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DISAGREEMENT POINTS IN WAGE BARGAINING

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Abstract

Workers face declining pay-offs during a strike. The consequence of this is explored in a non-cooperative sequential bargaining game of alternating offers. It turns out that the subgame perfect equilibrium wage is a weighted average of the standard bargaining solution in the literature and the outside option of the workers. The outside option affects the wage even when it does not constrain the outcome nor enters any of the parties utility functions.

In a cooperative framework the disagreement point of the workers should according to this model be represented by a weighted average of the strike pay and the outside option, the weights being determined by the length of time that the workers credibly can threaten to keep on striking. This paper thus gives support from a "corresponding" non-cooperative bargaining game to the rather prevalent use of models where the unemployment rate enters the Nash product determining bargained wages. Equilibrium unemployment prevails in an economy with wage bargaining at the firm level and limits on the workers ability to strike forever.

1. Introduction[1]

Workers face declining pay-offs during strike. This paper explores the consequences of this empirical fact in a non-cooperative sequential bargaining game of alternating offers. In stationary bargaining games of the Rubinstein (1982) type, the outside option of a player does not affect the outcome if it does not exceed what could be obtained in the bargaining game without the outside option. "(T)he threat of having a recourse to the outside option is empty, and has no effect on the outcome" (Sutton, 1986:715). In the non-stationary game presented here, however, the outside option may affect the outcome even when it does not constrain the agreement.

The wage bargaining model developed below is a standard alternating offers game of the Rubinstein (1982) type with an outside option. The union may opt out when responding to the firm's offer. The union is given an amount s in strike support for each of the first T periods in which there is no agreement. After period T the bargaining is a standard game of alternating offers with outside option. The strike payments for a limited period of time gives the game a non-stationary structure.

For some range of the outside option for the workers, the subgame perfect equilibrium (SPE) outcome of the game is immediate agreement on a weighted average of the outside option and the wage that would be the SPE outcome of a game with strike support for infinite many periods. If the outside option is better than what workers would obtain with strike support for infinite many periods, the outside option constrains the outcome. If the outside option is lower than what workers may obtain without any strike support, the outside option is irrelevant to the outcome.

In line with the Nash program (see Binmore and Dasgupta 1987:5), solutions to non-cooperative bargaining games have been used to determine the appropriate disagreement

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points in the cooperative Nash solution to the bargaining problem (Nash 1950). Traditionally, the disagreement points was located at the best alternative for the players, eg as in the model of McDonald and Solow (1981:905). Following the Rubinstein (1982) solution to the non-cooperative bargaining game, however, it is widely accepted that players' income while negotiations are in progress represents the appropriate disagreement point (See eg Moene (1989) and Scaramozzino (1991)).

In a "corresponding" cooperative formulation of the game developed below, the appropriate disagreement point of the workers turns out to be a weighted average of income during a strike and the workers' outside option. Similar formulations of the disagreement point are quite common in the literature (See eg Jackman and Layard (1990)). My approach here justifies this way of introducing the outside option in the Nash product from the *strategic features* of a corresponding non-cooperative game *even* when outside options do not enter the utility functions of unions *and* strike support is independent of labor market conditions. In my view, it also captures an essential feature of the union's ability to capture rent, namely the ability to *last a conflict*.

Introducing the outside option in the disagreement point produces a link between variables like average wages in the economy, unemployment rate and benefits and bargained wage. Such effects have been empirically established. An example is Nickell and Wadhwani (1990) concluding: "Outsider factors, in particular the state of the labor market as captured by aggregate unemployment and the proportion of long term unemployed, play an important role in wage determination at the firm level" (p. 507). Scaramozzino (1991:341) concludes that wage and employment determination in his sample has largely been driven by factors external to the firm.

The link between alternative wages and the bargaining outcome in any one firm is also utilized in theoretical models of equilibrium unemployment (See Fehr 1989). I close the paper by a brief analysis of the consequences of the firm specific bargaining framework developed below in a more general equilibrium model. This is basically done by plugging the bargaining solution into an equilibrium framework of the Pissarides (1985) type. It follows that equilibrium unemployment is higher the longer the unions are able to last.

