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Creative Bargaining*

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We examine what happens if, as players bargain, they can exert costly effort to expand the set of possible proposals. With side payments, new ideas influence the size of the pie but not its division. The benefits of one player's creativity are shared with the other player, so effort is inefficiently low. Without side payments, new ideas do influence the distribution, so players inefficiently limit their search to ideas that favor them. Getting an idea makes an agreement more likely, but it also makes the other player's ideas less likely to be adopted. Consequently, effort can be either excessive or suboptimal. *Journal of Economic Literature* Classification Number: C78. © 1998 Academic Press

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1. INTRODUCTION

There are few recent guides to negotiation that do not stress the importance of creative thinking.[1] Creativity has an important role in labor–management negotiations (Walton and McKersie, 1965), as well as in international disputes, where much effort is devoted to finding a "formula" to which each side can agree (Zartman and Berman, 1982, pp. 96–97). Zartman and Berman discuss the example of the 1975 disengagement agreement between Israel and Egypt:

> Kissinger . . . came up with an idea that would allow Israel to say that it had not completely abandoned the [two strategic Sinai] passes . . . . He would allow Israel to put its forward defense line at the bottom of the eastern slopes of the hills. Egypt would be

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[1] E.g., Fisher and Ury (1981, p. 58); Hall (1993); Lewicki *et al.* (1993, p. 107).

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> allowed to bring its troops to the western slopes of the hills, and the U.N. buffer zone would be at the peaks of the hills proper. Then Egypt could claim it had forced Israel to retreat from the passes, and Israel could say that it had not evacuated completely. (Zartman and Berman, 1982, pp. 100–101)

This paper studies the effects of creativity in bargaining models. We assume that, in the course of bargaining, a player can exert costly creative effort in an attempt to expand the set of available proposals. We examine two cases. If proposals can include side payments (i.e., monetary transfers), any increase in the pie is shared by both players. As a result, creativity is inefficiently low. This finding mirrors the hold-up problem in industrial organization (Rogerson, 1992; Tirole, 1986, 1988; Williamson, 1975). The anticipation of low effort in the future reduces the benefit of continuing to bargain. This can cause players to agree prematurely. This phenomenon contrasts with most of the prior bargaining literature, which assumes that the pie cannot grow.[2] With a fixed pie, the social optimum features immediate agreement; there cannot be less delay than this. Most of the bargaining literature has therefore focused on the phenomenon of inefficient delay.[3]

The assumption that side payments are feasible is not always realistic. One reason is moral hazard. A dictator or monarch who accepts money in return for a strategic mountain range may lose popularity because his people suspect that he will use the money for his own consumption. In other situations, a side payment may simply not be an effective way to transfer utility; consider a married couple with a joint checking account. Side payments may also be prohibited by law or policy, as in a dispute between two judges or two jurors about how to decide a case.

Without side payments, a player cannot say "I like your idea; pay me x dollars more and you have a deal." She is stuck with the utility that the proposal gives her. Consequently, a player has a socially excessive incentive to focus her search on ideas that would give her most of the surplus. This means that a player's creative success has both a positive and a negative effect on her opponent. It helps him by raising the probability of an agreement in the event that he fails to come up with a proposal of his own. But it hurts him if he does have an alternative, since it lowers the chance that

[2]Merlo and Wilson (1995, pp. 384–385) present another example of premature agreement with a changing pie. The pie increases exogenously after the first period, but the new pie can be split unequally only at a cost that exceeds the growth in the pie. In the second period one player is selected at random to make all future proposals. Players agree prematurely because delay leads one player to inefficiently exploit his bargaining power by demanding all of the pie.

[3]See Kennan and Wilson (1993); Avery and Zemsky (1994a) for reviews.

his own proposal will be adopted. Depending on which effect dominates, creative effort can be either excessive or suboptimal.

Effort can also be either excessive or suboptimal in patent races. Suboptimal R&D comes from spillovers, in which the losers imitate or build on the winner's ideas (Tirole, 1988, p. 400). The reason in bargaining is different: because of imperfect precision, a player may not be able to find an idea that extracts all of her opponent's surplus. *Excessive* R&D in patent races can occur for two reasons: (a) if one firm's success prevents the other firms from continuing with their own research, or (b) if the firms compete in a product market and one firm's success improves its competitive position (Tirole, 1988, p. 399). In bargaining, the reason is that one player's success raises the chance that the ultimate agreement will be unfavorable to the other player. One can see a certain similarity between this and (b).

