

When Outside Options Force Concessions to be Gradual^α

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Abstract

In many real-life negotiations, parties may decide to stop negotiating and have their dispute resolved in a second phase. This paper analyzes how the option to terminate the negotiation and move to a dispute resolution phase affects the parties' bargaining strategies. The key features of the model are that 1) making a concession in the negotiation phase increases the payoff^β the other party may get if the dispute resolution phase is triggered and 2) the dispute resolution procedure induces an efficiency loss as compared with a negotiated agreement. The main finding is that the mere threat of triggering the dispute resolution procedure forces equilibrium concessions in the negotiation phase to be gradual. We next discuss various institutional bargaining contexts like arbitration, mediation and international negotiations to which we suggest our insight applies. Journal of Economic Literature Classification Numbers: C72, C78, D60.

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1 Introduction

In many real-life negotiations, parties may decide to stop negotiating and have their dispute resolved in a second phase such as litigation, arbitration or just another bargaining phase. If the outcome of the second phase depends on what the parties did or proposed during the negotiation phase, we should expect parties to take into account this dependence and choose their negotiating strategy accordingly.

The simplest illustration of this phenomenon is the case of a pre-trial negotiation in which the judge would interpret any settlement offer as an evidence of guilt (in practice such interpretations are precluded by rules of evidence). In such a context, when a party makes a settlement offer, the other party has the option to wait for the trial and obtain a very favorable outcome. So neither party is willing to make a settlement offer. As a result, parties end up in court even if there is a cost of doing so.

In most cases however, settlement offers do not have such a drastic effect on the outcome of the second phase, and the parties may reach a complete agreement in the first phase.

The main insight of the paper is that even if the second phase is not triggered, the option to terminate bargaining and move to the second phase may force the concessions made in the bargaining phase to be gradual.

To illustrate our main insight, consider a negotiation context in which terminating the bargaining phase has the effect of postponing (at some cost) the negotiation to a later bargaining phase. A party might be willing to make a large concession if he believes that it will be reciprocated by the other party. However upon receiving a large concession, a party may be tempted to terminate the first bargaining phase without reciprocating: by doing so, this party would not only benefit from the concession made during the first bargaining phase; he would also get additional concessions in the second phase. The Camp David negotiations, as accounted for by President Carter (1982, page 392), offer a good example of why one party (Sadat)

did refrain from making a large concession (signing an agreement with the United States alone):

His (Sadat) own advisers had pointed out the danger in his signing an agreement with the United States alone. Later if direct discussions were ever resumed with the Israelis, they could say: "The Egyptians have already agreed to all these points. Now we will use what they have signed as the original basis for all future negotiations".

Sadat feared that his own concessions would be taken for granted in future negotiations, and that bargaining would continue as if no concession had been made.

To illustrate more formally our first observation that the option to terminate bargaining may affect the bargaining strategies used in equilibrium, consider the Rubinstein bargaining game, that is, a negotiation over the partition of a pie of size one between two parties who alternate in making offers and discount future payoffs with the same discount factor (close to 1, say). In equilibrium, the first party to move, e.g. party 1, should propose a partition close to $(\frac{1}{2}; \frac{1}{2})$ and party 2 should accept it (see Rubinstein 1982). Assume now that at each point where he moves, a party has the option of terminating the bargaining phase. Assume further that in such a case, parties enter a second phase yielding a compromise partition that lies in between the most generous partition offer of each party. If party 1 proposes the partition $(\frac{1}{2}; \frac{1}{2})$, party 2 would obtain $\frac{1}{2}$ by accepting it. Yet, rather than accepting party 1's offer, party 2 could instead reject it and opt for the second phase. The resulting share for party 2 would then lie in between $\frac{1}{2}$ and 1, and even if there is a (small) cost associated with the second phase, party 2 should prefer this outcome to the one resulting from the acceptance of party 1's offer. Thus party 2 would not accept party 1's offer, and anticipating this, we should expect party 1 to modify his offer to party 2.

To present our main result that the option to terminate bargaining may force concessions to be gradual, it will be more convenient to consider a variant of the

partition-order model: a concession game. The model of negotiation can be described as follows: (1) The parties move in alternate order and the pie has size 1; (2) When it is his turn to move, party i may either make a concession on what has not been conceded yet or terminate bargaining. Bargaining ends when either there is nothing left to be conceded or one of the parties terminates bargaining. In the latter case, the parties are assumed to enter a second phase that we call the resolution phase.¹

The resolution phase results in payoffs that depend on the concessions received by each party. We will assume that the larger the concession a party has received in the first phase, the higher the payoff of that party if the resolution phase is triggered. To illustrate this dependence, consider again the case of a negotiation where terminating has the effect of postponing (at some cost) the negotiation to a later bargaining phase. If the second bargaining phase results in an equal sharing of what has not been conceded in the first phase, a concession X_2 made by party 1 to party 2 would yield a share equal to $X_2 + (1 - X_1 - X_2)/2$ to party 2 (where X_1 denotes the concession made by party 2 to party 1). Thus even taking into account the cost of postponing a full agreement to the second phase, the payoff that party 2 would obtain by triggering the resolution phase is likely to be an increasing function of the share conceded by party 1 in the first phase. More generally, we will let α_j denote a lower bound on the marginal effect of an increase in party i 's concession on the payoff that party j would obtain by triggering the resolution phase. We will also let ϕ denote the efficiency loss associated with the dispute resolution procedure. We will show that whatever the equilibrium to be considered,² the equilibrium concession of party i cannot exceed ϕ/α_j . That is, equilibrium concessions, if any, must be gradual

¹Note that the option to terminate bargaining may be interpreted as an outside option. A key difference with Binmore et al. (1989) though is that the outcome of the second phase will depend on what happens in the bargaining phase.

²Whether the equilibrium is unique depends on how the discounting is specified and/or whether concessions are available immediately at the time they are made or only after the negotiation process ends.

(at least when this ratio is not too large).³

An essential feature of the resolution phase is the dependence of its outcome on the concessions made during bargaining. Is this a natural assumption? What kind of dependence should we expect in practice? A substantial part of this paper is devoted to answering these questions and our paper contributes to understanding why apparently different negotiation contexts have resolution phases structured similarly. We examine two broad types of negotiations: multi-stage negotiations (such as trade, environmental or territorial negotiations), where as explained above the resolution phase consists of a new bargaining phase, and negotiations where each party may ask for or provoke the intervention of a third party.

While the basic model outlined above assumes that the resolution phase takes a mechanical form, practice suggests that parties may sometimes have some flexibility in choosing the way they wish to have their dispute resolved in case negotiations break down; Arbitration may sometimes require the consent of both parties in order to be implemented; Concessions made in bargaining may be confidential and may therefore affect the resolution phase only if parties choose to disclose them. In international negotiations, concessions made in bargaining may have a long-term effect (on future negotiation rounds) only if a partial agreement has been signed at the end of the first round. We will extend the basic framework to cover these contexts and examine the circumstances under which our main insight carries over.

The rest of the paper is organized as follows. In Section 2 we present the model. The main insights are derived in Section 3. Section 4 suggests a wide range of applications of our model and discusses each assumption in light of each application. In Section 5 we suggest an extension of our model to cover the case where upon reaching the second phase, parties can withdraw their concessions. Section 6 discusses the relationship with the literature. Section 7 concludes.

³For the sake of the illustration, assume the outcome of the resolution phase is that what has not been conceded yet is split equally between the two parties. Assume further that there is a cost c for each party of terminating the bargaining phase. Equilibrium concessions cannot exceed $4c$.

2 The Model

Two parties $i = 1; 2$ are bargaining on the partition of a pie of size one. Each party moves in turn every other period. Party 1 moves in odd periods while party 2 moves in even periods. When it is her turn to move, party i can either make a concession to party j , where j stands for the party other than i , or she may terminate the negotiation - we will say that she opts out.

Let $C_i^k \geq 0, k \geq 1$ denote the concession made by party i in period k . Since party 1 (resp. 2) moves in odd (resp. even)-numbered periods, we have: $C_1^{2k} = C_2^{2k-1} = 0$ for all $k \geq 1$. At the beginning of period t , the total concession to party j is the sum of all the concessions made by party i to party j in earlier periods:

$$X_j^t = \sum_{k < t} C_i^k; \quad (1)$$

and what has not been conceded yet is

$$X^t = 1 - X_1^t - X_2^t; \quad (2)$$

The negotiation ends when there is nothing left to be conceded or when one party opts out. Equation (1) says that concessions are cumulative, and thus a party may only concede a share of what has not been conceded yet. Note that since concessions are positive, the total concession made to a party may only increase over time.