The plan of the paper is as follows. Section 2 describes the structure of the

bargaining game. Section 3 describes the subgame perfect equilibrium of the stationary version of the game. In this version the workers have strike support for either none or an infinite number of periods. Section 4 solves the game in which the workers have strike support for T periods. The disagreement point of the corresponding cooperative formulation is developed in section 5. A brief analysis of equilibrium unemployment in a world where unions cannot strike forever closes the paper.

2.   The Structure of the Bargaining Game

The union and firm bargain over the stream of income R. An agreement is a stream of wages W ϵ [0,R]. Both are defined as the present value of future streams of income. In case of an agreement the union gets the agreed W and the firm the profits P = (R-W). Employment is given and we define the variables as income per worker.

The bargaining procedure is as follows. The players take action each period in time t ϵ {0,1,2..}. The firm starts at t=0 by making a proposal (W ϵ [0,R]). The union either accepts this offer (chooses Y), rejects the offer (chooses N) or opts out (chooses O). If the offer is accepted, the game ends and the agreement is implemented. If the union opts out, the game ends and both players take their outside options. Following Binmore et al (1986:185), the "outside option is defined to be the best alternative a player can command if he withdraws unilaterally from the bargaining process."

The outside option of the union is the stream of alternative wages A ϵ [0,R]. The firm gets its alternative stream of profits P'. A' > A is the implied wage level from the best alternative stream of profits for the firm when assuming that the firm keeps its income stream unchanged: P' = R - A'.

If the union rejects the offer there is a strike and the firm gets zero income in period 0. The union collects a strike payment s, and negotiations passes over to time 1. The union then makes a wage demand, which the firm either accepts or rejects. In case of rejection, the union again collects support s, the firm has no income and negotiation passes over to time 2. It is then the firm's turn to counter-offer. Followed by a rejection of the other player's proposal, the union proposes in odd periods and the firm in even ones. There is no limit to the number of periods.

The union has, however, limited support. If the game reaches the odd period T the union exhausts its funds or supporters. If the firm rejects the union's demand in this period, the union collects its last strike support and the game passes over to period T+1. The game then follows an identical procedure with the following modification: from T+1 on both players receive zero income during conflict.

The bargaining procedure closely resembles that of Rubinstein and Osborn's

(1990:section 3.12) model with outside option. The structure added here is the strike support received by the union for the first T periods without agreement. After T the bargaining process is a standard game of alternating offers where one player may choose to take its outside option.

Note that the union is allowed to opt out only when responding to an offer by the firm. This basically excludes the possibility of making "take-it-or-leave-it" offers[2]. Note also that after a rejection of an offer, there is strike. Haller and Holden (1990) study a situation where the union has to decide whether or not to strike after a rejection. Their model has a multiplicity of equilibria, including some in which there is a strike.

The players' preferences are as follows. Both the firm and union are risk neutral and care about their stream of income only. They both share the common discount factor $\delta \in$ (0,1), and their preferences over outcomes (X,t) are represented by $\delta^t X_i$, where X_i is player i's income. Following the bargaining procedure set out above, the players' preferences over agreements (W,t) are:

$$U(W(0),\ 0) = W(0)$$

$$U(W(t),\ t) = \delta^t W(t) + \sum_{i=0}^{t-1} \delta^i s, \quad for \quad t \in \{1,2,..,T\}$$

$$U(W(t),\ t) = \delta^t W(t) + \sum_{i=0}^{T} \delta^i s, \quad for \quad t \geq T+1 \tag{1}$$

$$\Pi(W(t),\ t) = \delta^t (R - W(t)), \qquad \forall t$$

where the non-stationarity of the union's preferences follows from the non stationary structure of the bargaining procedure. The players' preferences over outside option outcomes follows from interchanging (W,t) with (A,t) (union) and (A',t) (firm) in (10).

Let Ω^t be the set of all sequences (W(0),..., W(t-1)) of offers before period t. *The strategy of the union* is a sequence $\sigma = \{\sigma^t\}^\infty_{t=0}$ of functions assigning to each history a wage level if t is odd and a reply if t is even. Thus $\sigma^t : \Omega^t \rightarrow [0,R]$ if t is odd, and $\sigma^t : \Omega^t \rightarrow$

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[2]See Rubinstein and Osborn (1990) section 3.12. where a game with "take-it-or-leave-it" offers opens for a multiplicity of subgame perfect equilibria.