2. BARGAINING WITH SIDE PAYMENTS

There are two players, 1 ("he") and 2 ("she"). Initially, the pie is of size s. Player 1 first chooses the probability p that he will find a way to increase the pie to $b > s$. For simplicity, we assume no subsequent creative steps.[4] The cost $C(p)$ of player 1's effort is strictly convex and increasing and satisfies the Inada conditions. Players 1 and 2 then alternate offers, with player 1 going first. Since there are side payments, a player can propose any partition. Payoffs are discounted at the rate $\delta \in (0, 1)$. We restrict to subgame perfect equilibria.

The subgame after player 1's creative step is simply a Rubinstein (1982) alternating-offers bargaining game with discount factor δ and pie s or b. The unique equilibrium of this subgame is for player 1 to propose that he receive the proportion $1/(1+\delta)$ of the pie. Player 2 accepts this offer. Player 1 thus chooses the effort level p^e that maximizes

$$p\frac{b}{1+\delta} + (1-p)\frac{s}{1+\delta} - C(p). \tag{1}$$

The first order condition is $C'(p^e) = (b-s)/(1+\delta)$. In contrast, the socially optimal effort p^o maximizes $pb + (1-p)s - C(p)$ and satisfies $C'(p^o) = b - s$.[5] This shows that $p^o > p^e$: there is not enough creative effort in equilibrium.

[4]Although the assumption of one period of creativity may seem special, similar results are obtained if players can try to enlarge the pie before every proposal (see Frankel, 1995).

[5]This assumes that each player has equal weight in the social welfare function. This is the only sensible assumption with side payments, since otherwise the social optimum would call for an infinitely large payment from one player to the other player.

Premature Agreement

The phenomenon of premature agreement occurs if we modify the game by adding an offer by player 2 that precedes player 1's creative step. The order is thus: player 2 offers a partition of s, player 1 responds, delay. If player 1 rejects, the above game is played. In period one, the social optimum calls for player 2 to make an acceptable offer if and only if the current pie s exceeds the expected joint payoff from waiting, $\delta(p^o b + (1 - p^o)s - C(p^o))$. In equilibrium, player 2 also makes an acceptable offer if and only if the current pie s exceeds the joint payoff from waiting, $\delta[p^e b + (1 - p^e)s - C(p^e)]$. This is because players agree to a partition $(x, s - x)$ only if both players 2 and 1 prefer it. Since the socially optimal effort p^o maximizes the joint payoff from waiting, this joint payoff must be lower under the equilibrium effort p^e. Hence, players agree immediately for a larger range of initial pie sizes s in equilibrium than in the social optimum. More precisely:

Claim 1. There is a $\underline{s}$ such that players agree in period 1 in equilibrium if and only if $s > \underline{s}$. In the social optimum, they agree in period 1 if and only if $s > \overline{s}$, where $\overline{s} > \underline{s}$.

Proof. See the Appendix.

Agreement is premature in the sense that players tend to split the pie when it is smaller. This remains true with many periods of creativity (Frankel, 1995), although there the expected *time to agreement* may be longer than in the social optimum. Although the players' minimum acceptable pie is smaller, they may need to bargain longer to attain it because of lower effort.

Timing

The model assumes that player 1 thinks creatively only after responding to player 2's proposal. If instead he thinks creatively *before* responding (e.g., while waiting for player 2 to propose), there can be excessive delay rather than premature agreement. At the time of his response, player 1 has private information about his potential counter offers. This private information induces player 2 to make an inefficiently low offer; i.e., one that player 1 sometimes rejects when it would be socially optimal to accept. This phenomenon is called "screening" (Kennan and Wilson, 1993) since player 2 collects a larger share from "types" of player 1 who are most eager to accept—i.e., those whose counterproposals would increase the pie only very little. Avery and Zemsky (1994b) examine this phenomenon in a model where the pie follows an exogenous stochastic process.