When a party opts out, a new phase -called the resolution phase- starts. An essential feature of the resolution phase will be that its outcome may depend on the concessions made during the negotiation phase. Formally, if X_i is the total concession made to party i at the time where the resolution phase is triggered, party i 's outside option payoff[®] is given by:

$$v_i^{\text{out}}(X_i; X_j);$$

where $v_i^{\text{out}}(X_i; X_j)$ is assumed to be strictly increasing with respect to its first argument X_i and strictly decreasing with respect to its second argument X_j . Specifically,

we will assume that there exists $\delta_i > 0$, $i = 1, 2$ such that

$$\text{For all } X_i, X_j, \frac{\partial v_i^{\text{out}}}{\partial X_i}(X_i; X_j) > \delta_i: \quad (\text{A1})$$

We will also assume that there is a cost associated with the outside option, that is,

$$\text{For all } X_1, X_2, v_1^{\text{out}}(X_1; X_2) + v_2^{\text{out}}(X_2; X_1) < 1: \quad (\text{A2})$$

Finally, we will assume that when the parties are about to reach an agreement, no party is willing to enter the resolution phase, that is, $X_i \geq v_i^{\text{out}}(X_i; 1 - X_i)$ for all X_i .⁴

Throughout the paper, we will consider as leading example the specification:

$$v_i^{\text{out}}(X_i; X_j) = X_i + \frac{X}{2} - c_i(X); \quad (3)$$

where $X = 1 - X_i - X_j$ and where $c_i(\cdot)$ is an increasing function of X . That specification covers many applications of interest, as argued in Section 4. It is readily verified that such a specification satisfies the above requirements on $v_i^{\text{out}}(\cdot; \cdot)$. Moreover, assumption (A1) is always met with $\delta_i = \frac{1}{2}$. Note that a possible interpretation of the specification is as follows: 1) The concessions made during the negotiation are confirmed, 2) what has not been conceded yet is shared equally between the two parties, and 3) party i incurs an extra cost $c_i(X)$ during the resolution phase.

To complete the description of the model, we will assume that both parties have the same discount factor denoted by δ .⁵ To summarize the model, consider a period t where it is party i 's turn to move:

1. Party i may either concede the rest of the pie: $C_i^t = X^t$. In that case, the negotiation stops, party i receives the share X_i^t of the pie, and party j receives

⁴Even though this assumption is natural, it is inessential for the derivation of our main results. It allows for a simpler treatment of the last concession.

⁵ $1 - \delta$ can be interpreted as a probability of breakdown from one period to another, where in case of breakdown the parties receive zero payoffs. We could alternatively assume that in case of breakdown the outside option is implemented. The main result to be derived in the next Section is robust to the change of specification.

the share $1 - X_i^t$. Payoffs to parties i and j are given by $\pm^{t_i} X_i^t$ and $\pm^{t_j} (1 - X_i^t)$, respectively.

2. Or she may make a partial concession $C_i^t \in [0, X_i^t]$. In that case, the new levels of total concessions are $X_i^{t+1} = X_i^t$ and $X_j^{t+1} = X_j^t + C_i^t$, and the game proceeds to the next stage where it is party j 's turn to move.
3. Or she may opt out. Player i 's payoff is then given by $\pm^{t_i} v_i^{\text{out}}(X_i^t; X_j^t)$.

Comments

1. We have chosen a concession model rather than a partition-offer model. Yet the strategic analysis to be presented below would also hold if we had considered a partition-offer model à la Rubinstein with history-dependent outside options given by $v_i^{\text{out}}(X_i; X_j)$, where $X_i = 1 - x_j$, $X_j = 1 - x_i$, and $(x_1; 1 - x_1)$, $(1 - x_2; x_2)$ are the most generous partition offers proposed by parties 1 and 2 respectively in earlier periods (x_i is the smallest among all previous offers of party i). In other words, the most generous offer $1 - x_2$ made by party 2 is interpreted as the total concession made by party 2 to party 1. What is left to be conceded is then equal to $1 - (1 - x_1 + 1 - x_2) = x_1 + x_2 - 1$.⁶ The concession model however will facilitate the exposition of the results.
2. Our model may be extended to deal with cases where the value to party i of the share X_i is $u_i(X_i)$ rather than X_i . This for example allows to cope with risk aversion where the value $v_i^{\text{out}}(X_i; X_j)$ should now be interpreted as the certainty equivalent derived by party i when the resolution phase is triggered.⁷

⁶Note that a difference between the two models is that after the offer of a party, the other party would have to say if she accepts or refuses it. The negotiation would end when an offer is accepted or when a party opts out.

⁷We would then interpret $1 - \pm$ as the probability of breakdown of the negotiation in each period (in case of breakdown, each party gets a share equal to 0), and we would assume that parties maximize expected utility.

3 Gradual Concessions

Imagine first that the parties do not have the possibility of opting out in the negotiation model described above. Then it can be shown that there is a unique Subgame Perfect Nash Equilibrium of this game in which party 1 concedes $C_1 = \frac{1}{1+\delta}$ in the first period and party 2 concedes the rest $C_2 = \frac{\delta}{1+\delta}$ in the second period. Hence when δ is close to 1, each party concedes in turn approximately half the pie. The intuition for this result is that of Rubinstein (1982). Party 1 concedes up to a point where the other party is sufficiently impatient to take advantage of the concession she received so that she optimally chooses to concede the rest right away (see the Appendix section of Admati and Perry (1991)).

We now turn to the role of the outside option, and first observe that it may have an effect on the equilibrium behavior of the parties. For the sake of illustration, consider the specification (3) and assume that the cost functions are constant and equal to c so that $v_i^{\text{out}}(X_1; X_2) = X_i + \frac{X_j}{2} - c$. Suppose (by contradiction) that there is no effect of the outside option. Then when δ is close to 1, party 1 should concede approximately half the pie to party 2 in period 1, and party 2 should concede the rest in period 2, as we have just seen. However, by opting out in the second period, party 2 can get $\frac{1}{2} - c$, which is more than what she gets by conceding the rest of the pie whenever $\frac{1}{2} - c > \frac{1}{2}$. Thus, the equilibrium strategy of party 2 is affected by the presence of the outside option. As a matter of fact, the equilibrium strategy of party 1 is also affected by the presence of the outside option. To see this, note that whenever party 1 concedes half the pie to party 2 in period 1, party 2 can secure $\frac{1}{2} - c$ by opting out in the next period. Since the total surplus to be shared among parties 1 and 2 cannot exceed the size of the pie, the best player 1 can expect by conceding half the pie cannot exceed $1 - (\frac{1}{2} - c) = \frac{1}{2} + c$. However, by opting out in the first place (before conceding anything) party 1 can secure $\frac{1}{2} - c$, which is more than $\frac{1}{2} + c$ whenever $c < \frac{1}{4}$. Consequently, conceding half the pie cannot be part of an equilibrium strategy whenever $c < \frac{1}{4}$.

We can go further in the use of the above type of dominance relations to derive an upper bound on equilibrium concessions that should be met in any Subgame Perfect Nash Equilibrium. To this end, we let $\phi(X_1; X_2)$ denote the efficiency loss resulting from the resolution phase when each party i has received X_i as total concession in the negotiation phase:

$$\phi(X_1; X_2) = 1 - v_1^{\text{out}}(X_1; X_2) - v_2^{\text{out}}(X_2; X_1) \quad (4)$$

Proposition 1 Let X_1 and X_2 denote the total concessions received by parties 1 and 2, respectively. Suppose it is party i 's turn to move. Whatever the SPNE to be considered, either party i opts out or party i makes a concession no greater than $\phi(X_1; X_2)_{\geq \underline{c}_j}$ (where \underline{c}_j is a lower bound on $\frac{v_j^{\text{out}}}{c_j}$, see A1)

The main insight of Proposition 1 is that due to the form of the outside option payoffs, equilibrium concessions are gradual. The reason for gradual concessions is as follows. When a party concedes, he increases the outside option of the other party thereby reducing the maximum payoff he may hope to get in equilibrium (because what the parties can hope to get together is bounded by the size of the pie). A party who would make a large concession would increase so much the other party's outside option that he would reduce the maximum payoff he might hope to get down to a point where he would prefer opting out right away (instead of making a large concession).

In the case of the specification (3), $\phi(X_1; X_2) = c_1(X) + c_2(X)$. Equilibrium concessions are then bounded by $2(c_1(X) + c_2(X))$. When in addition $c_i(X) = c(X)$, equilibrium concessions are bounded by $4c(X)$. In Appendix, when $c(0) > 0$ we exhibit (for an alternative specification of the form of discounting) a Subgame Perfect Nash Equilibrium in which parties make concessions; besides, we observe that for $c(X) < c > 0$ the bound $4c$ on equilibrium concessions is tight.

