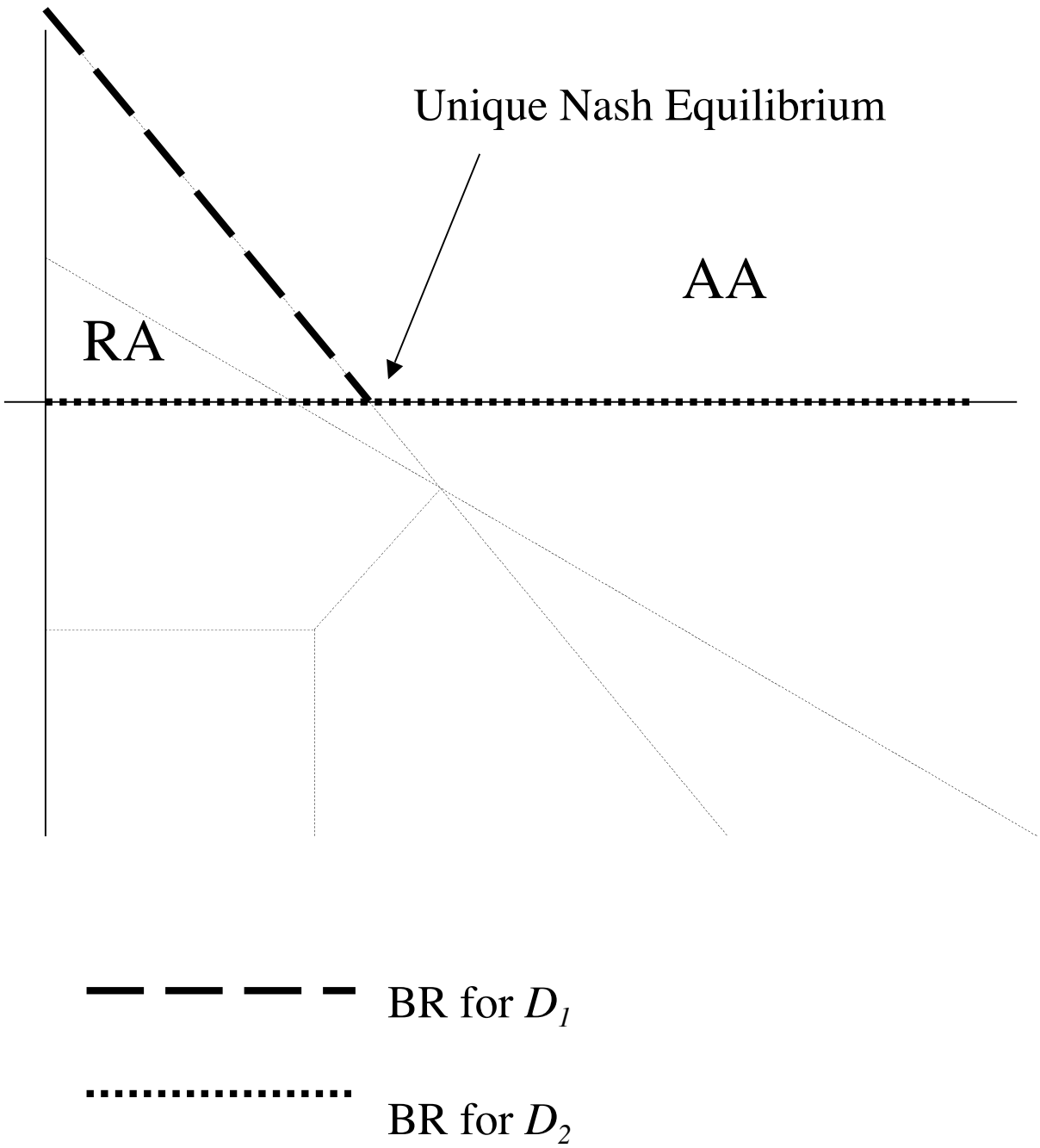


Fig 1.c
Unique Nash Equilibrium involving zero offer

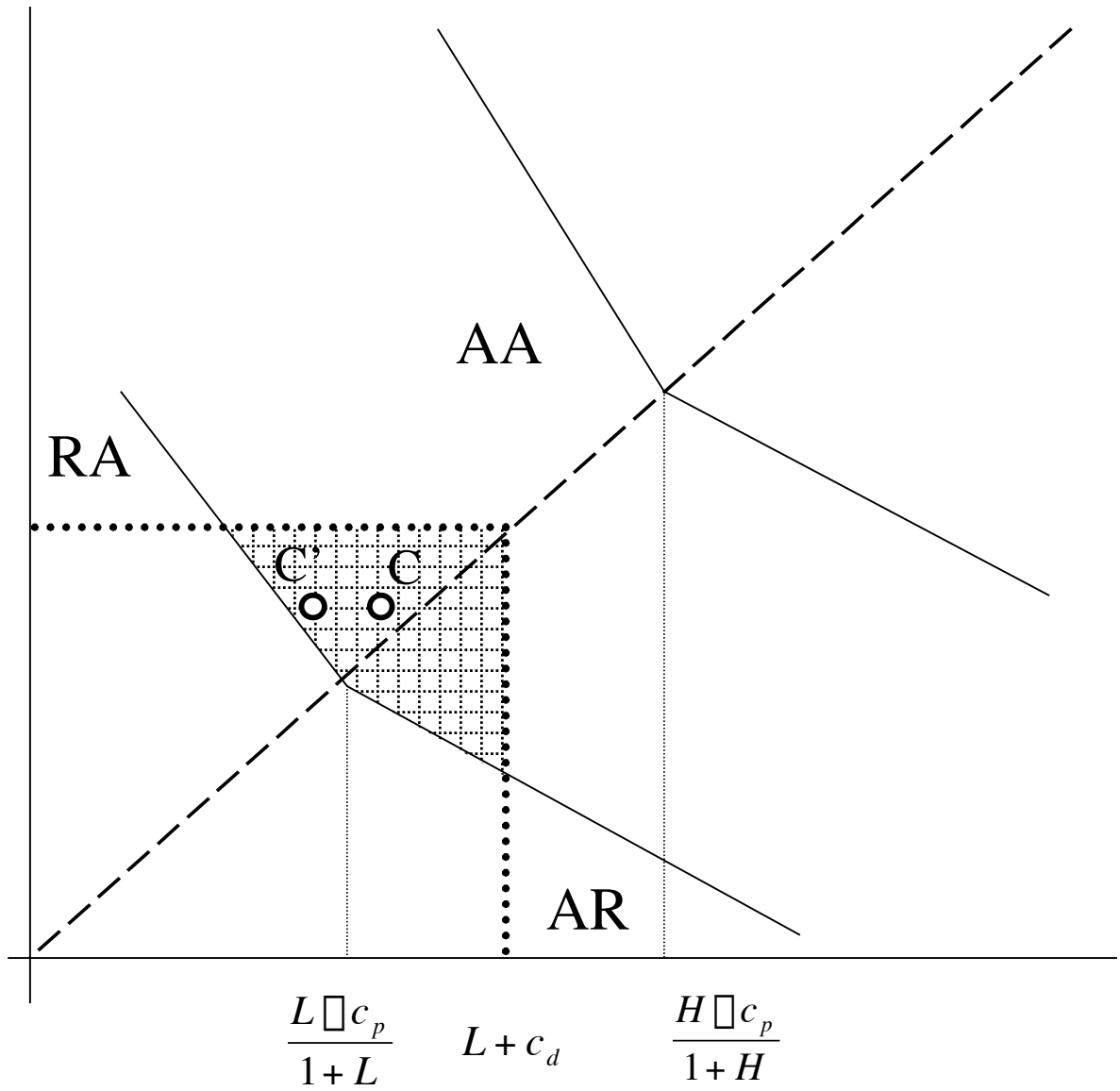


Fig 2.a set of distorted equilibria

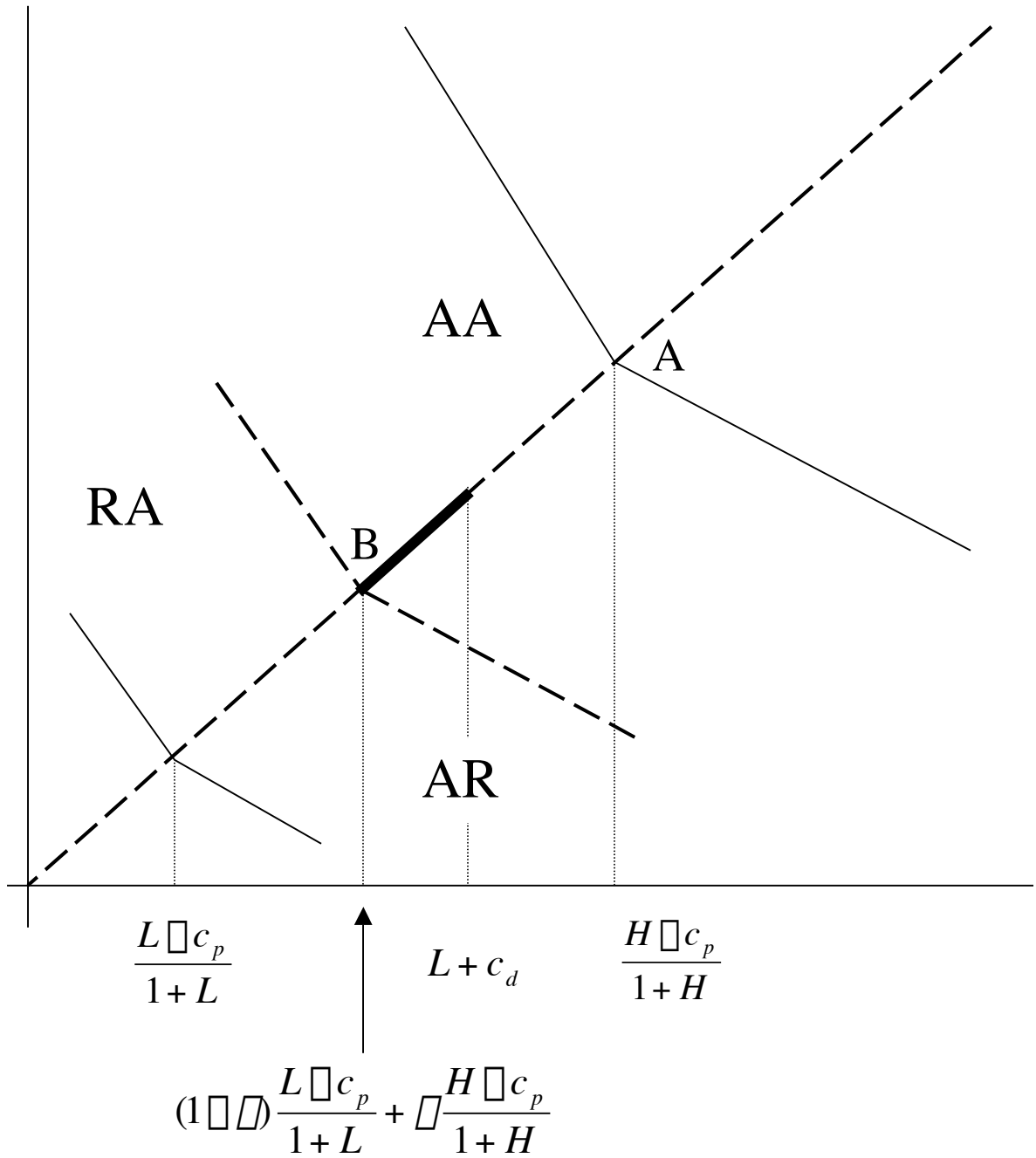


Fig 2.b set of pooling equilibria

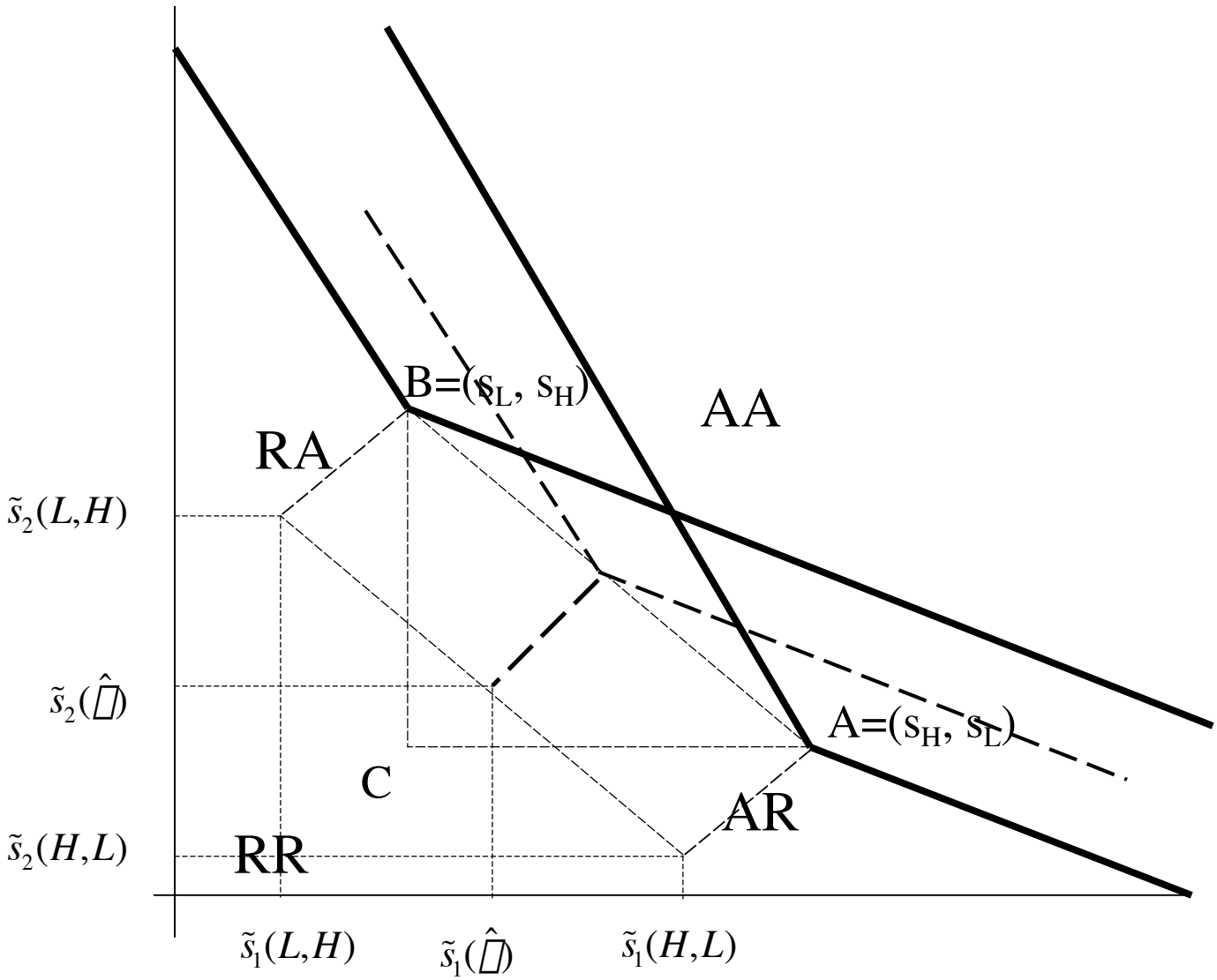