3. BARGAINING WITHOUT SIDE PAYMENTS

If side payments are not feasible, new ideas can affect not only the size of the pie but also its division. We find that players inefficiently restrict their search to ideas that mainly benefit them. This gives rise to a negative externality: one player's creative success raises the chance that his own idea will be implemented, and thus that the settlement will favor him at the expense of his opponent. This externality occurs only when the opponent also has an idea of her own. Otherwise there is a positive externality: one player's ideas help his opponent by making an agreement possible. Which externality dominates depends on a player's *creative precision*: his ability to narrow his search to ideas that give him almost all the pie. Effort is excessive if precision is sufficiently high.

We depart from the side payments model in two ways. First, we assume players are bargaining against a deadline. This assumption improves our ability to make predictions: without a deadline, there are many possible equilibria. Deadlines are also present in many real-world bargaining situations. (See Fershtman and Seidman, 1993, p. 308; Spier, 1992, for examples.) Importantly, the results we obtained with side payments still hold qualitatively if a deadline is introduced in that model. We also assume that both players can try to find ideas. This enriches the analysis by making it possible for a player's creativity to hurt her opponent. The results with side payments still hold when both players can look for ideas (see Frankel, 1995).

The model is as follows. The two players first *simultaneously* try to find ideas. (This assumption is weakened below.) With probability p_i, player i finds an idea, which gives her the utility $\tilde{x}_i$ and gives her opponent $1 - \tilde{x}_i$. $\tilde{x}_i$ is uniformly distributed on $[\underline{x}_i, \overline{x}_i]$. Player i *chooses* p_i, $\overline{x}_i$, and $\underline{x}_i$, subject to the constraints $\overline{x}_i \leq 1$ and $\underline{x}_i \geq 1/2$.[6] Let $\pi_i = \overline{x}_i - \underline{x}_i$ be the size of player i's search interval. We refer to $1/\pi_i$ as her *precision*. Player i's effort cost is given by $C(p_i, 1/\pi_i)$. We assume that in both arguments, C is strictly convex and increasing and satisfies the Inada conditions.

The players then simultaneously announce their ideas (if any). If there are no ideas, both players get zero. If there is only one idea, it is implemented. If there are two ideas, a (fair) coin is tossed to determine which idea to implement. The coin toss is intended to represent a more complex bargaining process in which the players perhaps argue about which idea is to be implemented, with neither *ex ante* more likely to prevail. Under this procedure, each player i always sets $\overline{x}_i$ to 1.

[6]Without the second restriction, player i might prefer player j's idea to her own. Accordingly, she might prefer to act as if she has no idea until she hears her opponent's idea. We do not consider this for the sake of brevity.

Player i's idea is adopted if (a) she *has* an idea (probability: p_i) *and* (b) her opponent either fails to get an idea (probability: $1 - p_j$) or loses the coin toss (probability: $p_j/2$). Therefore, i's idea is implemented with probability $p_i(1 - p_j/2)$ and her opponent's is implemented with probability $p_j(1 - p_i/2)$. Player i gets the payoff

$$U_i(p_i, p_j, \pi_i, \pi_j) = p_i \frac{1 - p_j}{2} E(\tilde{x}_i) + p_j \frac{1 - p_i}{2} E(1 - \tilde{x}_j) - C\left(p_i, \frac{1}{\pi_i}\right). \quad (2)$$

The social welfare function is $a_1 U_1(p_1, p_2, \pi_1, \pi_2) + a_2 U_2(p_2, p_1, \pi_2, \pi_1)$, where a_i is the social weight put on i's utility.[7] By the envelope theorem, player j's precision $1/\pi_j$ is excessive if $\partial U_i/\partial \pi_j > 0$. Since $\partial U_i/\partial \pi_j = p_j(1 - p_i/2)/2$, players *always* choose excessive precision.