Proof. We assume that parties' current concession levels are X_1 and X_2 . We denote by $X = 1 - X_1 - X_2$ the share not conceded yet, and without loss of generality, we

assume that it is player 1's turn to move. Assume that party 1 concedes $C_1 < X$ with positive probability in equilibrium. We consider the Subgame Perfect Nash Equilibrium of the sub-game where party 1 concedes C_1 and we denote by u_i the corresponding equilibrium payoff of party i . Since party 1 could have opted out in the first place instead of making any concession, party 1 should get at least what he can get by opting out:

$$u_1 \geq v_1^{\text{out}}(X_1; X_2): \quad (5)$$

After party 1's concession C_1 , the new total concession to party 2 is $X_2^0 = X_2 + C_1$. If $C_1 < X$, it is party 2's turn to move. By opting out, party 2 may thus secure $v_2^{\text{out}}(X_2 + C_1; X_1)$:

$$u_2 \geq v_2^{\text{out}}(X_2 + C_1; X_1): \quad (6)$$

The most parties 1 and 2 can hope to get together is 1 (by assumption A2), that is, $u_1 + u_2 \leq 1$ since party 1 only made a partial concession and an agreement was thus not reached immediately. Also, $u_1 \geq 0$ since party 1 can receive a positive share by conceding the rest. Combined with the previous inequality, one obtains:

$$u_1 + \frac{u_2}{\pm} \leq \frac{1}{\pm}(u_1 + u_2) \leq 1: \quad (7)$$

The inequalities (5), (6) and (7) imply that:

$$v_1^{\text{out}}(X_1; X_2) + v_2^{\text{out}}(X_2 + C_1; X_1) \leq 1: \quad (8)$$

That inequality also holds when party 1 concedes the rest since then $u_1 = X_1 = 1 - X_2^0$ and $X_2^0 \geq v_2^{\text{out}}(X_2^0; X_1)$ (see Section 2), therefore implying together with (5):

$$v_1^{\text{out}}(X_1; X_2) \leq u_1 \leq 1 - v_2^{\text{out}}(X_2^0; X_1)$$

By definition of $\phi(\xi; \xi)$, (8) implies that:

$$v_2^{\text{out}}(X_2 + C_1; X_1) \leq v_2^{\text{out}}(X_2; X_1) + \phi(X_1; X_2): \quad (9)$$

Finally, the assumption that $\frac{\partial v_2^{\text{out}}}{\partial X_2}(X_2; X_1) > \pm_2$ implies that

$$v_2^{\text{out}}(X_2 + C_1; X_1) \geq v_2^{\text{out}}(X_2; X_1) + \pm_2 C_1;$$

which combined with (9) yields the wished result $v_i^{\text{out}}(X_1; X_2) \geq c_1$. ■

We wish to point out several significant directions in which the result of Proposition 1 is robust. First, the result of Proposition 1 would continue to hold even if discounting were to take the form of a probability of breakdown and if the outcome in case of breakdown were the outside option or just any other (inefficient) outcome.⁸ In the same vein, Proposition 1 would continue to hold even if the parties could immediately benefit from the concessions they receive.

Second, we suggested that the model could be extended to deal with the case where the value to party i of share X_i differs from X_i . To be more precise, assume that the value of X_i to party i is of the form $u_i(X_i) = (1 + \mu_i)X_i$ with the specification of the outside option payoff as given by (3) (i.e., $v_i^{\text{out}}(X_i; X_j) = (1 + \mu_i)(X_i + \frac{X_j}{2}) - c_i(X)$). Then the bound on the size of the equilibrium concessions made by party i is $2(\frac{c_1(X)}{1 + \mu_1} + \frac{c_2(X)}{1 + \mu_2})$.⁹ More interestingly, consider a variant of the model in which μ_i is known to be positive, but the exact value of $(1 + \mu_i)$ is only privately known to party i . Then from easy adaptations of our analysis, it can be shown that any (perfect Bayesian) equilibrium concession is bounded by $2(c_1(X) + c_2(X))$. Thus, our insight is robust to the introduction of asymmetric information.

Third, coming back to our complete information setup it should be noted that the proof of Proposition 1 holds for any equilibrium strategies, not for a specific selection of SPNE. Even better, it does not require that the parties be fully aware of the equilibrium strategies. It only relies on two levels of conditionally iterated dominance relations, which suggests that even the play of moderately sophisticated players may satisfy the restrictions shown in Proposition 1.

⁸To see this, observe that the key argument in the proof of Proposition 1 relies on comparisons of equilibrium payoffs with outside option payoffs, rather than comparisons of equilibrium payoffs across time.

⁹This can be easily seen by dividing party i 's payoff by $1 + \mu_i$ and observing that the model is analogous to our main model with the cost $c_i(X)$ replaced by $c_i(X)/(1 + \mu_i)$.

When the resolution phase is triggered: So far we have illustrated the effect the resolution phase may have on the equilibrium concessions to be made in the bargaining phase. Yet in some cases the parties may prefer terminating the negotiation right away (as our first example in the introduction suggested). We wish to explore within our setup whether the parties sometimes prefer to have their dispute resolved in the resolution phase. It should be noted that in principle the cost of the resolution phase can always be avoided by making concessions. However, despite its cost we will show that sometimes the parties prefer that option.

Specifically, the fact that equilibrium concessions are gradual (Proposition 1) implies that if an agreement is to be reached with no party opting out it must be delayed. However, delaying the agreement is costly (because of discounting). When the inefficiency associated with the outside option $\phi(\tau; \tau)$ is low, Proposition 1 shows that many rounds of negotiation are necessary to reach an agreement if no party is to opt out. When $\phi(\tau; \tau)$ is sufficiently low, eventually the inefficiency loss which results from the delay implied by Proposition 1 is larger than the efficiency loss induced by the outside option. In such situations, we will show that the parties have incentives to opt out.

Formally, we consider the case where $v_i^{\text{out}}(0; 0) > 0$ for $i = 1; 2$ (so that moving to the second phase right away yields positive profits). We will let $L(n)$ denote the efficiency loss associated with an agreement obtained at date n , that is, delayed $n - 1$ periods:¹⁰

$$L(n) = 1 - \delta^{n-1}$$

We also let $\bar{\delta}$ denote an upper bound on $\delta(X_1; X_2)$. We let \underline{n} denote the smallest integer greater than $\min_i \delta_i = \bar{\delta}$. By Proposition 1 we know that it must take at least \underline{n} periods to reach a negotiated agreement, resulting in an efficiency loss at least

¹⁰If discounting took another form for example that of a breakdown, then the efficiency loss in case of delayed agreement would depend on the outcome in case of breakdown. We would still find similar insights as long as delaying the agreement for n_0 periods involves some efficiency loss such that when n_0 goes to infinity, it converges to a positive value.

equal to $L(\underline{n})$. We have the following Proposition proved in Appendix:

Proposition 2 If $\bar{c} < L(\underline{n})$, then in equilibrium party 1 opts out right away.

Proposition 2 shows that despite its cost, the outside option is sometimes used in equilibrium. The point is that when the cost of the outside option is small, the threat that the other party opts out forces each party to make small concessions, which results in a rather inefficient outcome. By Proposition 1, the condition $\bar{c} < L(\underline{n})$ implies that opting out is socially more efficient than trying to obtain a negotiated agreement. Thus, in any (pure strategies) equilibrium the resolution phase must be triggered at some point; otherwise one of the parties would strictly prefer to opt out (in either period 1 or 2) rather than obtaining the assumed equilibrium payoff (which would lead to a contradiction). Proposition 2 goes one step further and shows that in equilibrium the resolution phase is triggered immediately in the first period. This is so because if, say the outside option were to be triggered in period $t > 1$, the party whose turn it is to move at period $t - 1$ should have strictly preferred to opt out rather than making a concession (thus yielding a contradiction).¹¹

Note that as pointed out by a referee, the latter argument implies that our model cannot explain as an equilibrium outcome that the resolution procedure is triggered after a process of concessions and counterconcessions.

Also note that Proposition 2 does not make any assumption on the shape of the function $\phi(\cdot; \cdot)$. For some particular specification of this function, the result that party 1 opts out immediately may be derived more directly. In the leading specification with $c_i(X) = \alpha X$ ($\alpha < 1=2$) for example, a party always prefers to opt out rather than conceding the rest. Thus no party is willing to make the last concession and there cannot be a negotiated agreement.¹²

¹¹The argument implicitly assumes that $\frac{\partial v_i^{\text{out}}}{\partial X_j} < 0$ (which is the case in our leading example). However, using a slightly more elaborate argument (see Appendix), Proposition 2 is valid even without that assumption.

¹²For this particular specification, the outside option may induce significant losses and still be used in equilibrium even if α is close to 1.

