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Proceedings of the 3-rd
Polish-Finnish Symposium
Gdańsk-Sobieszewo, September 26-29, 1988

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Warszawa 1989

Secretary of the Conference
dr. Andrzej Stachurski

Wykonano z gotowych oryginałów tekstowych
dostarczonych przez autorów

ISBN 83-00-02543-X

SOME ASPECTS OF THE USE OF THREATS IN NEGOTIATIONS

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ABSTRACT
We concentrate on the part of bargaining strategies which have the nature of a threat and are announced before the actual bargaining process starts. There may be two different goals of such pre-announcements. The first one concerns their influence on the possible agreement, while the second is connected with stabilizing its realization. The aspects of the first type of threat strategies are considered with the help of an example of labor-management bargaining. In this context we shortly illustrate the problems of the choice of different "dimensions" of a threat, such as the length of a strike, its intensity, and the bargaining schedule. On the other hand the second type of threats, i.e. those which are announced in order to stabilize the possible cooperation, must take into account such aspects like stabilization power and credibility. It appears, however, that they can also influence the agreement.

KEYWORDS: Decision Making, Mathematical Models, Game Theory, Bargaining, Threats, Strategies, Labor-Management Negotiations, Cooperation

1. INTRODUCTION

An important feature of economic systems is the multiplicity of decision makers having various goals they want to attain. This leads to conflicts of interests and, as a result, a problem we are faced with is how to reach a compromise and cooperation.

The classical approach to the bargaining problem has been proposed by Nash (1950) and consists in pointing out a unique solution which fulfills a proposed set of axioms. Other axiomatic solutions have also been proposed

(Roth,1979). Rubinstein (1982) has taken quite a different approach. He has modelled the negotiation process explicitly as a sequence of alternating offers. The solution is given by a perfect equilibrium in such a game. This direction, i.e. the noncooperative models of bargaining, has been developing in two directions. The first enriches the bargaining process through introduction of additional strategic possibilities (e.g. Wolinsky,1986; Hoel,1987; Binmore,Herrero,1988), while the second direction takes into account incomplete information (e.g. Rubinstein,1985; Chatterjee,Samuelson,1987).

We shall consider bargaining situations in which before the actual negotiation, a communication phase exists. This makes the *announcements of strategies* to be realized in the future possible. Typically such strategies are formulated conditionally and therefore they can be called *threats*. The notion of a threat was introduced for the first time by Nash (1953) and concerned the possibility of moving the so called status quo point. Nash, however, made two basic assumptions. The first says that a player can commit himself to the possible implementation of his threat. The second one says that once an agreement has been reached it is binding. Note that both these assumptions are connected with the problem of making binding commitments (about the implementation of certain strategies). Nowadays models in which the above assumptions are weakened or dropped determine a significant research direction in analyzing the questions of cooperation (Harsanyi,1977; Farrell,1987; Harsanyi,Selten,1988).

In this paper we briefly discuss two situations in which threat strategies are announced in the communication phase preceeding the actual negotiations. There may be two different goals of such pre-announcements. The first one concerns their influence on the possible agreement, while the second is connected with stabilizing its realization. The aspects of the first type of threat strategies are considered with the help of an example of labor-management bargaining. In this context we briefly illustrate the problems of the choice of different "dimensions" of a threat, such as the length of a strike, its intensity, and the bargaining schedule. On the other hand, the second type of threats, i.e. those which are announced in order to stabilize the possible cooperation, must take into account such aspects like stabilization power and credibility. It appears, however, that they can also influence the agreement.

2. THE INFLUENCE OF THREAT STRATEGIES ON NEGOTIATED AGREEMENTS

The problem will be shortly illustrated by a model describing labor-management negotiations in a firm (Pattanaik,Stefanski,1988). Both parties are interested in maximizing their goal over a time horizon 0...T. The labor union (U) is not satisfied with the present situation and wants to change the vector v of decisions (wages, employment level). In order to force management (F) to take part in negotiations U can take strike action. In general, there are various strike actions possible which are harmful to the firm to different extents. Therefore we shall talk about a flexible strike and we introduce a notion of *strike intensity* $s\in[0,1]$.

Then U can choose $s\in[0,1]$, while F controls the decision vector $v\in V$. We assume that other parameters describing a firm are constant over time, and that the parties' goal functions are additive over time. The one period components of these functions are denoted by $x_U(v,s)$ and $x_F(v,s)$.

The starting point in our model is a certain decision vector v^o (and, of course, $s=0$). U wants to reach an agreement about changing v^o to a certain v^A such that $x_U(v^A,0)> x_U(v^o,0)$. However, the strike threat may be useful because $x_F(v^A,0)< x_F(v^o,0)$. Of course the implementation of a strike could be harmful to F as well as to U: $x_F(v,s)< x_F(v,0)$, $x_U(v,s)< v,0)$, $s>0$.