We are also interested in whether a player's incentive for effort is suboptimal or excessive. To answer this, we check whether p_j is socially excessive given the other choices π_j, π_i, and p_i.[8] By the envelope theorem, p_j is socially excessive in this sense whenever $\partial U_i/\partial p_j < 0$. Since $E(\tilde{x}_j) = 1 - \pi_j/2$ and $E(\tilde{x}_i) = 1 - \pi_i/2$, this holds when (after some algebra),

$$p_i(2 - \pi_i) - (2 - p_i)\pi_j > 0. \quad (3)$$

Note that the left-hand side is increasing in the two players' precisions, $1/\pi_j$ and $1/\pi_i$, as well as the effort of j's opponent, p_i. Greater effort by i raises the chance that i has an idea of her own, so it becomes more likely that the externality from j's success will be negative rather than positive. An increase in precision strengthens the negative externality *vis-à-vis* the positive one: it raises i's loss from j's success if i has her own idea and lowers i's gain if she does not. If the cost of precision is sufficiently small, j's effort will be excessive since π_j will be close to zero.

Asynchronous Moves

The phenomenon of excessive effort does not depend on the assumption that the two players search simultaneously for ideas. Consider the following modification of the above game. First, player 1 searches for an idea and announces any he finds. Player 2 then either accepts or rejects. If she accepts, the idea is immediately implemented. If not, or if player 1 failed to find an idea, then after one period of delay player 2 looks for an idea

[7] Without side payments, there is no reason to assume that $a_1 = a_2$.

[8] One could also ask whether p_j is simply larger in equilibrium than in the social optimum. We think this is a less interesting question. Since p_j and π_j interact in the cost function, any such difference could be due to how different values of π_j affect the creative technology rather than to the relative strength of competing externalities.

of her own. If, following this, only one player has found an idea, then this idea is implemented. If both have found ideas, a coin is tossed. The discount factor is $\delta \in [0, 1]$. For simplicity, assume that $C(p_i, 1/\pi_i) = C(p_i)$. Accordingly, each player i will set $\pi_i = 0$, so that $\overline{x}_i = \underline{x}_i = x_i$. We also assume that $C''(p) > 1/2$ for all p. This condition simplifies the analysis, for reasons that are explained below.

Claim 2. There is a unique $\delta^* \in (0, 1)$ such that:

1. If $\delta > \delta^*$, player 1 looks for an idea that gives him the whole pie. Player 2 always rejects and looks for an idea that gives her the whole pie. Player 1's effort p_1 is excessive. Player 2's effort is excessive if player 1 finds an idea but efficient otherwise.

2. If $\delta < \delta^*$, player 1 searches for an idea that is acceptable to player 2. His effort is excessive if δ is sufficiently small.[9] If he fails, player 2 looks for an idea that gives her the whole pie and her effort is efficient.

Proof. Appendix.

This equilibrium has a property that may seem unusual. In bargaining with side payments, symmetric information, and a unique equilibrium, players agree when the current pie exceeds the joint payoff from continuing to bargain.[10] Although there are no side payments in our game, player 1 can still look for a partition that makes player 2 just willing to accept. He does so when $\delta < \delta^*$; why not when $\delta > \delta^*$? The answer is that in our game, a more generous offer from player 1 raises player 2's payoff from refusing: if she fails to find an idea or if she loses the coin toss, player 1's now more generous idea will be implemented. Accordingly, an increase in player 1's offer raises the minimum that player 2 will accept. Greater patience strengthens this effect since player 2's payoff from rejecting is more strongly affected by what will happen one period hence. When players are sufficiently patient, there is no offer that is acceptable to player 2 and that player 1 prefers to asking for the whole pie. A similar phenomenon occurs in concession games, where each proposal implies a commitment not to ask for more later (see, e.g., Fershtman and Seidman, 1993; Compte and Jehiel, 1995).

The rest of the intuition is as follows. The assumption $C'' > 1/2$ guarantees that if player 1 does not look for an idea that player 2 can accept, he

[9] Depending on the cost function, player 1's effort may be either excessive or suboptimal when δ is large (i.e., close to δ^*).

[10] Merlo and Wilson (1995) prove this result for a broad class of bargaining games. They show that a unique subgame perfect equilibrium must be stationary (Merlo and Wilson, 1995, p. 394) and that in every stationary equilibrium, players agree whenever it is Pareto optimal to do so (Merlo and Wilson, 1995, p. 386).

will look for one that gives him the whole pie. The only reason to do otherwise would be to induce player 2 to try less hard to find an idea of her own. If $C'' > 1/2$, player 2 would not reduce her effort enough for this to be worthwhile.