From Proposition 2, we can infer some interesting comparative statics relative to the effects of the outside option costs on the efficiency of the negotiation process. On the one hand, when those costs are very high we have seen that a negotiated agreement is reached in two rounds (since opting out is then not a credible option). The outcome is quite efficient. On the other hand, when those costs are very small, one can infer from Proposition 2 that party 1 opts out right away, which is also quite efficient. The worst case for efficiency appears for intermediate ranges of the outside option costs, since then either the outside option is triggered but this is costly or there is a process of concession and counter-concession, but this must take time by Proposition 1. Thus the welfare varies non-monotonically with the cost of the outside option.

4 Applications

We wish to apply our model to various negotiation environments. We thus review the assumptions of our model in the light of these applications. More specifically, we will focus on the two main assumptions of our model: the assumption that each party may terminate negotiations thereby moving to another phase, and the assumption that conceding more in the first phase increases the other party's payoff in case the second phase is triggered.

4.1 The transition to a new phase

There are two basic types of behavior that are consistent with our termination assumption: a party may decide to call in a third party to solve the dispute, or he may decide to leave the bargaining table. For example, in commercial contracts with arbitration clauses, a party may stop negotiating at any time, and call for the resolution of the dispute by an arbitrator. Also, in international negotiations, any party may decide to break off negotiations, and the resolution of the unsettled issues is then postponed to a later bargaining phase.

It might be argued that in many contexts, such unilateral moves to end negotiations are not possible. Yet, in most instances, there are alternative behaviors that result in outcomes very similar to the ones that would obtain if one party had broken off the negotiation. In labor negotiations for example, even though a single party cannot in general unilaterally decide to terminate negotiation, she may provoke an impasse (or wait for a pre-announced deadline) that will result in arbitration being exogenously triggered. In international negotiations, breaking off negotiations is always possible. Yet being perceived by outsiders as responsible for the breaking off of the negotiation might be too costly. Nevertheless refusing to make any further concession would have similar consequences as breaking off the negotiation with the difference that the responsibility about who caused the breakoff is more diffuse (and thus it is less costly).

Our unilateral termination assumption should thus be interpreted more broadly as follows: any party may take an action that affects the nature of the interaction between the parties. Such an action may for example consist of a commitment to one's current position; this type of behavior generally triggers a similar response by the other party, and both parties are then led to an impasse.

What comes out of an impasse depends on the particular environment in which bargaining takes place. We have already mentioned arbitration and a new bargaining phase as possible outcomes. More generally, an impasse may lead to a more active participation of a third party (neutral, mediator), and a combination of further bargaining and third party's influence. The context (contracts, protocol, norms) may regulate how and when a third party may be called upon.

The next subsection analyzes in more detail the form of these outcomes and their dependence on past concessions, as well as the effect of third parties' interventions on the outcome.

4.2 The dependence on past concessions

Our second assumption relates to how the payoffs obtained in the second phase depend on the concessions made in the first phase in the various negotiation contexts mentioned above. In order to investigate this dependence, it will be convenient to rewrite the payoff function of the second phase as follows:

$$v_i^{\text{out}}(X_1; X_2) = X_i + s_i(X_1; X_2) - c_i(X_1; X_2)$$

where

$$s_1(X_1; X_2) + s_2(X_1; X_2) = 1 - X_1 - X_2;$$

The interpretation is that in the second phase, party i gets whatever the other party has conceded to him in the first phase, plus a share $s_i(X_1; X_2)$ of what has not been conceded in the first phase. The cost of moving to the second phase is equal to $c_i(X_1; X_2)$ for party i .

Our analysis applies most straightforwardly to contexts in which the extra share $s_i(X_1; X_2)$ and the cost $c_i(X_1; X_2)$ solely depend (increasingly) on the share X not conceded yet:¹³

$$s_i(X_1; X_2) = s_i(X)$$

$$c_i(X_1; X_2) = c_i(X):$$

In international negotiations, it seems reasonable to assume that negotiators would take the concessions made in the past for granted, and start any new round of negotiation from the final positions reached in the last round (implying that $s_i(\cdot)$ and $c_i(\cdot)$ depend solely on X). Indeed, a key feature of the Camp David story reported in the introduction is that Sadat feared that the concessions made in the

¹³The marginal effect of an increase in X_i on party i 's payoff (in case the second phase is triggered) is then at least:

$$1 - \max_X [s_i^0(X) - c_i^0(X)]:$$

First phase would serve as the starting point for the second phase. Similar accounts can be found in other contexts. Kissinger (1979, page 789), describing Gromyko's negotiating strategy, writes:

"He had a prodigious memory that enabled him to bank on every concession, however slight, he believed we had made - or perhaps even hinted at. It would then become the starting point for the next round."

Consider now the case of negotiations in which a third party is eventually called in when there is an impasse. Let us make two assumptions that we will discuss shortly:

- 1) The third party takes a compromise position in between the positions of the parties, for example the average position.;
- 2) The third party's position is eventually implemented.

Then we have:

$$s_i(X) = \frac{X}{2}:$$

We start with arbitration, where implementation is not an issue. The two most common forms of arbitration are conventional arbitration, where the arbitrator is free to choose any final partition, and final-offer arbitration, where the arbitrator is forced to pick either one of the parties' final position.

In conventional arbitration, the view that arbitrators compromise between parties's position (or split the difference) has been suggested in some early works, in particular by Stevens (1966) (who proposed the final-offer procedure precisely as a way to prevent arbitrators from splitting the difference between offers). Since then, the empirical literature dealing with the determinants of arbitrators' actual behavior has found that a more accurate description of arbitrators' behavior is one in which the final choice of the arbitrator also depends on his own preference or expertise

of the case. Nevertheless, Farber and Bazerman (1986) found a dependence on the parties' average position.¹⁴

In final-offer arbitration, the arbitrator cannot split-the-difference between offers: he is forced to pick either one of the parties' last offer, and supposedly picks the one he prefers most. In this context, a party who makes a large concession does not necessarily weaken his position. Assume for example that the ideal point of the arbitrator is $1=2$. By conceding $1=2$, party 1 makes sure that calling the arbitrator is always a dominated strategy for party 2 (who would rather concede the rest rather than call the arbitrator because the arbitrator would always pick $1=2$). So the threat that party 2 calls the arbitrator cannot weaken party 1.

Nevertheless, if there is some uncertainty about arbitrators' ideal point, our analysis becomes relevant again. The simplest illustration is the extreme case in which half of the arbitrators always favor party 1's position (because their ideal point is close to $X_1 = 1$ and $X_2 = 0$, say) and half of the arbitrators always favor party 2's position. Then with probability half the arbitrated outcome will result in partition $(X_i; 1; X_i)$ and with probability half it will result in partition $(1; X_j; X_j)$. Conceding does not increase the probability to obtain a favorable arbitrated outcome, and in expectation each party i gets a share equal to $\frac{X_i}{2}$. This form of heterogeneity is clearly extreme, but the conclusion that $\frac{\partial v_i^{\text{out}}}{\partial X_i} > 0$ will carry over to other distributions over arbitrators' ideal points, as long as the distribution is not too concentrated over a unique ideal point.¹⁵

¹⁴In addition to their empirical analysis, Farber and Bazerman (1986) provide a theoretical explanation for the dependence of the arbitrator's preferred outcome on the parties' positions: arbitrators typically have less information than the parties about the case. Thus the offers of the parties may convey some information about the case, which may be used by the arbitrator. For the sake of the illustration, consider a negotiation about multiple issues, each of which may be of different value to each of the parties. An arbitrator who believes that the concessions were made to maximize the surplus would confirm the concessions made in the bargaining phase. Anticipating this behavior of the arbitrator, the parties would indeed make the concessions which generate the highest surplus (see also Gibbons (1988)).

¹⁵Bi-modal distribution would yield the desired conclusion. Yet bi-modality is not necessary: it

More generally, our model applies to alternative forms of arbitration, as long as two conditions hold: 1) the arbitrated outcome does not lie outside the range of partitions defined by the parties' last positions;¹⁶ 2) arbitrators are sufficiently heterogeneous in their preference.

Investigating whether arbitrators' views are heterogeneous seems thus of importance in view of the application of our model to arbitration. Empirical analysis of arbitrators' decisions reveals that arbitrators are heterogeneous in their preferences (Ashenfelter and Bloom (1984) and Ashenfelter (1987)). Possible sources of heterogeneity across arbitrators include the variety of norms that may apply to any particular case (see Bazerman (1985)) and the variety of arbitrators' backgrounds (see Bloom and Cavanagh (1986) who provide data showing that unions tend to prefer arbitrators with a legal background, while employers tend to prefer arbitrators with an economics background).

As mentioned before, arbitration is not the only type of interventions by third parties. As is often the case in a deadlock, parties may seek mediators' recommendations. Unlike arbitrators' decisions though, a mediator's recommendations can be checked that if the distribution over ideal points is uniform over $[0; 1]$, then $\frac{\partial v_1^{\text{out}}}{\partial X_1}$ is equal to X_1 .

