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Extreme equilibria in the negotiation model with different time preferences ☆

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ABSTRACT

We study a negotiation model with a disagreement game between offers and counteroffers. When players have different time preferences, delay can be Pareto efficient, thereby violates the presumption of the Hicks Paradox. We show that all equilibria are characterized by the extreme equilibria. Making unacceptable offers supports extreme equilibria, and significantly alters the backward-induction technique to find the extreme equilibrium payoffs. A player's worst equilibrium payoff is characterized by a minmax problem involving efficient equilibrium payoffs that are above the bargaining frontier, which is possible when players have sufficiently different time preferences.

1. Introduction

Recognized as early as Nash (1953), endogenous threats during disagreement are essential to bargaining problems. Costly delay and strikes can occur in equilibrium, such as in the wage negotiation model of Fernandez and Glazer (1991). This leads to what is known as the Hicks Paradox: If a theory predicts when a strike will occur and what the outcome will be, the parties can agree to this outcome in advance, and so avoid the cost of the strike (see Kennan, 1986). The Hicks Paradox presumes that delay and strikes are Pareto inefficient. Houba and Wen (2008) demonstrate, however, that delay can be Pareto efficient in the wage negotiation model when players have different time preferences. Because it is crucial to the backward-induction technique of Shaked and Sutton (1984) whether delay is efficient or not, it is necessary to reexamine this technique in the presence of Pareto efficient delay in bargaining problems.

We study a general negotiation model that incorporates endogenous threats to the bilateral bargaining model of Rubinstein (1982). Early studies, such as Fernandez and Glazer (1991), Haller (1991), Haller and Holden (1990), and Bolt (1995), model the union's decision to strike explicitly between offers and counteroffers. Busch and Wen (1995, 2001), Houba (1997), and Slantchev (2003) generalize this model by introducing a normal-form disagreement game to represent endogenous

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threats.[1] Although players are completely or even perfectly informed in this class of bargaining games, there are generally multiple perfect equilibria, including many inefficient ones with delayed agreements or even no agreement at all. The set of equilibrium outcomes is characterized by the extreme equilibria — equilibria that give each player either his worst or best equilibrium payoff. Houba and Wen (2008) demonstrate Pareto efficient delay can be a part of the extreme equilibria in the wage negotiation model when players have different time preferences.

When players have different time preferences, reaching an immediate agreement can be Pareto dominated by disagreeing for a certain number of periods, even though every disagreement outcome is Pareto dominated by some agreement. In the context of other dynamic problems, a Pareto improvement is possible through intertemporal rearrangement of payoffs among agents with different time preferences, see Ramsey (1928) and Bewley (1972). Such an improvement can be achieved if the less patient agent trades his future payoffs for higher current payoffs with the more patient agent. Lehrer and Pauzner (1999) show that when players have different time preferences, many perfect equilibrium payoffs in a repeated game are outside the set of feasible payoffs of the stage game, and illustrate how the set of perfect equilibrium payoffs depends on the discount factors. This issue also occurs in the negotiation model when players have different time preferences. In this paper, we show what equilibrium outcomes with delay are efficient and how they affect the characterization of extreme equilibria.

The backward-induction technique of Shaked and Sutton (1984) is widely used to study extreme equilibria in bargaining problems. To apply this technique, one player's best continuation payoff is identified while maintaining the other player's worst continuation payoff. If and only if all the continuation payoffs are bounded by the bargaining frontier, such as in the negotiation model under common time preferences, the proposing player will always make an acceptable offer in any extreme equilibrium. Without first establishing the Pareto efficiency of any immediate agreement, we should not exclude the possibility of making unacceptable offers in the extreme equilibria.[2] In presenting the model of Rubinstein (1982), Fudenberg and Tirole (1991) include the possibility of making unacceptable offers in the backward-induction technique. Although the analysis of Houba and Wen (2008) characterizes the extreme equilibria in the model of Fernandez and Glazer (1991) by taking all these considerations into account, their analysis is too specific to be applicable in a general negotiation model. Thus, this paper adapts the backward-induction technique to study the extreme equilibrium payoffs in the general case.

When players are sufficiently patient, the worst equilibrium payoff of a proposing player is determined by the least fixed point of a minmax problem, which depends on the Pareto frontier of equilibrium payoffs. What complicates matters is that the Pareto frontier of equilibrium payoffs is in turn characterized by the worst equilibrium payoffs of the proposing players. To characterize the Pareto frontier of equilibrium payoffs by the players' worst equilibrium payoffs, we discuss how to modify the technique of Lehrer and Pauzner (1999) for the differences between a negotiation game and a repeated game. Given the inter-dependence between the worst equilibrium payoffs and the Pareto frontier of equilibrium payoffs, our analysis provides a general technique to characterize the extreme equilibrium payoffs, and hence the set of all equilibrium payoffs, in the negotiation model with different time preferences.

The rest of this paper is organized as follows. Section 2 presents the negotiation model with different time preferences. In Section 3, we establish the existence of subgame-perfect equilibrium and show that all equilibrium payoffs are characterized by the players' worst equilibrium payoffs. We then focus on the players' extreme equilibrium payoffs in Section 4, and characterize every player's worst equilibrium payoff by the least fixed point of a minmax problem. In Section 5, we turn our analysis to efficient equilibrium payoffs, which are the cause of the complications in characterizing equilibria when players have different time preferences.

2. A negotiation model

Two players negotiate for an agreement in the presence of a disagreement game. There are infinitely many periods and players alternate in making offers until they reach an agreement. During the bargaining phase of every period before agreement is reached, one player proposes an offer and the other player responds by either accepting or rejecting it. If the offer is accepted, then the negotiations end with the accepted offer as the agreement. Otherwise, the disagreement game is played once during the disagreement phase before the negotiations proceed to the following period.[3]

Let $B = \{(x_1, x_2) \in \mathbb{R}^2\colon\ x_1 + x_2 = 1\}$ denote the set of all possible agreements, also called the bargaining frontier. For $i \in \{1, 2\}$, player i receives a payoff of x_i in every period after the players agree on $x = (x_1, x_2) \in B$. The disagreement game is modeled as a normal-form game[4]: $\langle A_1, A_2, d_1, d_2\rangle$, where for $i \in \{1, 2\}$, A_i is the set of player i's disagreement actions and $d_i : A = A_1 \times A_2 \to \mathbb{R}$ is player i's disagreement payoff function. We assume that A_i is compact, d_i is continuous, and the disagreement game admits a Nash equilibrium. As is common in this literature, every disagreement outcome $a \in A$ is weakly dominated by some agreement: $d_1(a) + d_2(a) \leqslant 1$ for all $a \in A$. By convention, with slight abuse of notation, we

[1] See the surveys by Muthoo (1999) and Houba and Bolt (2002).

[2] Unacceptable offers are also necessary in the stochastic bargaining model of Merlo and Wilson (1995), which is different from the model studied in this paper.

[3] Given the extensive description of this model by Busch and Wen (1995), ours is kept brief.

[4] As in previous work, the disagreement game is assumed to be the same in all periods, and this enables us to characterize the set of equilibrium outcomes. Our key insights, however, do not rely on this simplification.