{Y,N,O} if t is even. Similarly, *the strategy of the firm* is a sequence $\gamma = \{\gamma^t\}^{\infty}_{t=0}$ of functions assigning to each history a wage level if t is even and a reply if t is odd. Thus γ^t : $\Omega^t \rightarrow [0,R]$ if t is even, and $\gamma^t : \Omega^t \rightarrow \{Y,N\}$ if t is odd.

3.   The Stationary Game - a Reference Case

Consider a game where the union gets everlasting support if necessary. Let $S = s/(1-\delta)$ be the discounted value of the stream of support from an everlasting strike. We have S < R.[3] With everlasting strike support the above described game is stationary in the following sense: U(Y,t) > U(W,t+1) iff U(Y,0) > U(W,1) and Π(Y,t) > Π(W,t+1) iff Π(Y,0) > Π(W,1). The unique SPE of the above game with stationary payoffs is well known, see eg Sutton (1986) and Rubinstein and Osborn (1990).

1.   If A < $[\delta/(1+\delta)]$ R + $[1/(1+\delta)]$ S the game has a unique SPE. The firm always offers a wage W = $[\delta/(1+\delta)]$ R + $[1/(1+\delta)]$ S and accepts any demand W $\leq$ $[1/(1+\delta)]$ R + $[\delta/(1+\delta)]$ S. The union always demands a wage W = $[1/(1+\delta)]$ R + $[\delta/(1+\delta)]$ S and accepts any offer W $\geq$ $[\delta/(1+\delta)]$ R + $[1/(1+\delta)]$ S. The union never opts out. Agreement is reached immediately on the wage offered by the firm.

2.   If A > $[\delta/(1+\delta)]$ R + $[1/(1+\delta)]$ S the game has a unique SPE. The firm always offers a wage W = A and accepts any demand W $\leq$ $(1-\delta)$R + δA. The union always demands a wage W = $(1-\delta)$R + δA and accepts any W $\geq$ A. The union opts out if the firm offers W < A. Agreement is reached immediately on the wage offered by the firm.

3.   If A = $[\delta/(1+\delta)]$ R + $[1/(1+\delta)]$ S in every SPE the outcome is an immediate agreement on W = A.

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[3]If S > R the union would prefer an everlasting strike to any feasible agreement.

The SPE strategies presented (1-3 above) are adaptations of Rubinstein and Osborn's (1990) Proposition 3.5 for a game of alternating offers where one player may opt out only when responding to an offer, and is not proven here.

Let $V(R,S) = [\delta/(1+\delta)]\ R + [1/(1+\delta)]\ S$ be the "inside wage" when the union gets support for any number of periods. The immediately agreed wage in the game of alternating offers set out above with everlasting strike support is then:

$$W = \max \{\ V(R,S),\ A\ \}\qquad(2)$$

and for the game with no strike support we have:

$$W = \max \{\ V(R,0),\ A\}\qquad(3)$$

Alternative wages constrain the outcome. This is the typical bargaining solution encountered in the literature. In the next section we study the bargaining solution when union's strike support is not everlasting.

4. The Subgame Perfect Equilibrium with Limited Strike Support

Proposition 1

Assume $s < (1-\delta)R$. In the game described above with strike support for T periods:

1. *If $A < V(R,0)$ there exists a unique SPE. The immediately agreed wage is*
   $W = [\delta/(1+\delta)]\ R + [(1-\delta^{T+1})/(1+\delta)]\ S.$
2. *If $V(R,0) < A < V(R,S)$ there exists a unique SPE. The immediately agreed wage is*
   $W = (1-\delta^{T+1})\ V(R,S) + \delta^{T+1}\ A$
3. *If $V(R,S) < A$ there exists a unique SPE. The immediately agreed wage is $W = A$.*
4. *a)* *If $A = V(R,0)$ in every SPE there is immediate agreement on*
      $W = (1-\delta^{T+1})\ V(R,S) + \delta^{T+1}\ A.$
   b) *If $A = V(R,S)$ in every SPE there is immediate agreement on $W = A$.*

Proof: Consider first the subgame from $T+1$ on. The union have no strike funds left, and the game is a standard stationary game of alternating offers. The SPE strategies are described by (1-3) in the previous section. Let $W^*(T+1)$ be the SPE outcome of the subgame starting in period $T+1$. From (3) we have that in part 1 of the above proposition $W^*(T+1) = V(R,0)$, in part 2, 3 and 4 $W^*(T+1) = A$.