Formally, let $(Y; 1 - Y)$ denote the ideal partition of the arbitrator, and assume that Y is uniformly distributed over $[0; 1]$. Party 1 either gets 0 or X in addition to X_1 depending on whether Y is closer to X_1 or $1 - X_2$. That is, the expected additional share s_1 is equal to

$$s_1(X_1; X_2) = X \Pr\{Y < X_1 + \frac{X}{2}\}$$

which yields

$$\frac{\partial}{\partial X_1} s_1(X_1; X_2) = 1 - X_1$$

implying that the marginal effect $\frac{\partial v_1^{\text{out}}}{\partial X_1}$ remains positive (larger or equal to X_1)

¹⁶It is a stylized fact that in practice, arbitrators rarely take positions that lie outside the range defined by the parties' final positions. Even in cases where arbitrators are not concerned by their reputation for fairness (using data gathered from hypothetical cases), Farber and Bazerman (1986) find that two thirds of the awards that do not lie strictly within the range defined by the parties lie exactly on one of the parties' last positions.

are not binding. Yet a third party's recommendation may be effective for various reasons: 1) the recommendation creates a focal point.¹⁷ 2) Accepting a mediator's suggestion saves face: it is less likely to be attributed to weakness than a concession to the other party.¹⁸ 3) The contractual conditions may give the third party some enforcing powers: this third party may have the contractual capacity to arbitrate, or fee-shifting rules like the Michigan rule may apply.¹⁹

In any event, a lack of enforcing power may actually reinforce the mediator's compromising behavior. Indeed, the mediator's concern for success should prompt him to make suggestions that are most likely to be accepted by the parties, with the following consequences on the type of recommendations made, as explained by Pruitt (1981, page 209):

For a mediator's suggestion to be effective, it must seem fair and reasonable to both parties. Otherwise, the suggestion is likely to be rejected and the mediator may even suffer a reputation loss... This explains in part why mediators so often recommend splitting the difference between the two parties' initial offers.

Finally let us briefly mention the case in which no third party would intervene to help parties out of deadlock. Even in this case, a dependence on what happened in the bargaining phase may still be at work, through the internalization of social norms. The positions on which parties committed themselves in deadlock are most likely to serve as an anchor providing a basis for future negotiations (if they resume); and a principle of equal concessions (that is, splitting the difference between the current position of both parties) tends to be advocated by the parties in such cases (Pruitt

¹⁷Kilgus (1964) writes: "the mediator's suggestions are influential mainly because they create focal point". See also Schelling (1960).

¹⁸See Pruitt and Johnson 1970 for empirical evidence.

¹⁹The Michigan rule states that if a party rejects the mediator's settlement proposal and subsequently obtains an award that is more than 10% worse for him than the proposed settlement, that party has to bear the legal cost of the other side (See Bähring-Uhle 1996, page 311).

1981, page 62-63).

4.3 The sources of inefficiencies

We now review the various sources of inefficiencies that arise when one party terminates the current negotiation phase.

In multi-stage negotiations, resuming negotiations generates administrative costs (with a fixed and a varying part). In addition, a long period of time may elapse before the negotiation can resume, implying that a fraction of what is left to be negotiated vanishes in delays. If the concessions made in the first bargaining phase can be enjoyed immediately, the cost to party i is of the form

$$c_i(X) = \delta s_i(X) + c(X);$$

where δ is the discount rate between the bargaining phases, $s_i(X)$ is the share of X that party i may expect to get in the second bargaining phase and $c(X)$ denotes the administrative costs, say (observe that $c(0) > 0$ as soon as there are fixed costs). If the concessions made in the first bargaining phase cannot be enjoyed before the end of the second phase, there is an extra cost of δX_i where X_i is the provisional concession received by party i in the first bargaining phase.

In cases of a third party's intervention, each party has to pay a fee. The fee is generally composed of a fixed part and a varying part which depends on the complexity of the case or the number of issues to be settled,²⁰ thus resulting in a strictly positive cost $c(X)$ that is non-decreasing with the share X still to be shared.²¹ Since arbitrators are heterogeneous, the outcome of the second phase may be uncertain,

²⁰These fees generally depend increasingly on the time spent by the arbitrator (see for example Böhning-Uhle (1996, page 113) for more details on the cost of arbitration). The cost is thus an increasing function of the size of the share or the number of issues to be arbitrated.

²¹Another reason for why the cost incurred by the parties may be bounded away from 0 is that the third party may with positive probability decide to arbitrate the case as if no concession had been made.

and risk aversion is then another source of inefficiency.²² Other inefficiencies also arise if the third party's intervention leads to a sub-optimal outcome, for example because he is less aware than the parties of what is efficient for them.²³

5 Discussion

In Section 2, we have modeled the second phase as a mechanical device that takes as inputs the bargaining positions reached at the end of the first phase. Thus implicitly, we have assumed that the final bargaining positions would carry over to the second phase.

To illustrate the importance of this assumption, consider the case in which each party could commit to withdraw all his concessions upon reaching the second phase. Triggering the second phase would then give each party i a payoff equal to

$$v_i^{\text{out}}(0; 0)$$

independently of the history of bargaining. The analysis of such a game would then be similar to that of Binmore et al. (1988): the threat of triggering the second phase would not be credible (as long as $v_i^{\text{out}}(0; 0) < \frac{1}{1+\delta}$ for each party i); the outcome of the game would then coincide with that of Rubinstein (1982).

In the rest of this Section we provide some arguments as to why in a wide range of contexts, it seems legitimate to assume that some elements of the final bargaining

²²The role of risk aversion as a source of costs in the context of arbitration has been pointed out by Farber and Katz 1979. Formally, let $v_i^{\text{out}}(X_i; X_j)$ denote the certainty equivalent that party i derives from the resolution phase. Because of risk aversion, the function $\phi(X_1; X_2)$ defined by:

$$\phi(X_1; X_2) = 1 - \beta \left(\delta v_1^{\text{out}}(X_1; X_2) + \delta v_2^{\text{out}}(X_2; X_1) \right)$$

is strictly positive and includes the inefficiency due to risk aversion. The insights of Section 3 can subsequently be applied to that form of costs too.

²³The possibility to continue bargaining after the third party's intervention may to some extent mitigate the latter effect. (Further bargaining is sometimes possible even after the arbitrator's decision.)

positions carry over to the second phase. First, drawing on practical cases, we identify (exogenous) channels by which concessions made in the bargaining phase carry over to the second phase. Second, based on a stylized extension of our basic model, we suggest that even if no element of the bargaining positions is exogenously carried over to the second phase, sometimes it is ex post in the joint interest of the two parties to publicize their bargaining positions, thus making the concession withdrawal non-credible.

5.1 The carry-over effect

The critical question is the following: why one of the parties (or his lawyer) would not make an 'informal' offer at the start of the game, with the understanding that if it is not accepted right away, it will be withdrawn? More generally, in contexts where negotiations are secret, why would concessions or offers made in bargaining have any effect on the second phase, in case it is triggered?

In the context of international negotiations, *Iklić* (1964, pages 22-23) mention three reasons why a government is likely to start out a new round of negotiation that is close to the one it held at the end of the previous round of negotiations: 1) reverting to a harder position would be considered improper (i.e. convention that concessions should not be retracted); 2) the terminal position in the previous round may become part of the government's propaganda, creating a commitment that may survive into the next round; and 3) the internal decision-process in the government may suffer inertia so that the only internally agreed position for the new round is the one left over from the last round.

In the context of disputes arbitrated by a third party, legislation may prevent negotiation offers to be used in hearings (for example in litigation, federal rule of evidence 408 prevents the use of the bargaining record as evidence in litigation). However, *Elkouri and Elkouri* (1985, page 844) give accounts of negotiations where pre-arbitration offers surfaced during arbitration hearings, and in an article that

explores the scope of Federal Rule of Evidence 408, Brazil (1988, page 957) writes:

\...despite the policy that inspires rule 408, there are many circumstances in which the things that lawyers and clients say and do during settlement negotiations will not be protected from disclosure or barred from use at trial".

Nevertheless, there are circumstances in which concessions can be withdrawn or do not surface in the second phase, and it is the purpose of the next subsection to investigate this case.

5.2 Allowing for the withdrawal of concessions

Consider now a situation in which parties are allowed to withdraw their concessions in case the second phase is triggered. Even in such a situation, parties may decide to jointly agree on carrying over their concessions to the next phase (or just publicize them). Alternatively, parties may decide to make a partial agreement based on the concessions made (this is a natural option when there are many issues and each concession corresponds to giving in on a particular issue).

We will exhibit circumstances under which it will be in the joint interest of both parties to carry over the outcome of the first phase to the second phase.