Besides the intensity s, U announces the *length of strike* $\tau\in\{1,2,\dots,T\}$. Since the talks need not take place in every time period then U has also the possibility of announcing the set of time periods $B\subset\{0,1,\dots,\tau\}$ in which it will bargain with F. The set B will be called *bargaining schedule*. Thus, we have a triple (s,τ,B) announced by the union.

The set of agreements attainable at $t\in\{0,1,\dots,T\}$ is denoted by Z_t:

$$Z_t=\{(X_U,X_F):\ X_U= tx_U(v^o,s)+ (T-t)x_U(v,0),\quad X_F= tx_F(v^o,s)+ (T-t)x_F(v,0),\ v\in V\}. \tag{1}$$

The last period in which U and F can make an agreement is $t_L=\max\{t:t\in B\}$. If they do not do it then they will attain the *disagreement outcomes*:

$$X_i^d(s,\tau)= \tau x_i(v^o,s)+ (T-t)x_i(v^o,0)\ ,\qquad i\in\{U,F\}. \tag{2}$$

Nash's scheme is applied to solving the bargaining problem at successive stages. Computations are carried out backward beginning from t_L. Then, if we order the set B from t_1 to t_L in such a way that $t_1<t_2<\dots<t_L$, and denote by $N(G)$ the Nash's bargaining solution of the game G, then this process can be described as follows:

$$\begin{aligned} X^A(s,\tau,B,t_L)&= N(Z_{t_L},X^d(s,\tau)),\\ X^A(s,\tau,B,t_{L-1})&= N(Z_{t_{L-1}},\ X^A(s,\tau,B,t_L)),\\ &\ \vdots \\ X^A(s,\tau,B,t_1)&= N(Z_{t_1},X^A(s,\tau,B,t_2)). \end{aligned} \tag{3}$$

$X^A(.)=(X_U^A(.),X_F^A(.))$ denotes the agreement outcomes. If an agreement is made at t_A, then from the equations

$$X_i^A(s,\tau,B,t_A)= t_A x_i(v^O,s)+ (T-t_A)x_i(v^A,0) \quad , i\in(U,F) \quad (4)$$

we can derive the decision vector v^A which realizes it.

It follows from the fact that complete information is assumed in the model that an agreement should be made at $t_A=0$. The problem we are interested in concerns the optimal (from the U's point of view) choice of the triple (s,τ,B):

$$(s^*,\tau^*,B^*)= \arg\max_{(s,\tau,B)} X_U^A(s,\tau,B,0). \quad (5)$$

We shall distinguish two cases:

1. with the assumption that all the announcements are treated as credible,
2. without the above assumption.

Because of the lack of space we will only roughly outline the nature of the results (Pattanaik,Stefanski,1988).

Case 1.

Taking into account (3) and (2) it follows that the optimal length of a strike is:

$$\tau^*= T. \quad (6)$$

It can be noted that the optimal B^* should always contain $\{0\}$. Then the following proposition can be proved: if $\tau=T$ and $B_1=\{0\}\cup B_1'$, $B_2=\{0\}\cup B_2'$ then $X_U^A(s,T,B_1,0)= X_U^A(s,T,B_2,0)$ for all $B_1',B_2'\subset\{1,2,...,T-1\}$ and for all $s\in[0,1]$. Thus

$$B^*= \{0\}\cup B' \quad , \quad B'\subset\{1,2,...,T-1\}. \quad (7)$$

In other words, it does not matter whether the parties talk at intermediate stages or they do not.

The optimal choice of strike intensity appears to be equivalent to the solution of a single stage problem which is easy to solve:

$$s^*= \arg\max_{s\in[0,1]} X_U^A(s,\tau^*,B^*,0)= \arg\max_{s\in[0,1]} x_U^A(v^O,s). \quad (8)$$

Case 2.

In this case not only the influence of (s,τ,B) must be taken into account, but also what could happen if the announced threat was not believed. This complicates the situation. Note that in case 1 the optimal parameters (6),(7),(8) are independent of each other. Without the credibility assumption, however, they are interconnected.

Since the strike is disadvantageous to both parties, then taking into account (2) we have:

$X_i^d(s,\tau_1) > X_i^d(s,\tau_2)$, $i\in\{U,F\}$, if $\tau_1<\tau_2$.