If $\delta > \delta^*$, player 1's effort is excessive because it can only hurt player 2. The reason is the same as with simultaneous offers and no precision cost: player 1's success affects player 2 only by reducing the probability that player 2's idea will be implemented. Likewise, player player 2's effort must be excessive if player 1 has an idea of his own. If he does not, player 2's effort is efficient since it has no effect on player 1, who always gets zero. (With a small cost of precision, player 2's effort would be suboptimal if player 1 failed to get an idea, since player 2's success would then help player 1.)

Now suppose $\delta < \delta^*$. To see whether player 1's effort is efficient, we must consider the effect of his success on player 2's payoff. Since player 2 is indifferent between accepting and rejecting, it suffices to consider the effect on her payoff from *rejecting*. Player 1 asks for less than the whole pie; in contrast, any idea of player 2's gives her the whole pie. Hence, player 1's success helps player 2 if she fails to get an idea of her own and hurts her if she succeeds. As δ shrinks to zero, player 2 becomes more and more impatient, so the amount that player 1 can successfully demand goes to one. This makes the positive externality from player 1's success smaller and the negative externality larger. In this limit, only the negative externality remains, so player 1's effort is excessive for small enough δ. For large δ, player 1's effort might in principle be suboptimal; we cannot say without additional assumptions on the cost function.

A. APPENDIX

Proof of Claim 1. Players agree in period 1 in equilibrium if $s \geq V_e(s) \stackrel{d}{=} \delta(p^e b + (1-p^e)s - C(p^e))$. They agree in the social optimum if $s \geq V_o(s) \stackrel{d}{=} \delta(p^o b + (1-p^o)s - C(p^o))$. By the envelope theorem, $V_o'(s) = \delta(1-p^o) < 1$. This shows that there is an $\bar{s} \in \Re$ such that players agree in the social optimum if and only if $s \geq \bar{s}$. The envelope theorem also implies that

$$V_e'(s) = \delta(1-p^e) + \frac{\delta^2(b-s)}{1+\delta}\left[\frac{\partial p^e}{\partial s}\right].$$

This holds because p^e maximizes player 1's payoff from waiting,

$$\delta\left[\frac{p^e b + (1-p^e)s}{1+\delta} - C(p^e)\right], \tag{4}$$

and since $V_e(s)$ is the sum of (4) and player 2's payoff from waiting, $\delta^2(p^e b + (1 - p^e)s)/(1 + \delta)$. But since $C'(p^e) = (b - s)/(1 + \delta)$, $\partial p^e/\partial s < 0$. This shows that $V_e'(s) < 1$. Hence, there is an $\underline{s} \in \Re$ such that players agree in equilibrium if and only if $s \geq \underline{s}$. We showed in Section 2 that, for all s, $V_e(s) < V_o(s)$. Since $V_o(\bar{s}) = \bar{s}$, we have $V_e(\bar{s}) < \bar{s}$, so that $\underline{s} < \bar{s}$.

Proof of Claim 2. Player 2 cannot affect player 1's behavior. Thus, whenever she looks for an idea of her own, it must be one that gives her the whole pie.

Say player 1 proposes an idea. If player 2 accepts, she gets $1 - x_1$. Rejecting gives her

$$\delta\left[\frac{p_2}{2} + \left(1 - \frac{p_2}{2}\right)(1 - x_1) - C(p_2)\right].$$

Hence, player 2 accepts if and only if

$$(1 - x_1)(1 - \delta) > \max_{p_2} \delta\left(\frac{x_1 p_2}{2 - C(p_2)}\right). \tag{5}$$

Since an increase in x_1 lowers the left-hand side and raises the right, there is a unique $x_1^*(\delta)$ such that player 2 accepts if and only if $x_1 \leq x_1^*(\delta)$. Moreover, $x_1^*(\delta)$ is a *decreasing* function of δ since a higher δ also lowers the left-hand side of (5) and raises the right. By the Inada conditions, for every $x_1 > 0$ there is a $p_2 > 0$ such that $x_1 p_2/2 - C(p_2)$ is strictly positive. This implies that $\lim_{\delta\to 1} x_1^*(\delta) = 0$. It follows directly from (5) that $\lim_{\delta\to 0} x_1^*(\delta) = 1$.