We formalize the idea of concession withdrawal as follows. Suppose the bargaining positions at the end of the first phase are summarized by $(X_1; X_2)$. If either party decides to withdraw his concessions, the outcome for party i of the dispute resolution phase is $v_i^{\text{out}}(0; 0)$. If both parties decide to maintain their concessions, the outcome for party i is $v_i^{\text{out}}(X_1; X_2)$.

Suppose that $v_i^{\text{out}}(X_1; X_2)$ takes the following form:

$$v_i^{\text{out}}(X_1; X_2) = X_i + \frac{1 - \alpha_i}{2} \frac{X_1 - X_2}{\alpha_i} c(X)$$

We start with a case where the possibility of withdrawing concessions may completely cancel out the effect identified in Section 3. Suppose that the cost of the dispute

resolution phase is independent of the bargaining position:

$$c(X) = c_0:$$

Then whatever the bargaining position $(X_1; X_2)$ reached in the first phase, the party who has conceded more (party i if $X_i < X_j$) prefers to withdraw concessions (because $v_i^{\text{out}}(0; 0) > v_i^{\text{out}}(X_1; X_2)$), and the outcome of the game is that of the game with fixed outside option (as in Binmore et al.).

Consider now the case where the cost of the dispute resolution phase depends increasingly on the size of the share not conceded yet, say

$$c(X) = c_0 + cX$$

(This dependence is consistent with the discussion of Subsection 4.3). Assume that party 1 has conceded $\frac{1}{2}$ (as in the case of fixed outside option, say). Then by conceding more than some threshold \bar{X}_1 , $\bar{X}_1 = \frac{1}{2} \frac{1+2c}{1+c}$ party 2 can ensure that party 1 will not withdraw his concessions in case the resolution phase procedure is triggered (because $v_1^{\text{out}}(X_1; \frac{1}{2}) > v_1^{\text{out}}(0; 0)$ for every $X_1 > \bar{X}_1$).

Party 1's large concession of $\frac{1}{2}$ may actually weaken party 1, because it secures a payoff strictly larger than $1/2$ to party 2. Indeed, after having conceded $\frac{1}{2}$, party 2 may opt for the resolution phase and secure $v_2^{\text{out}}(\bar{X}_1; \frac{1}{2}) = \frac{1}{2} + \frac{3c}{2(1+c)}$ if c , which is strictly more than $\frac{1}{2}$ (at least when c is not too large).²⁴

The above line of reasoning may in fact be used to show that if the cost of going to the resolution phase is sufficiently decreasing with the amount of the share not conceded yet, then equilibrium concessions will be gradual. If these costs are sufficiently decreasing, the bounds on equilibrium concessions derived in Proposition 1 will in fact carry over to this case too: after some concessions have been made (and

²⁴The complete argument is a little more subtle, since party 2 cannot trigger the resolution phase right after his own concession. But if party 1 makes another concession, this may only improve further party 2's position, who can always "under-reciprocate" so as to make party 1 slightly prefer not to withdraw his concessions in case the resolution phase is triggered.

as long as the total concessions made by the two parties remain balanced enough) withdrawing concessions will not be credible for either party.

The key point in the above analysis is that withdrawing concessions may be Pareto dominated by the option to carry over the concessions made in the first phase. A similar insight applies to situations in which parties have some freedom in choosing the way they wish to have their dispute resolved (in case an impasse has arisen). Consider a situation in which the parties may choose among two dispute resolution procedures: litigation which may be very costly and arbitration where partial agreements are more likely to be easily enforceable. If the parties could commit to litigate in case of termination of the bargaining phase, the concessions made in the bargaining phase might be large (see Proposition 1). However, this may not be credible as arbitration is generally less costly than litigation.

6 Relationship with the literature

From a theoretical perspective, our paper belongs to the tradition of sequential bargaining pioneered by Rubinstein (1982) and further extended to allow for outside options by Binmore et al. (1989). Only the case of fixed outside options was considered by Binmore et al. (1989). In contrast, our paper considers the effect of history-dependent outside options, showing that this history dependence may generate gradual concessions.²⁵

²⁵Note that Admati and Perry (1991) may be interpreted as a bargaining game. They examine the pattern of voluntary contributions to a joint project and find that if contributions are assumed to be sunk whether or not the project is realized, equilibrium contributions are gradual. However this graduality would disappear with the introduction of small asymmetries between the parties (In contrast, our gradual concessions result does not depend on any symmetry assumption between the parties). Graduality also disappears in the subscription game where the contributions are conditional on the realization of the project. Note that Fershtmann and Seidmann (1993) examine a model similar to the latter one, in which there is a deadline and the identity of the last proposer is uncertain. In that model, parties either agree immediately or wait for the deadline (in which case a take-it-or-leave-it offer is made). For an interesting two-period model where agreement is not

Our result may seem to conflict with the Coasian view that in a perfect information setting, agreement should be immediate. The Coasian intuition would go as follows: if the parties can perfectly anticipate the equilibrium outcome, then this outcome should not be inefficient because the first proposer could make an offer that would make both parties better off (hence that would be accepted by the responder). This intuition turns out to be incorrect in a setting where outside options depend on past offers, as our paper shows: The mere proposal of a Pareto superior offer changes outside options payoffs, and as a consequence, acceptance of the Pareto superior offer by the responder is not secured anymore.

From a more applied perspective, our paper is concerned with the working of institutions or bargaining environments that provide the parties with outside options. Examples of such institutions include arbitration and litigation. Our approach should thus be examined in the light of the industrial relations literature pioneered by Stevens (1966), concerned with the effect of various arbitration institutions such as Final Offer arbitration or Conventional arbitration on the negotiation. It should also be examined in the light of the pre-trial negotiation literature.

The industrial relation literature has identified an important effect that might be caused by some arbitration procedures, the chilling effect (see for example Feuille (1975)). The chilling effect basically asserts that when the arbitrated outcome is a compromise between the positions of the parties, then there is an incentive for the parties to adopt a more extreme position so as to tilt the arbitrated outcome in their favor, therefore chilling the willingness of the parties to voluntarily compromise by themselves (without the arbitrator).^{26;27} A formalization of this chilling effect can be

immediate, see Boyce (1994).

²⁶Another version of the chilling effect asserts that when the arbitrated outcome is too efficient, the potential gains from negotiating are small. There is then a risk that the parties do not negotiate anymore and prefer to rely on the arbitrator, therefore chilling the willingness of the parties to reach an agreement on their own.

²⁷More generally, the extent to which various arbitration institutions affect whether disputes end up in arbitration has been examined by Ashenfelter et alii (1992).

found in Crawford (1979) and in Farber (1981). Yet their analysis is static: parties simultaneously make a final proposal to the arbitrator, who then makes his decision. The negotiation process that could have taken place before these final proposals is not modelled. In our view, these models capture why some arbitration procedures may freeze parties' positions at the hearings. Yet they do not explain why these arbitration procedures would also chill bargaining or prevent compromises during bargaining. In contrast, our model is dynamic and it contributes to understanding why and when some arbitration procedures as well as the heterogeneity of arbitrator preferences may be responsible for the chilling of the pace of negotiations.

The pre-trial negotiation literature examines bargaining under the threat of litigation and shares with us the feature that a party has access to outside options: going to court.²⁸ In large part though, this literature focuses on the signalling effect of the decision of going to court, where the signalling bears on the private information that one of the parties may have on some characteristics of the case to be litigated.²⁹ Besides, the negotiation is usually reduced to a one step procedure (see for example Bebchuk 1984): one party, the plaintiff, makes a settlement offer. The other party, the defendant, either accepts it or rejects it. If it is rejected, litigation follows unless the case is dropped by the plaintiff.³⁰

²⁸For an early informal description of the effect the judicial system might have on pre-trial bargaining, see Mnookin and Kornhauser (1979).

²⁹In this context, this literature also raises the issue of how the costs of litigation should be shared between the plaintiff and the defendant (Shavell 1982, Bebchuk 1984, Spier 1994).

³⁰A notable exception is Spier (1992), who analyzes a dynamic extension of the above model. Several differences with our model should be pointed out: In Spier, 1) The parties do not have the same preferences over the date of the settlements (the defendant prefers to delay settlements) and this shifts the focus of her analysis to the timing of the settlements; 2) Going to trial provide the parties with fixed outside options (at least in the perfect information case), and 3) All the bargaining power is given to one side, since only one party makes the offers.

7 Conclusion

We have investigated the effect of dispute resolution procedures on negotiations. In most applications of interest, dispute resolution procedures are likely to generate outside options that depend on the outcome of the bargaining phase as suggested in Section 4. Our main findings are that such a dependence of the outside options can explain that (rational) concessions are gradual and that negotiated agreements require several gradual steps.³¹ Thus contrary to the equilibrium strategies arising in the Rubinstein bargaining model (or Binmore et al.), we obtain here a rich dynamics on the equilibrium path. Whenever the parties enter the bargaining process, agreement is never reached at once.