Then $X^d(s,\tau)\in D_s$, where

$$D_s = \{(X_U,X_F)\in Z_0:\ X_i > Tx_i(v^o,s),\ i\in\{U,F\},\ \text{or}\ X_i = Tx_i(v^o,s),\ i\in\{U,F\}\}. \quad (9)$$

It appears that the set D_s can be divided into three sets A_s, B_s, E_s (such that $A_s\cup B_s\cup E_s=D_s$ and $A_s\cap B_s=\emptyset$, $A_s\cap E_s=\emptyset$, $B_s\cap E_s=\emptyset$) so that the optimal bargaining schedule depends on the position of the end of disagreement trajectory $X^d(s,\tau)$ (Pattanaik, Stefanski, 1988):

$$\hat{B}(s,\tau)=\begin{cases}\{0,1,\ldots,\tau\} & \text{if}\quad X^d(s,\tau)\in A_s\\ \{0\}\cup B' & \text{if}\quad X^d(s,\tau)\in C_s\\ \{0\} & \text{if}\quad X^d(s,\tau)\in E_s\end{cases} \quad (10)$$

where B' is any subset of $\{1,2,\ldots,\tau\}$.

When determining the optimal s and τ the notions of time limits $t_U(s,\tau)$ and $t_F(s,\tau)$ are introduced. $t_i(s,\tau)$ is the latest time period at which for the partner $i\in\{U,F\}$ it is better to win the conflict than to resign from the struggle at the very beginning (i.e. at t=0). Winning at t means for U that F accepts $X^A(.)$ at t. Thus

$$t_U(s,\tau)=\max\{t\in\hat{B}(s,\tau):\ X_U^A(s,\tau,\hat{B}(s,\tau),t)\geq Tx_U(v^o,0)\} \quad (11)$$

On the other hand winning the conflict at t means for F that U calls off the strike at t and returns to s=0:

$$t_F(s,\tau)=\max\{t\in\{0,1,\ldots,\tau\}:\ tx_F(v^o,s)+(T-t)x_F(v^o,0)\geq X_F^A(s,\tau,\hat{B}(s,\tau),0)\} \quad (12)$$

The time between $t_F(s,\tau)$ and $t_U(s,\tau)$ (which makes sense only if $t_U(.) > t_F(.))$ is the time when winning the conflict is still advantageous to U but already not to F. Then, if the declared strike $(s,\tau,\hat{B}(s,\tau))$ makes such a situation possible, we can say that such a strike announcement is credible. Note that we do not take future reputation into account here. Let us denote

$$\Psi = \{(s,\tau)\in[0,1]\times\{1,2,\ldots,T\}: t_U(s,\tau)> t_F(s,\tau)\}. \qquad (13)$$

The set Ψ is used when determining the optimal strike intensity and length of strike:

$$(s^{**},\tau^{**})= \begin{cases} \arg\max\limits_{(s,\tau)\in\Psi} X_U^A(s,\tau,\hat{B}(s,\tau),0) & \text{when } \Psi\neq\emptyset \\ (0,0) & \text{when } \Psi=\emptyset \end{cases} \qquad (14)$$

Of course $B^{**}= \hat{B}(s^{**},\tau^{**})$.

3. USING THREATS TO STABILIZE COOPERATION BASED ON INFORMAL AGREEMENTS

Typically it is assumed that once an agreement is signed it is binding. However, this is not true in many situations, when the above assumption is dropped, we will talk about informal agreements. In such a case the problem of stabilization of the implementation of an agreement arises. When it is not done exogenously then it must be done by the partners through the appropriate choice of their strategies. Typically the strategies should contain *retaliation threats* (for breaking the agreement). It often happens that a decision maker cannot commit himself to realize a threat, and its possible realization can be harmful not only to the threatenee but also to the threatener. In such a case the problem of the credibility of a threat emerges. The question which faces the parties is then the choice of retaliation strategies, which must be a compromise between their effectiveness (deterring power) and credibility.

Let us illustrate that by a simple game called Chicken:

$u_1 \backslash u_2$	1	0
1	(p_1^3, p_2^3)	(p_1^2, p_2^4)
0	(p_1^4, p_2^2)	(p_1^1, p_2^1)

Decision $u_i=1$ means cooperation, $u_i=0$ the lack of cooperation. The superscripts denote utility ordering, i.e. p_i^4 is the best payoff, p_i^1 the worst. Nash equilibria are circled. It seems that the outcome (p_i^3, p_i^3) could be recommended as a reasonable solution. Note, however, that it is not stable since both players would have an incentive to deviate. To stabilize cooperation the strategies

$$\gamma_i(u_j) = \begin{cases} 1 & \text{if} \quad u_j=1 \\ 0 & \text{if} \quad u_j=0 \end{cases}, \quad i,j=1,2;\ i\neq j,$$

could be used. However the credibility of such strategies is rather doubtful.