We now show that player 1 chooses either $x_1 = x_1^*(\delta)$ or $x_1 = 1$. First, no $x_1 < x_1^*(\delta)$ can be optimal, since ideas in $(x_1, x_1^*(\delta))$ are better for player 1 and still acceptable to player 2. Suppose instead that player 1 chooses some $x_1 \in (x_1^*(\delta), 1)$. Let player 2's effort choice after being offered $1 - x_1$ be $p_2^*(x_1)$. This maximizes $1 - x_1 + (p_2^*(x_1)x_1)/2 - C(p_2^*(x_1))$. Player 1's utility is $U_1 = p_1(1 - [p_2^*(x_1)]/2)x_1$. Optimality of x_1 implies that

$$\frac{\partial U_1}{\partial x_1} = p_1\left[1 - \frac{p_2^*(x_1)}{2} - \frac{x_1}{2}\frac{dp_2^*(x_1)}{dx_1}\right] = 0. \tag{6}$$

From player 2's first order condition, $C'(p_2^*(x_1)) = x_1/2$. This implies that

$$\frac{dp_2^*(x_1)}{dx_1} = \frac{1}{2C''(p_2^*(x_1))}.$$

Substituting, (6) becomes $p_2^*(x_1) + x_1/[2C''(p_2^*(x_1))] = 2$. This has no solution if $C'' > 1/2$. This shows that x_1 equals either $x_1^*(\delta)$ or 1.

We now determine which of these player 1 chooses. If he sets $x_1 = x_1^*(\delta)$, he gets $p_1 x_1^*(\delta) - C(p_1)$. If he sets $x_1 = 1$, he gets $\delta p_1(1 - p_2^*(1)/2) -$

$C(p_1)$. Comparing, we find that player 1 sets $x_1 = x_1^*(\delta)$ if and only if $x_1^*(\delta)$ exceeds $\delta(1 - p_2^*(1)/2)$ and $x_1 = 1$ otherwise. But since $p_2^*(1)$ is independent of δ and $x_1^*(\delta)$ is decreasing in δ, there is a δ^* such that player 1 sets $x_1 = x_1^*(\delta)$ for all $\delta < \delta^*$ and $x_1 = 1$ for all $\delta > \delta^*$. The fact that $\delta^* \in (0, 1)$ follows from

$$\lim_{\delta \to 0} x_1^*(\delta) = 1 > \lim_{\delta \to 0} \delta \left(1 - \frac{p_2^*(1)}{2}\right),$$

and

$$\lim_{\delta \to 1} x_1^*(\delta) = 0 < \lim_{\delta \to 1} \delta \left(1 - \frac{p_2^*(1)}{2}\right).$$

This shows that the equilibrium has the given form. It remains to verify the efficiency claims. Player 2's effort is always efficient if player 1 fails to find an idea since whatever happens, player 1 gets zero. Let us consider the case $\delta > \delta^*$. Player 2's utility is

$$p_1\left(\frac{p_2(1)}{2} - C(p_2(1))\right) + (1 - p_1)\big(p_2^0 - C(p_2^0)\big),$$

where p_2^0 is player 2's effort if player 1 fails to find an idea. Since this is decreasing in p_1 for the optimal $p_2(1)$ and p_2^0, player 1's effort is excessive. Now let us consider player 2's effort. Player 1's utility is $p_1(1 - (p_2(1)/2))$. Since this is decreasing in $p_2(1)$, player 2's effort is excessive if player 1 finds an idea. But player 1's utility does not depend on p_2^0, which therefore must be efficient.

Now consider the case $\delta < \delta^*$. Player 1's effort is excessive if his success hurts player 2. If he succeeds, player 2 gets

$$1 - x_1^*(\delta) = \delta\left(1 - x_1^*(\delta) + \max_{p_2}\left[\frac{x_1^*(\delta) p_2}{2} - C(p_2)\right]\right).$$

Solving this for $1 - x_1^*(\delta)$, we find that player 2 gets

$$\frac{\delta}{(1-\delta)} \max_{p_2}\left(\frac{x_1^*(\delta)}{2} p_2 - C(p_2)\right).$$

If player 1 fails, player 2 gets $\max_{p_2}(p_2 - C(p_2))$. This implies that if $\delta \approx 0$, player 2 does better if player 1 fails, so player 1's effort is excessive.

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