Fig 3.a *P*'s decision when $\hat{\Pi}$=1/2

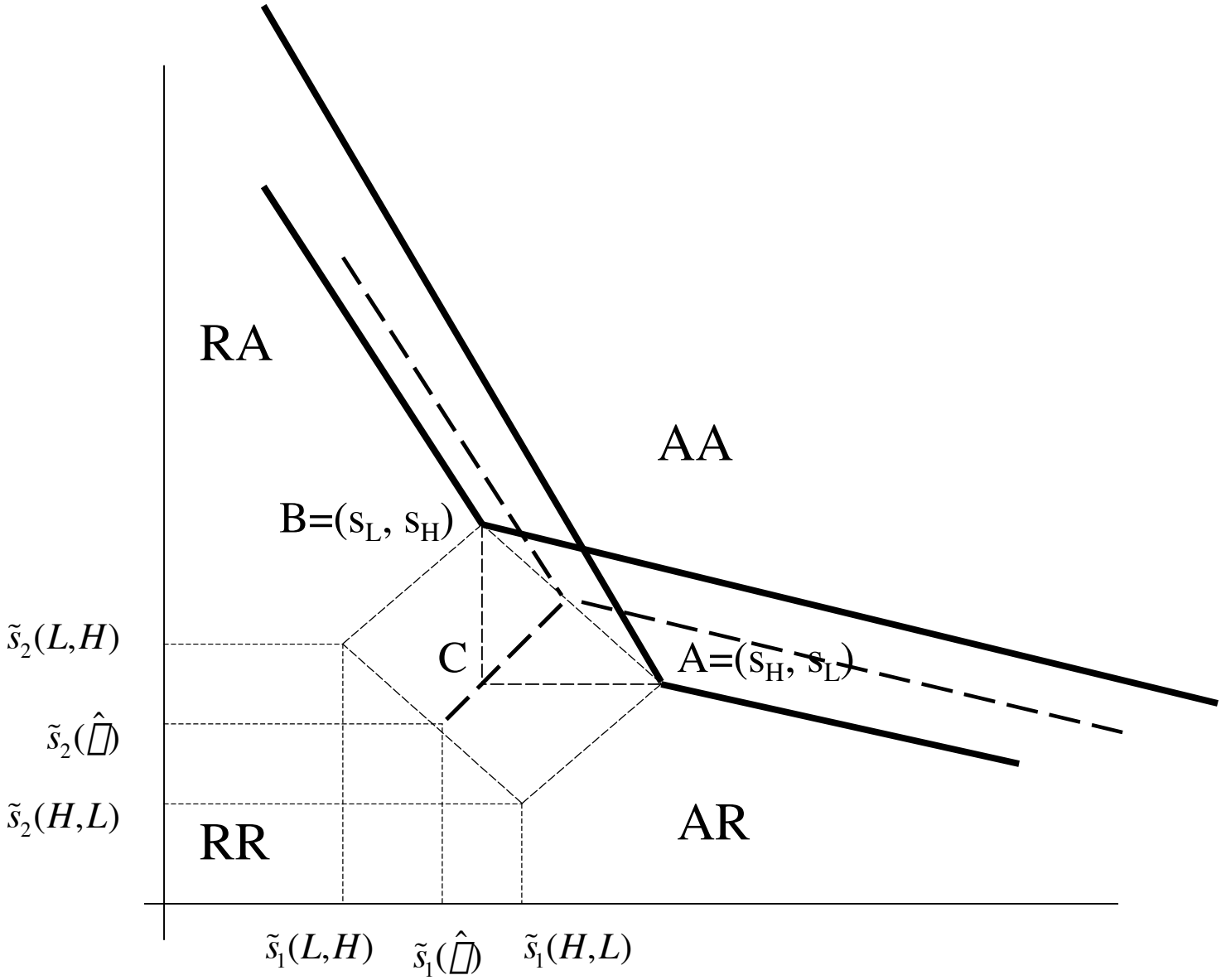


Fig 3.b *P*'s decision when $\hat{\Pi}$=1/2

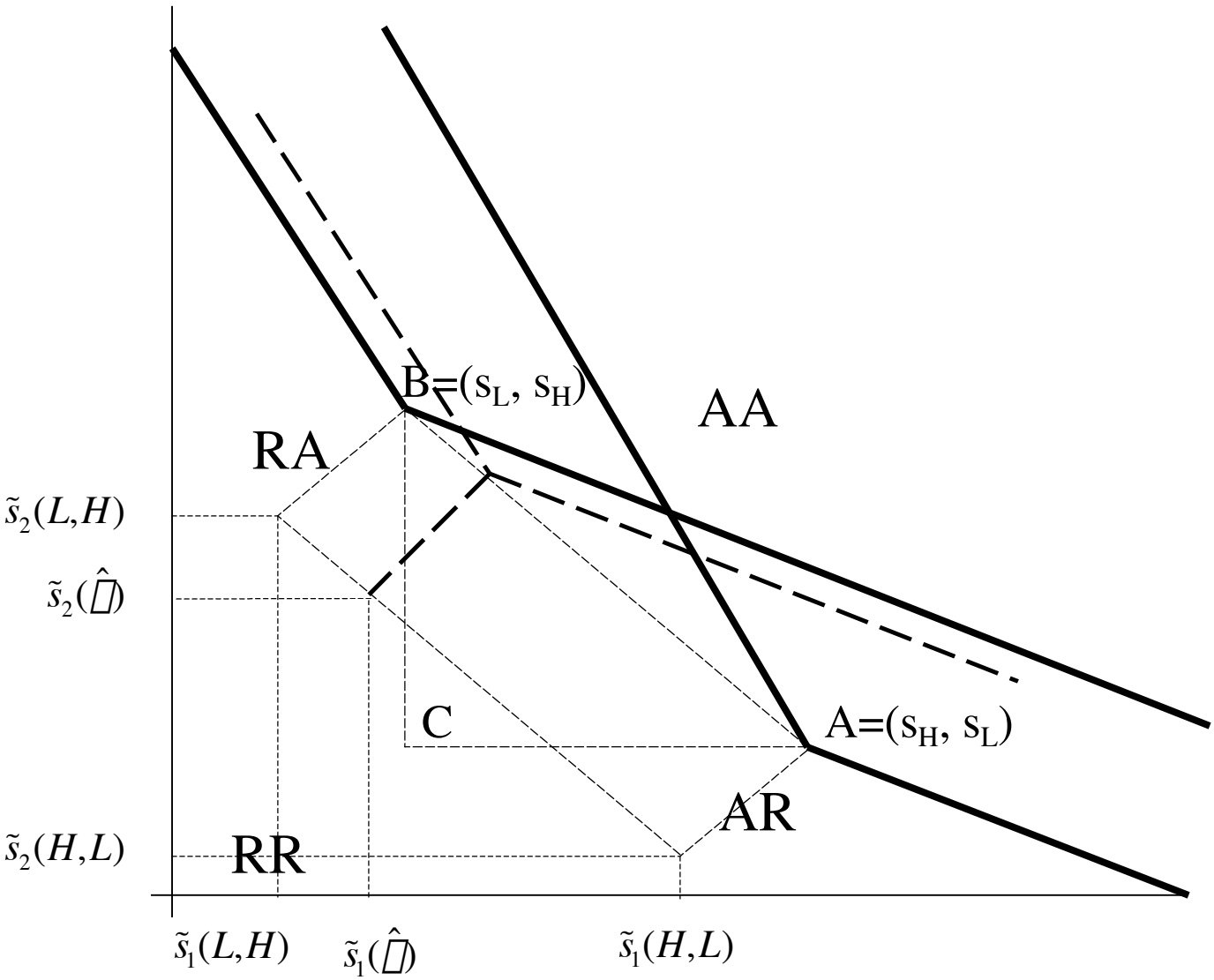


Fig 3.c *P*'s decision when $\hat{\Pi} \square 0$

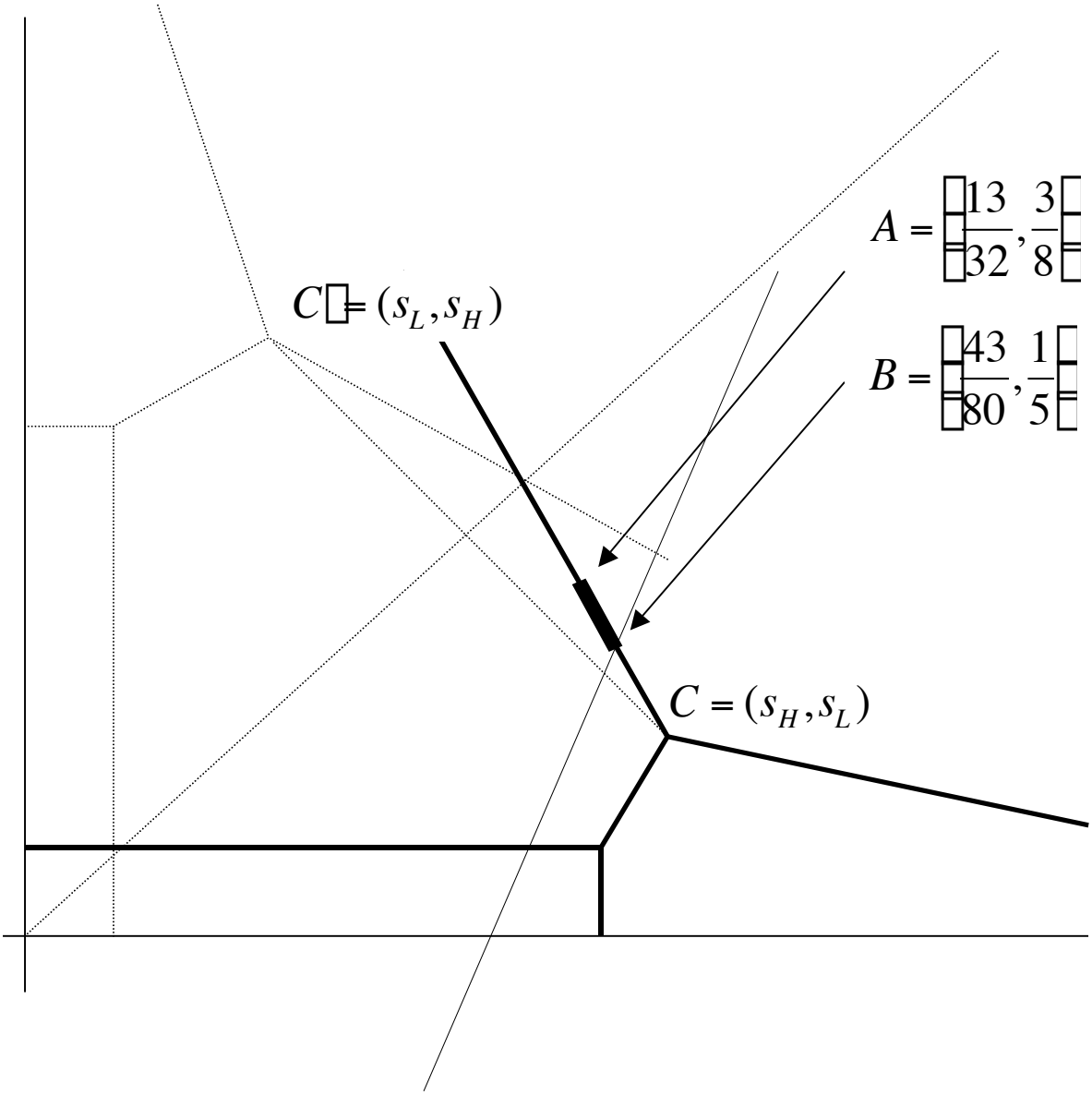