In the context of arbitration, evidence consistent with our main results (Proposition 1) have been developed in an experiment run by Magenau (1983) who compares concession rates depending on whether the arbitrator (a mechanical device in the experiment) has access to the bargaining record or not. He finds that dispute rates are smaller (and concessions are bigger) when the arbitrator does not have access to the bargaining record. Further experiments are required though to assess better how the level of arbitration costs (as well as how these costs depend on the concessions made) would modify the size of concessions.

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³¹Our findings imply that negotiated agreements are delayed. Our insights should however be contrasted with those of Fernandez and Glazer (1991) and Haller and Holden (1990) who sustain delayed outcomes in labor negotiations thanks to the existence of multiple equilibria (which do not display delay). See also Ma and Manove (1993), Merlo and Wilson (1995), and Jehiel and Moldovanu (1995 a-b) for alternative explanations for delays in negotiations with complete information. For a survey of delays in negotiations with incomplete information, see Kennan and Wilson (1993).

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Appendix

Gradual equilibrium concessions: an example Our main result - Proposition 1 - leaves open whether parties will in equilibrium make concessions or eventually decide to opt out. In this Appendix we show that sometimes parties will choose to enter the process of concessions and counterconcessions and that the bound on equilibrium concessions derived in Proposition 1 is tight.

To simplify the exposition, we will consider a variant of the model, which we now describe. The timing and alternatives accessible to the parties are the same as the ones described in the main text. Final payoffs are modified as follows.

1. Concessions are available immediately as soon as they are received.
2. When parties reach an agreement (without opting out), party i derives an extra payoff $e_i > 0$.
3. As long as there is no agreement, there is a probability $1 - \delta$ of breakdown after each round. In case of breakdown, parties receive no payoff (in addition to the concessions they already enjoyed).

4. When a party opts out, and the share not conceded yet is X each party gets a payoff equal to $w^{\text{out}}(X) = \frac{X}{2} + c(X)$ (in addition to the concessions already enjoyed).

Before proceeding to the analysis, several comments are worth mentioning: a) It is easy to check that Proposition 1 holds for this variant of the model, with an upper bound on concessions given by $2(e_1 + e_2) + 4c(X)$; b) Assuming that concessions are available immediately (rather than upon reaching an agreement) simplifies the equilibrium analysis in that the payoff relevant information can be reduced to the share not conceded yet X ; c) We also add to the original model the feature that each party derives a strictly positive extra payoff e_i upon reaching an agreement.³²

Analysis: Suppose $e_1 \geq e_2$. We define below a class of behavior strategy profiles that specify what parties do whenever it is their turn to move as a function of the share X not conceded yet, and that generate gradual concessions. We will then examine when these strategies constitute a Subgame Perfect Nash Equilibrium.

The class of behavioral strategy profile we consider is characterized by two sequences $X^{(k)}$ and $\bar{X}^{(k)}$, with $0 \leq k \leq n$, satisfying $X^{(0)} = 0$,

$$\begin{aligned} X^{(k)} &< \bar{X}^{(k)} < X^{(k+1)} \text{ for every } k, \text{ and} \\ \bar{X}^{(n)} &< 1 < X^{(n+1)}. \end{aligned}$$

The behavioral strategies associated with two such sequences are defined by:

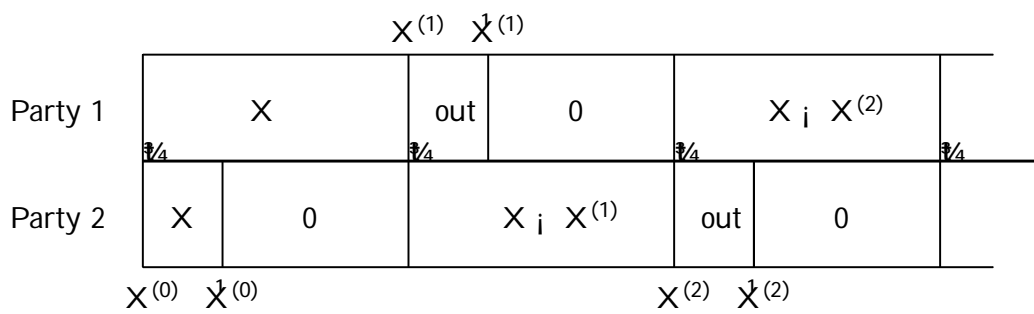
- ² For X such that $X^{(0)} \leq X \leq X^{(1)}$, party 1 concedes X ; party 2 concedes X if $X \leq \bar{X}^{(0)}$, and he concedes 0 otherwise;

And for $k \geq 1$;

³²A possible interpretation of the extra payoffs is that when an agreement is reached the relationship between the two parties can be pursued in the future resulting in an expected extra payoff e_i for party i : An alternative interpretation is that preliminary concessions have been made, and that these concessions may only be enjoyed if a total agreement is reached.

- 2 For X such that $X^{(2k_i-1)} < X \cdot X^{(2k)}$; party 2 concedes $X \downarrow X^{(2k_i-1)}$; party 1 opts out if $X \cdot \bar{X}^{(2k)}$, and he concedes 0 otherwise.
- 2 For X , $X^{(2k)} < X \cdot X^{(2k+1)}$, party 1 concedes $X \downarrow X^{(2k)}$; party 2 opts out if $X \cdot \bar{X}^{(2k)}$, and he concedes 0 otherwise.

These strategies are summarized in Figure 1.



† The axis indicates the share X left to be conceded

† We have indicated inside the boxes the equilibrium move of each party as a function of X

Figure 1: Equilibrium with gradual concessions

When parties follow these strategies, parties alternate in making concessions. If for example n is even, party 1 makes an initial concession equal to $1 \downarrow X^{(n)}$, next party 2 concedes $X^{(n)} \downarrow X^{(n_i-1)}$, next party 1 concedes $X^{(n_i-1)} \downarrow X^{(n_i-2)}$, and so on until there is nothing left to be conceded, that is, until $X = X^{(0)} = 0$.

We now exhibit a pair of sequences $X^{(k)}$ and $\bar{X}^{(k)}$ for which the strategies defined above are in equilibrium. The sequence $X^{(k)}$ is defined by induction on k . We choose $X^{(1)}$ and $X^{(2)}$ such that

$$w^{\text{out}}(X^{(1)}) = e_1 \text{ and } w^{\text{out}}(X^{(2)}) = \pm(X^{(1)} + e_2)$$

and for every $k \geq 3$, we choose $X^{(k)}$ such that

$$w^{\text{out}}(X^{(k)}) = \pm(X^{(k_i-1)} \downarrow X^{(k_i-2)}) + \pm^2 w^{\text{out}}(X^{(k_i-2)}): \quad (10)$$

The sequence $\bar{X}^{(k)}$ is defined by $\bar{X}^{(0)} = \frac{1+\delta}{\delta}e_2$, and for every $k = 1; 2; \dots$,

$$w^{\text{out}}(\bar{X}^{(k)}) = \delta(\bar{X}^{(k)} \downarrow X^{(k)}) + \delta^2 w^{\text{out}}(X^{(k)}): \quad (11)$$

For δ sufficiently close to 1, these equations define sequences that have the desired properties.³³ To understand how $X^{(k)}$ is constructed, consider for example the case where $X = X^{(k)}$ and k is odd, so that party 1 is supposed to concede a positive share. Expression (10) may be rewritten as

$$w^{\text{out}}(X^{(k)}) = \sum_{s=0}^{k-1} \delta^{2s+1} (X^{(k-2s+1)} \downarrow X^{(k-2s)}) + \delta^{k+1} e_1$$

implying that $w^{\text{out}}(X^{(k)})$ is equal to the discounted payoff party 1 obtains if he concedes $X^{(k)} \downarrow X^{(k-1)}$ now and the parties behave according to the strategies defined above. In other words, at $X = X^{(k)}$, the party who is supposed to concede, say party 1, is indifferent between opting out and conceding. Note that since this is true for any $k \geq 1$, then (under the proposed strategies), the party who is supposed to concede a strictly positive share does so to a point where the other party is precisely indifferent between opting out and conceding further (and under the proposed strategy that other party concedes). Now to understand how $\bar{X}^{(k)}$ is constructed, observe that at $X = \bar{X}^{(k)}$ party 1 is indifferent between opting out and waiting for party 2 to concede $X \downarrow X^{(k)}$ in the next stage.

Proof : We check that in every subgames for which the share left is equal to X , no profitable one-shot deviations exist. We start with the case of low values of $X \leq X^{(1)}$, and then proceed by induction on k .