Consider next the game before $T+1$. This game may now be solved backwards. Assume that in every SPE of the subgame starting in period $t+1$ there is immediate agreement on $W^*(t+1)$. We show first that when this is the case, in every SPE of the subgame starting in period t there is immediate agreement on $W^*(t)$.

In any odd $t < T$ the union may do no better than accepting a wage satisfying $W(t) \geq \max \{\delta W^*(t+1) + s, A\}$. The firm prefers immediate agreement on the best acceptable wage to being rejected: If $\delta W^*(t+1) + s > A$ then $(R - W(t)) > \delta (R - W^*(t+1))$ by the assumption that $(1-\delta) R > s$. If $\delta W^*(t+1) + s \leq A$ then the firm prefers the best acceptable wage to being rejected when $A < (1-\delta) R + \delta W^*(t+1)$, which is true as $\delta W^*(t+1) \leq A - s$ and $(1-\delta) R > s$. Every SPE strategy of the subgame starting in odd period t thus prescribes the offer:

$$W(t) = \max\{ \delta W^*(t+1) + s, A\} \tag{4}$$

from the firm and acceptance of any offer as good as this for the union. Note that if $\delta W^*(t+1) + s = A$, a SPE strategy for the union may involve either opting out *or* rejecting when facing an offer less than A, in any other case the pair of actions prescribed by any SPE for odd period t is unique.

In any even $t \leq T$ the firm accepts a wage satisfying $W(t) \leq (1-\delta) R + \delta W^*(t+1)$. The union prefers the highest acceptable wage to demanding an unacceptable one when $(1-\delta) R + \delta W^*(t+1) > \delta W^*(t+1) + s$, which is always the case for $(1-\delta) R > s$. Every SPE strategy of the subgame starting in even period t thus prescribes the offer:

$$W(t) = (1-\delta)R + \delta W^*(t+1) \tag{5}$$

from the union and acceptance of any offer as good as this for the firm. The pair of actions prescribed by any SPE for even period t is unique.

Given the unique outcome of the subgame starting in period $T+1$, in every SPE of the entire game there must be a unique outcome involving immediate agreement on the firm's offer $W^*(0)$.

If $A \neq V(R,S)$ the SPE strategies prescribe unique actions in every period $t < T+1$. We know that with $A \neq V(R,0)$, the subgame following period T has one unique SPE. Thus the SPE of cases 1 - 3 is unique.

We now proceed by solving the game for the cases 1-3. We start with case 1: $A < V(R,0)$. We have $W^*(T+1) = [\delta/(1+\delta)]\ R$. At T the union demands $W^*(T) = [1/(1+\delta)]R$ according to (4). The subgame starting in T-1 has immediate agreement on $W^*(T-1) = [\delta/(1+\delta)]\ R + s = [\delta/(1+\delta)]R + [(1-\delta^2)/(1+\delta)]S$ according to (3). Proceeding backwards we get $W^*(T-i) = [\delta/(1+\delta)]R + [(1-\delta^{i+1})/(1+\delta)]S$ for all odd $i \leq T$. The union never opts out as $\delta W^*(T-i) + s > A$ for all i, but rather rejects an unacceptable offer and continue bargaining. Setting $T=i$ we find $W^{*0} = [\delta/(1+\delta)]\ R + [(1-\delta^{T+1})/(1+\delta)]\ S$. Which completes the proof for case 1.

Consider case 2: $V(R,0) < A < V(R,S)$. We have $W^*(T+1) = A$. If the union gets an unacceptable demand after T, it opts out rather than continue bargaining. At T the union demands $W^*(T) = (1-\delta)\ R + \delta\ A$ according to (4) which the firm accepts. At T-1 the firm offers $W^*(T-1) = (1-\delta^2)\ V(R,S) + \delta^2\ A$ according to (3). The union prefers to accept rather than both rejecting and opting out. Facing an unacceptable offer, the union chooses to reject rather than opt out as $(1-\delta^2)\ V(R,S) + \delta^2\ A > A$. Working backwards we find for every odd $i \leq T$: $W^*(T-i) = (1-\delta^{i+1})\ V(R,S) + \delta^{i+1}\ A$. In periods $t < T+1$ the union never chooses to opt out facing an unacceptable offer as the value of rejection in each period is a weighted sum of A and $V(R,S) > A$. Setting $i = 0$ we find $W^*(0) = (1-\delta^{T+1})\ V(R,S) + \delta^{T+1}\ A$. This completes the proof for case 2.