Fig 4 set of distorted equilibria

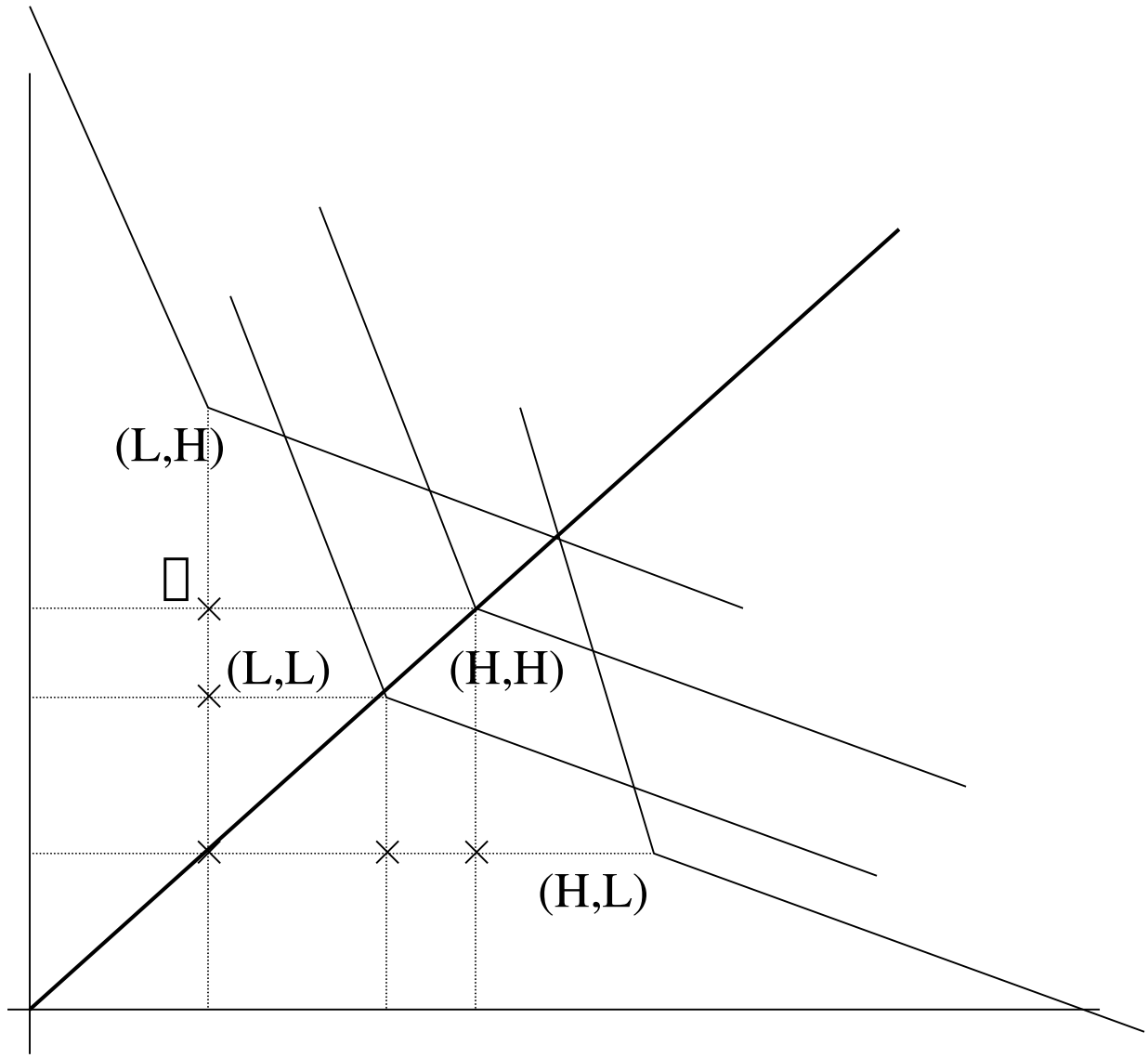


Fig 5. possibility of signal-jamming in the case of independence

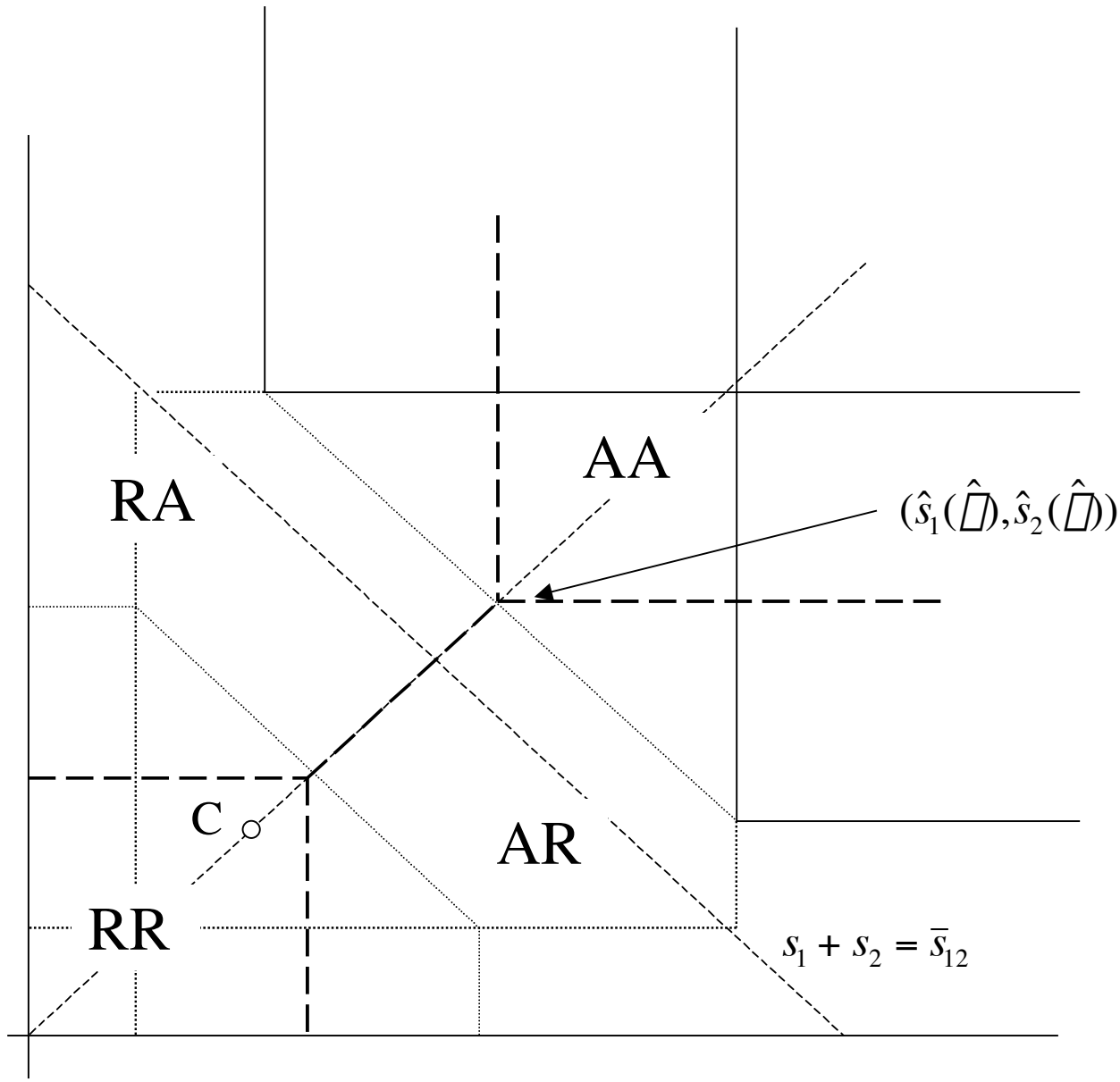


Fig 6 Secret Negotiation

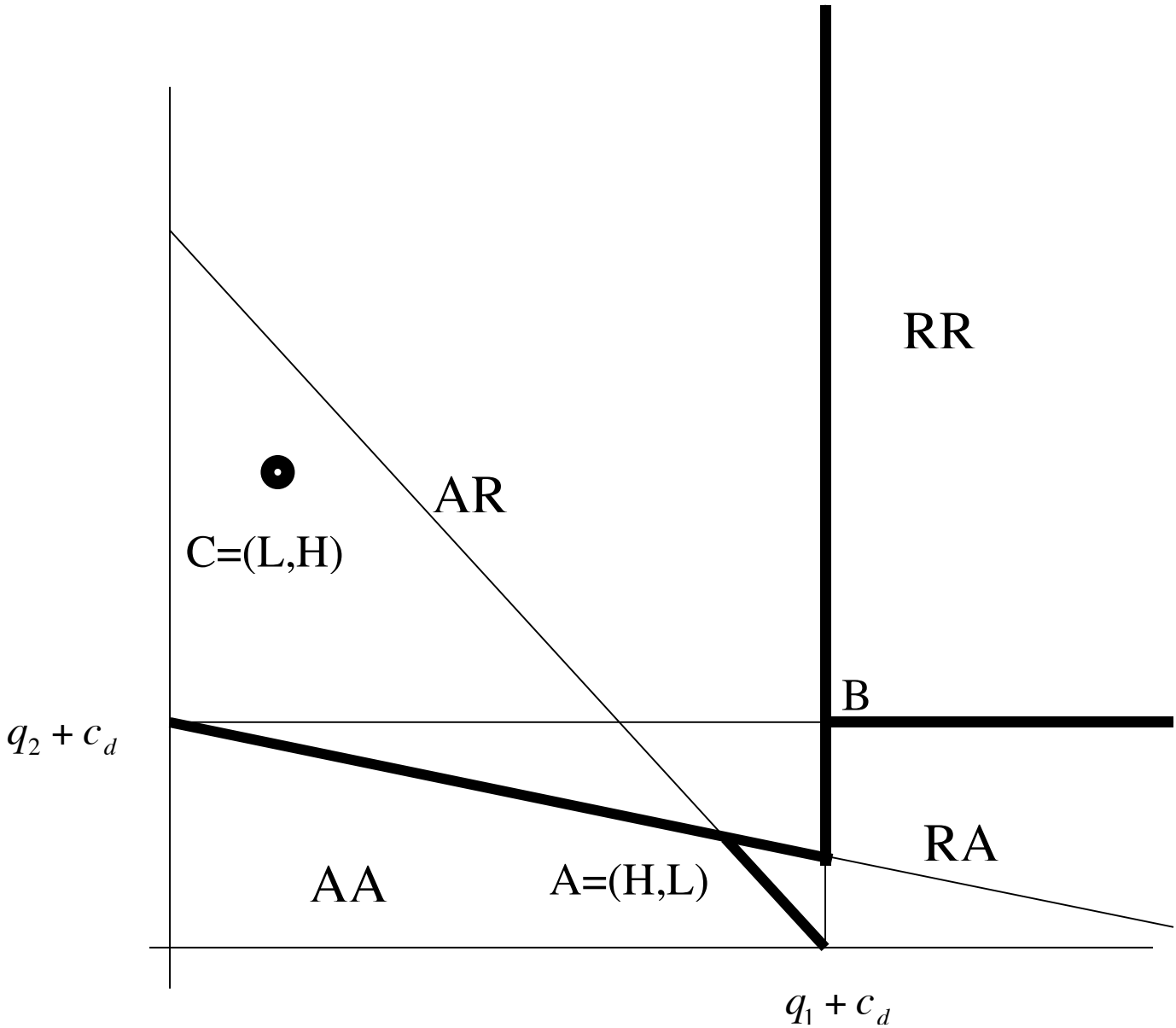


Fig 7 *D*s' decisions when *P* makes offers