Nevertheless, in situations in which there is a larger number of possible decisions, the problem of finding a compromise between credibility and effectiveness makes sense. An example of such a game can be even a continuous version of Chicken, where decisions u_1, u_2 are taken from the interval $[0,1]$ and the payoffs:

$$P_i(u_1,u_2) = -(1-p_i^3+p_i^2)u_1u_2 + p_i^2u_i + u_j\ , \quad i,j=1,2;\ i\neq j. \quad (15)$$

Let us use the following simple game based on (15) as an illustrative example. At the beginning the partners announce threats r_1 and r_2, where $r_i: [0,1]\to[0,1]$. Then they negotiate an agreement on cooperation $(u_1^A, u_2^A)\in[0,1]^2$ (yielding an outcome $y^A = (y_1^A, y_2^A)$). Next, the players simultaneously make decisions u_1, u_2. If the agreement is then honoured by both partners or both break it then the game ends with payoffs $y_i=$

$P_i(u_1,u_2)$, $i=1,2$. However if only one partner breaks the agreement then his partner can retaliate with $u_i^r = r_i(u_j)$, and finally they get $y_k = P_k(u_i^r, u_j)$, $k=1,2$; $i,j\in\{1,2\}$; $i\neq j$.

Note that a given pair (r_1,r_2) stabilizes only certain agreements. A set of these agreements will be denoted by $U^A(r_1,r_2)$:

$$U^A(r_1,r_2) = \{(u_1^A, u_2^A)\in[0,1]^2 : P_j(u_1^A,u_2^A) \geq \max_{u_j\in[0,1]} P_j(r_i(u_j),u_j),\quad j,i=1,2,\quad j\neq i\}. \quad (16)$$

The corresponding set of outcomes:

$$S^A(r_1,r_2) = \{(y_1,y_2):\ y_i = P_i(u_1,u_2),\ (u_1,u_2)\in U^A(r_1,r_2),\ i=1,2\}$$

If y^o denotes the status quo then we have a bargaining game $(S^A(.),y^o)$ which cannot be solved by Nash's scheme because the set $S^A(.)$ can be nonconvex. We can apply, for instance, the Kalai-Smorodinsky (1975) method instead. If Φ stands for the solution concept then we have

$$y^A = \Phi(S^A(r_1,r_2),y^o) \quad (17)$$

Notice, that the threats r_1,r_2 influence the bargaining solution, and that this is not done in a conventional way (of moving the status quo) but consists in the changes of the *shape* of the set of stable agreements $S^A(r_1,r_2)$.

The following question can be asked when we think of the threat's credibility: why, in fact, should a player be willing to execute a threat if it could be harmful to him? It seems that a reasonable answer is that he could be afraid of his reputation in the future. Assume that player j has broken the agreement but his partner will not apply r_i. Denote the subjective loss of reputation for i by α_i. His partner, i.e. j, does not know α_i. We assume however that his belief about α_i is summarized in a probability distribution $h_j(\alpha_i)$. Without going into details we say only that the cost of applying r_i will be denoted by $c_i(r_i,u_j)$ (Stefanski,1988). Then, decision maker j could assess the probability that r_i

will not be executed:

$$\pi_j(r_i,u_j)= \int_0^{c(r_i,u_j)} h_j(\alpha_i)\, d\alpha_i . \qquad (18)$$

$\pi_j(r_i,u_j)$ reflects the *incredibility* of the possible execution of r_i. Notice that it depends not only on the threat r_i, but also on the breaking decision u_j. Taking the expected outcome

$$Y^B_j(r_i,u_j)= (1-\pi_j(r_i,u_j))\, P_j(r_i(u_j),u_j) + \\ + \pi_j(r_i,u_j)\, P_j(R_i(u_j),u_j), \qquad (19)$$

into account player j could determine his optimal breaking decision:

$$u^B_j(r_i)= \arg \max_{u_j\in[0,1]} Y^B_j(r_i,u_j) \qquad (20)$$

Now we come to the question whether it is optimal for a player to respect an agreement. Note, that a player has three types of strategies:

AR - to respect the agreement, and in case of his partner's deviation *not* to execute the threat,

Ar - to respect the agreement, and execute r_i in case the partner breaks the agreement,

$\bar{A}$ - to break the agreement.

The resulting game is with incomplete information. It appears that if

$$y^A_1 > Y^B_1(r_2,u^B_1(r_2)), \\ y^A_2 > Y^B_2(r_1,u^B_2(r_1)) \qquad (21)$$

then the pair of strategies (Ar, Ar) forms an equilibrium.

In the choice of a threat an important role is played by $Y^B_j(r_i,u^B_j(r_i))$. We conclude by saying that when choosing r_i, a player must find a compromise among (Stefanski, 1988):

1. the influence of r_i on the agreement outcome y^A (through the shape of $S^A(.)$),

2. the credibility of r_i (connected with the possible execution cost $c_i(.)$),

3. stabilization ability (bound up with $Y_j^B(r_i, u_j^B(r_i))$).

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