Consider case 3: $V(R,S) < A$. We have $W^*(T+1) = A$. At T the union demands $W^*(T) = (1-\delta)\ R + \delta\ A$ according to (4) which the firm accepts. At T-1 the union prefers to opt out rather than rejection: Rejection gives $\delta\ (1-\delta)\ R + \delta^2\ A + s = (1-\delta^2)\ V(R,S) + \delta^2\ A < A$. The firm thus offers $W^*(T-1) = A$ according to (3) which is accepted by the union. This outcome is identical to the one in the subgame starting in period $T+1$, and working backwards gives $W^*(0) = A$. The union always opts out rather than rejecting an

offer W < A. This completes the proof of 3.

Consider case 4a): V(R,0) = A. We have W*(T+1) = A. According to (3) in the previous section, the subgame following period T may have several SPE's, some in which the union opts out after receiving an offer W < A and some in which the union rejects such offers and continue bargaining. In every SPE, however, there is immediate agreement in T+1 on the offer A, and the reasoning from the proof for case 2 regarding choices in periods t < T+1 may be applied to this case as well. This concludes the proof of case 4a).

Consider last case 4b): V(R,S) = A. We have W*(T+1) = A, and in periods t > T the union always opts out rather than continue bargaining when confronted with an offer W < A. In periods t < T+1, however, the union is always indifferent between opting out and rejecting as $(1-\delta^t) V(R,S) + \delta^t A = A$ for any t. Apart from this point, which destroys the uniqueness of the SPE, in every SPE W*(0) = A according to the same reasoning as in the proof for case 3. This completes the proof of case 4b). □

The proposition establishes the following solution to the bargaining game where workers may opt out and have limited strike support:

$$
W = \begin{cases} \dfrac{\delta}{1+\delta}R + \dfrac{1-\delta^{T+1}}{1+\delta}S & A < V(R,0) \\ \max\{(1-\delta^{T+1})\ V(R,S) + \delta^{T+1}A,\ A\} & A > V(R,0) \end{cases} \tag{6}
$$

We abstract from the particular sequence of moves set out above[4] by taking the limit as the time between offers approaches zero (see Binmore 1987, section 8). Let $\delta^{\Delta t+T} = e^{-r(\Delta t+T)}$. As $\Delta \to$ zero $\beta = \delta^\Delta/(1+\delta^\Delta) \to 1/2$ and $\delta^{\Delta + T} \to e^{-rT}$. (6) thus takes the form:

$$
W = \begin{cases} \beta R + (1-\beta)(1-e^{-rT})S & \text{for } A < V(R,0) \\ \max\{\ (1-e^{-rT})V(R,S) + e^{-rT}A,\ A\ \} & \text{for } A \geq V(R,0) \end{cases} \tag{7}
$$

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[4] If the union starts at t=0 and we stick to an odd T, we obtain the same solution with $\delta/(1+\delta)$ and $1/(1+\delta)$ interchanged in the expression for V(R,S). If we have an even T, the result is slightly less elegant as the first mover is also the last mover before T+1. These differences vanish in the limiting "simultaneous moves" game.

Remark 1. The assumption that $(1-\delta)$ R $>$ s is crucial for the result that every SPE prescribes immediate agreement and no strike. In order to see this, consider a game where T $= 1$ and $(1-\delta)$ R $<$ s. The outcome of the game from period T$+1$ $= 2$ on is W*(2).

In period 1 the firm accepts any W(1) $\leq$ $(1-\delta)$ R $+$ δ W*(2). The union, however, prefers one period strike rather than obtaining agreement on the best agreeable wage for the firm: If the firm rejects the union's demand, the union gets s $+$ δW*(2) $>$ $(1-\delta)$ R $+$ δW*(2). The union also prefers strike to opting out: s $+$ δ W*(2) $>$ A as W*(2) $=$ max $\{[\delta/(1+\delta)]$ R, A$\}$, A $<$ R and $(1-\delta)$ R $>$ s. SPE strategies prescribes a strike in period 1.