Supplementary material

A. Detailed Proof for the Claim that [C1] implies [C2]

Assume that q_1 and q_2 are strictly smaller than 1. Suppose [C2] is violated. Then, we have

$$c_d + \frac{c_{pp} - c_p}{1 - q_1} < (1 - r_1)q_1q_2$$

$$c_d + \frac{c_{pp} - c_p}{1 - q_2} < (1 - r_2)q_1q_2$$

By summing them, we get

$$2c_d + \left(\frac{1}{1 - q_1} + \frac{1}{1 - q_2}\right)(c_{pp} - c_p) < (2 - r_1 - r_2)q_1q_2 = q_1q_2.$$

It is easiest to satisfy the above condition when $c_d = 0$. Since we are going to disprove $A > B$, let us say $c_d = 0$. Then, it is equivalent to

$$c_{pp} < c_p + \frac{q_1q_2(1 - q_1)(1 - q_2)}{(1 - q_1) + (1 - q_2)}. \tag{1}$$

On the other hand, if $A > B$, the following equation must hold ($A_1 > B_1$):

$$\begin{aligned} \frac{q_1(1 - q_2) - (1 - q_1)c_p}{1 - q_1q_2} &> q_1 - \frac{c_{pp} - c_p}{1 - q_1} \\ \Leftrightarrow c_{pp} - \left(1 + \frac{(1 - q_1)^2}{1 - q_1q_2}\right)c_p &> q_1(1 - q_1) - \frac{q_1(1 - q_1)(1 - q_2)}{1 - q_1q_2} \\ \Leftrightarrow c_{pp} &> \left(1 + \frac{(1 - q_1)^2}{1 - q_1q_2}\right)c_p + q_1(1 - q_1) - \frac{q_1(1 - q_1)(1 - q_2)}{1 - q_1q_2}. \end{aligned} \tag{2}$$