³³To see why, and to illustrate further the size of the concessions made under this strategy profile, consider the case where $c(X) = c$, hence $w^{\text{out}}(X) = X/2 \downarrow c$, and let the extra payoffs e_i , $i = 1; 2$ be small and the discount factor δ be close to 1. The last concession (made by party 1) is close to $2c$; the previous concession (made by party 2) is close to $4c$. Rearranging equation (10), we get that $X^{(k)} \downarrow X^{(k-1)} \approx \frac{1}{4} X^{(k-1)} \downarrow X^{(k-2)}$ for all $k > 2$ so that all previous equilibrium concessions except possibly the first one are close to $X^{(2)} \downarrow X^{(1)} \approx \frac{1}{4} 4c$. Besides, when δ is very close to 1, $\bar{X}^{(k)}$ is very close to $X^{(k)}$. So we have $X^{(k)} < \bar{X}^{(k)} < X^{(k+1)}$ as desired.

Step 1: $X > X^{(1)}$:

Party 2 obtains e_2 if she concedes the rest immediately, or $\pm(X - C_2 + e_2)$ if she makes a partial concession equal to C_2 ; with $C_2 < X$, (because party 1 concedes $X - C_2$ in the next period). By definition of $X^{(0)} = \frac{1}{\pm}e_2$, it is therefore optimal for party 2 to concede the rest if $X < X^{(0)}$, and to concede nothing if $X > X^{(0)}$.

Party 1 may obtain a share at most equal to $X^{(0)}$ from party 2. Since e_1 is larger than $\pm(X^{(0)} + e_1)$, party 1 prefers conceding the rest immediately (the preference is strict if $e_1 > e_2$).

Step 2: $X^{(k)} < X < X^{(k+1)}$, $k \geq 1$.

We let $i = 1$ (respectively $i = 2$) if k is odd, and we let party j be the party other than i . Under the proposed equilibrium strategies, party i (if it is his turn to move) concedes $X - X^{(k)}$ and obtains a payoff equal to $w^{\text{out}}(X^{(k+1)})$ (by definition of $X^{(k+1)}$), and party j if it is her turn to move, either opts out (if $X < X^{(k)}$) or concedes nothing. We will check each party's incentives shortly. We start with two preliminary observations.

a) It cannot be optimal for a player, say party 1, to concede down to a level X^0 from which the other party does not make a counter concession.

Indeed, if party 2 opts out at X^0 , party 1 obtains $\pm w^{\text{out}}(X^0)$, hence he would have rather opted out right away. And if party 2 concedes nothing and say $X^{(1)} < X^0 < X^{(1+1)}$, party 1 would have rather conceded $X - X^{(1)}$ right away.

b) It cannot be optimal for a player, say party 1, to concede $X - X^0$ with $X^0 < X$ and $X^{(1)} < X^0 < X^{(1+1)}$. Indeed, either the above case applies, or party 2 is supposed to concede next, in which case she concedes $X^0 - X^{(1)}$. But party 1 would rather concede less than $X - X^0$ because party 2 would concede down to $X^{(1)}$ in any case.³⁴

Party i 's incentives: To satisfy a) and b), party i must make a concession equal to $X - X^{(k-2s)}$ for some $s \geq 0$. The resulting payoff for party 1 is equal to

³⁴The only exception is if party 1 concedes to $X^0 = X^{(0)}$, but such a concession gives party 1 a payoff equal e_1 which is strictly below $w^{\text{out}}(X)$, for $X > X^{(1)}$.

$w^{\text{out}}(X^{(k_i - 2s + 1)})$, and it is largest for $s = 0$.

Party j 's incentives: To satisfy a) and b), if party j makes a positive concession, that concession must be equal to $X_j - X^{(k_i - 2s_i - 1)}$ for some $s_i \geq 0$. The resulting payoff for party 2 is equal to $w^{\text{out}}(X^{(k_i - 2s)})$, it is largest for $s = 0$, but it is still strictly below the payoff $w^{\text{out}}(X)$ that party 2 would obtain by opting out right away. It is thus optimal for party j to either concede nothing or opt out. Which of these two options he prefers depends on whether X is above or below $X^{(k)}$. ■

It may be shown that when $e_1 > e_2$ the above strategies are in fact the only Subgame Perfect Nash Equilibrium in this setup (the argument makes iterative use of dominance relations).

Proof of Proposition 2 In what follows, we consider a candidate equilibrium \mathfrak{A} . It will be convenient to denote by h the current history of concessions, and to express the total concessions X_i , the outside option value v_i^{out} , and the efficiency loss ϕ as a function of the current history h . The length of the history h is denoted $\ell(h)$. To avoid confusion, we will also denote by \hat{h} a complete path of the game, with the convention that the resolution phase has been triggered if $X_1(\hat{h}) + X_2(\hat{h}) < 1$. The number $1 + \ell(\hat{h})$ is thus the date at which the negotiation terminates.

In what follows, we consider a history h reached with positive probability in equilibrium, and we denote by $v_i(h)$ the (continuation) equilibrium payoff for party i , and by $v(h)$ the sum $v_1(h) + v_2(h)$. We also define:

$$\begin{aligned} \hat{v}^i(h) &= \delta^{\ell(h)} (v_i^{\text{out}}(h) - \phi(h)) \text{ if } X_1(h) + X_2(h) < 1 \\ &= \delta^{\ell(h)} v_i^{\text{out}}(h) \text{ otherwise} \end{aligned}$$

That is, $\hat{v}^i(h)$ is the sum of the parties' discounted payoffs that would result if h were the realized path of the game and the resolution phase were triggered. Given the previous definitions, we have:

$$\delta^{\ell(h)} v(h) = E[\delta^{\ell(\hat{h})} v(\hat{h}) \mid h; \mathfrak{A}] = E[\hat{v}^1(\hat{h}) \mid h; \mathfrak{A}] \quad (12)$$

We now prove that if $\ell(h) \geq 1$, then, because each party has access to the outside option, we have:

$$v_i(h) \geq 1 - \beta_i \cdot v_j^{\text{out}}(h) \quad (13)$$

Indeed, assume that at date $t = 1 + \ell(h)$, it is party i 's turn to move. Since party i may opt out, we must have:

$$v_i(h) \geq v_i^{\text{out}}(h)$$

When $t \geq 2$, then at date $t - 1$, it is party j 's turn to move. Consider the history h^0 preceding h . In equilibrium, party j chooses a concession leading to h with positive probability. Therefore we must have $v_j(h^0) = \beta_j v_j(h)$. Since party j could have opted out or conceded the rest after h^0 , we must have $v_j(h^0) \geq \max\{v_j^{\text{out}}(h^0); 0\}$. Given our monotonicity assumptions, we obtain:

$$v_j(h) \geq \max\left\{\frac{v_j^{\text{out}}(h)}{\beta_j}; 0\right\} \geq v_j^{\text{out}}(h)$$

implying (13):

Assume now that party 1 does not opt out immediately. Among all the histories h of length $\ell(h) \geq 1$ which are reached with positive probability in equilibrium, consider the history h^* for which $v_1(h)$ is largest, and when several such histories exist, choose the longest one. The assumption $\beta < L(\underline{n})$ implies that there cannot be a negotiated agreement at h^* .³⁵ Assume by contradiction that the party who moves at $\ell^* = \ell(h^*)$, say party i , opts out with probability $\beta_i^{\text{out}} < 1$. By definition of h^* , for any continuation history h (following h^*) reached with positive probability in equilibrium we have $v_i(h) < v_i(h^*)$. We obtain from (12) that $\beta_i v_i(h) < \beta_i v_i(h^*)$ (the inequality is strict because $\beta_i^{\text{out}} < 1$): Yet from (13), we know that $\beta_i v_i(h)$ cannot be smaller than $v_i(h^*)$. Thus party i must opt out with probability 1 at h^* .

Consider now (at the date $\ell(h^*)$) the history h^0 preceding h^* . It cannot be that in equilibrium, party j makes a positive concession that would be followed by party

³⁵Otherwise, we would have $\ell(h^*) > \underline{n}$, and thus $v_1(h^*) \cdot \beta_1^{\underline{n}+1} < \beta_1(1 - \beta_1) \cdot v_1(h_1)$, where h_1 is any history of length 1.

i opting out with probability 1 because party j should rather prefer either opting out himself (if $v_j^{\text{out}}(h^0)$ is positive) or conceding the rest to terminate the negotiation (otherwise). Therefore we must have $X_k(h^a) = X_k(h^0)$ for $k = 1, 2$, implying that $\phi(h^0) = \phi(h^a)$, and further $\psi(h^0) > \psi(h^a)$. If $\psi(h^a) > 1$, we get a contradiction to the definition of h^a . Thus $\psi(h^a) = 1$, implying that party 1 obtains $\pm v_1^{\text{out}}(0; 0)$ in equilibrium. Since party 1 could have obtained $v_1^{\text{out}}(0; 0)$ by opting out immediately, we get a contradiction. Therefore in equilibrium, party 1 opts out immediately. ■