In period 0 the union accepts any W(0) $\geq$ $(1+\delta)$ s $+$ δ^2 W*(2). By offering an unacceptable wage in period 0, the firm has to wait two periods before agreement and gets δ^2 (R $-$ W*(2)) $>$ $(1+\delta)$ s $+$ δ^2W*(2) for $(1-\delta)$ R $<$ s. The firm thus offers an unacceptable low wage in period 0.

We have thus a bargaining model with full information in which every SPE prescribes a strike. This is not surprising, though, once we recognize that in the two first periods of this model, the strike generates more income than production, and outcomes with strike are Pareto optimal.

While unreasonable in the stationary case with everlasting strike support, $(1-\delta)$ R $<$ s is conceivable in the case with support limited in time. I do not, however, view the model here as a good model of strikes for the following three reasons: a) It is hard to come up with any good reason why supporters should give more strike support to the union than the total loss to both parties of a strike. b) All empirical knowledge I have about payments during strike supports an assumption that workers gets less incomes during strike than they are ordinary paid. c) The model would predict counter-cyclical strikes rather than the pro-cyclical pattern that seems to be the case (see eg. Kennan and Wilson (1989)).

Remark 2. The outside option A *constrains* the outcome of the game only when it would also constrain a game without limits to the number of periods the union gets support A $>$ V(R,S) (or S $<$ A $- \delta$ (R-A)).

When V(R,0) $<$ A $<$ V(R,S) the agreed wage is a weighted sum of the inside wage that would prevail could the union get support for any length of strike *and* the outside

option to the workers. The union is certain to get the outside option from $T+1$ on, and a strike support of $s > (1-\delta)[A - \delta(R-A)]$ is sufficient to make the strike threat credible. The firm gives more than A to avoid the (limited) strike. In this case the outside option clearly affects the agreement even when it does not constrain the outcome.

If $A < V(R,0)$ the outside option is *irrelevant* for the outcome of the bargaining game.

The firm may not resort to an outside option in the game developed here. This is basically done to make the game simple. Introducing an outside option to the firm adds nothing new as long as the firms' preferences are stationary. We are thus studying wage bargaining in firms where the outside option to the firm do not represent a credible threat in any period during negotiations.

Clearly, the model presented may be mirrored by a model in which the firm has an outside option and faces declining pay offs during conflict. An example could be the firm selling off inventories for a given number of periods, after which it incurs heavy losses. It is the outside option of the first player to exhaust its funds and "give in" that potentially affects the outcome[5]. I have chosen to focus on declining pay-offs for the union mainly because it seems that it is more difficult for workers to smooth their income profile than for firms.

Remark 3. It may well be reasonable to assume that workers *have to* take their outside option after T periods of striking. If workers need a minimum flow of income to get by and have strike support for only a limited amount of time, they will give in and accept A in period $T+1$. Under such an assumption, following the reasoning for case 2 in the proof, the SPE outcome is immediate agreement on the wage given by the latter part of (7) for any A.

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[5] This point creates a discontinuity in the payoffs from investing in strike funds, inventories etc. before the players sit down at the negotiating table. This discontinuity is responsible for non-existence of Nash equilibria in pure strategies in a simultaneous pre-bargaining investment game. I am currently working on this issue together with Michael Wallerstein, UCLA.

Remark 4. The results stem from the existence and properties of the discount coefficient δ. Note, however, that the results rely on the discount coefficient only when solving the stationary infinite horizon subgame starting in period T+1. Once we get a unique outcome of this latter subgame, however, the backwards analysis gives a single outcome of the entire game - even with no discounting and $\delta = 1$.