Since the slope of the inequality (2) is steeper than that of (1), we need the following condition to have a pair (q_1, q_2) satisfying (1) and (2) simultaneously:

$$q_1(1 - q_1) - \frac{q_1(1 - q_1)(1 - q_2)}{1 - q_1q_2} < \frac{q_1q_2(1 - q_1)(1 - q_2)}{(1 - q_1) + (1 - q_2)}. \tag{3}$$

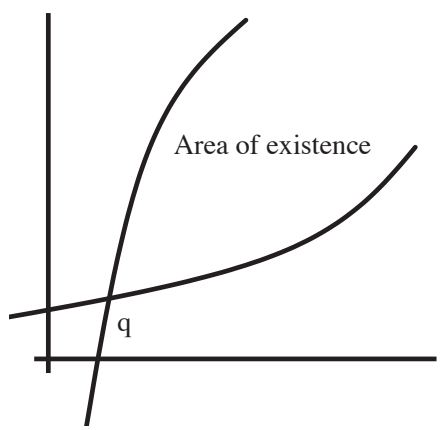
Then, we have

$$
\begin{aligned}
q_1(1-q_1)[(1-q_1)+(1-q_2)](1-q_1q_2) - q_1(1-q_1)(1-q_2)[(1-q_1)+(1-q_2)] \\
> q_1q_2(1-q_1)(1-q_2)(1-q_1q_2) \\
\Leftrightarrow q_1(1-q_1)^2(1-q_1q_2) + q_1(1-q_1)(1-q_2)(1-q_1q_2) \\
-q_1(1-q_1)^2(1-q_2) - q_1(1-q_1)(1-q_2)^2 - q_1q_2(1-q_1)(1-q_2)(1-q_1q_2) < 0 \\
\Leftrightarrow -q_1(1-q_1)(1-q_2)^2q_1q_2 + q_1q_2(1-q_1)^3 < 0 \\
\Leftrightarrow q_1q_2(1-q_1)[(1-q_1)^2 - q_1(1-q_2)^2] < 0 \\
(1-q_1)^2 < q_1(1-q_2)^2. \qquad (4)
\end{aligned}
$$

By the same calculation, $A_2 > B_2$ implies

$$(1-q_1)^2 < q_2(1-q_1)^2. \qquad (5)$$

Then, a set of pairs of (q_1, q_2) satisfying (4) and (5) is drawn in the following graph



Here, q is derived by

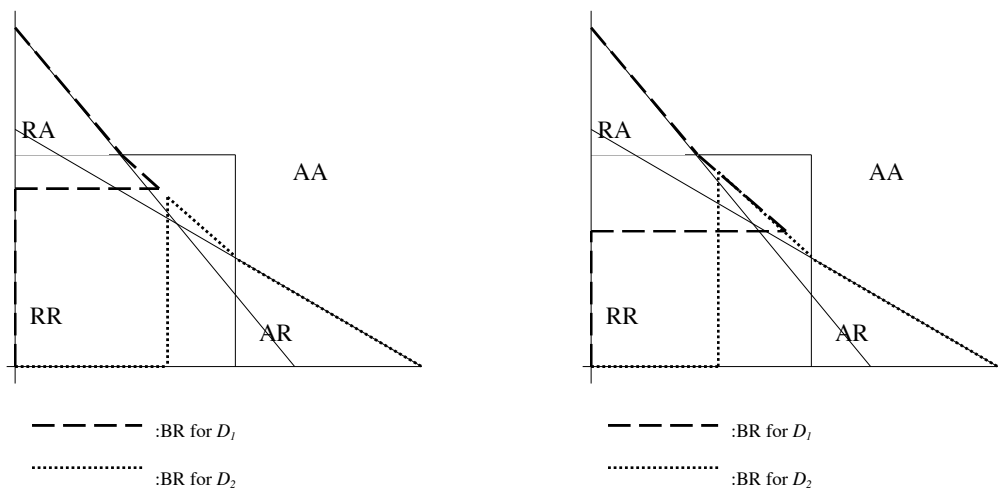
$$(1-q)^2 = q(1-q)^2,$$

which implies that $q = 1$. Therefore, there is no (q_1, q_2) that yields $A > B$ and multiple equilibrium, since q_i cannot be greater than or equal to 1.

B. A Numerical Example for an Equilibrium in Which Both Offers are Rejected

Let $q_1 = q_2 = r_i = 1/2$, $c_d = 1/20$, $c_{pp} = 1/20$, $c_p = 1/40$. Then, you can check that condition (1) and (2) are satisfied. (However, as we have shown $A > B$ doesn't hold.)

Note that if [C2] is violated too much, (i.e., the difference between left side and the right side is too large), we only have unique equilibrium $(s_1, s_2) = (0, 0)$. In other words, the best response lines just stick to x-axis or y-axis as in the following left graph. If [C2] is violated a little bit, typical graph is the right one.



C. Detailed Proof for the Claim that [CN1] implies [CN2]

If $q_i < \tilde{s}_i^N - c_d$ for all $i = 1, 2$, $q_1 + q_2 = 1 < \tilde{s}_1^N + \tilde{s}_2^N - 2c_d$. Let $A = 1 + 2c_d$. Also, we have $\tilde{s}_1^N + \tilde{s}_2^N = \frac{q_1^2 + q_2^2 - c_p}{1 - q_1 q_2} = \frac{1 - 2q_1 q_2 - c_p}{1 - q_1 q_2} \equiv B$. Since $A \geq B$, this is contradictory.