Consider for example a finite game of τ + T periods without discounting. Assume also that the union have to give in at T+1 because they simply cannot afford to keep on striking without strike support. We calculate the SPE outcome using per bargaining period income w, s, r and a rather than the present values of all future income. Assume r > s and r > a. The union accepts w(T+1) = a. In period T the union can do no better than demanding the wage satisfying $(\tau+1)(r\text{-}w(T)) = \tau(r\text{-}a)$, which gives w(T) = $[1/(\tau+1)]r$ + $[\tau/(\tau+1)]a$. In period T-1 the firm have to offer a wage satisfying $(\tau+2)w(T\text{-}1) = s$ + $(\tau+1)w(T)$, which gives w(T-1) = $[2/(\tau+2)][(r+s)/2]$ + $[\tau/(\tau+2)]a$ to get acceptance from the union. Working backwards we find for any odd T, the agreed wage:

$$w(0) = (1-\theta)\frac{r+s}{2} + \theta a \tag{8}$$

where $\theta = \tau/(\tau+T+1)$. Note that w(t) > a for all t < T, which implies that the union never chooses to opt out before T+1 if they get an unacceptable offer. The outcome is immediate agreement on (8).

Assuming that the players share a common discount factor is a simplification. Let the firm have the discount factor d. The standard stationary alternating offers bargaining game has a unique SPE with internal solution V(R,S)=$[\delta(1\text{-}d)/(1\text{-}d\delta)]R$ + $[(1\text{-}\delta)/(1\text{-}d\delta)]S$ (see eg Sutton 1986). We consider only the case where V(R,0) < A < V(R,S). Working backwards from period T+1 as in the above proof for case 2 gives the immediately agreed wage:

$$W(0) = (1-(d\delta)^{\frac{T+1}{2}})V(R,S)+(d\delta)^{\frac{T+1}{2}}A \tag{9}$$

The bargaining power parameter of the internal wage V(R,S) is thus modified in the obvious

manner, while the weight given to the internal wage vs. the outside option is determined by the average discount factor.

5. Disagreement Points in the Cooperative Formulation

In this section the results from the above non-cooperative bargaining game is utilized in a discussion of cooperative solution concepts. The main point is that in a "corresponding" cooperative game to the non-cooperative model of this paper, both strike payments and the outside option of the workers enters the disagreement point

The outside option of the workers is the best alternative stream of income outside the firm. The introduction of alternative income in the disagreement point is quite common in the literature. It has previously typically been justified in three ways:

First, it is assumed to be the relevant status quo or disagreement point without reference to a non-cooperative structure. Examples are McDonald and Solow (1981:905) and Pissarides (1985:389) who assumes that the outside option is the relevant disagreement point. Secondly, it has been assumed that payoff during conflict also depends on labor market conditions. An example is Blanchflower and Oswald (1990:220) who writes: "The value of u* (income while on strike) will depend on the availability of, and wage paid in, temporary work". Finally, it has been quite common to introduce alternative income in the union maximand, either by assuming that the union maximizes rent above alternative income, or by assuming an utilitarian union maximizing the weighted sum income in present firm and alternative income, with weights determined by membership relative to employment. (See eg Nickell 1990:414).

My approach here justifies this way of introducing the outside option in the Nash product from the *strategic features* of a corresponding non-cooperative game *even* when outside options do not enter the utility functions of unions *and* strike support is independent of labor market conditions.

The relationship between the static axiomatic and the dynamic strategic approaches to bargaining is studied in Binmore et al (1986). In the limiting game of simultaneous

moves, V(R,S) may be interpreted also as the generalized Nash solution of a cooperative game and we have:

$$V(R,S) = \text{arg}\max_W [(W-S)^\beta (R-W)^{1-\beta}] \tag{10}$$

where (S,0) represents the disagreement point and ß the union's bargaining power parameter.

Consider the case where A < V(R,0). The outside option does not represent a credible alternative in period T+1. The agreed wage may then be interpreted as the generalized Nash solution of a corresponding cooperative game with a disagreement point ((1-e^{-rT})S,0) (cf. (7)). Reasonably, compared to the standard case, introducing a limit to strike support only reduces the union's disagreement point by the discounted value of support "lost". The outside option does not matter for the outcome.

The case where V(R,0) < A < V(R,S) provides the most central part of this paper. The outside option is credible in period T+1, and the union prefers to opt out when facing an offer W < A. In period t = 0, however, the union is equipped with support for T periods, and the outside option does not represent a credible alternative. (7) may in this case also be written in the following manner:

$$W = p \ R + (1-p) \ \{(1-\alpha)S + \alpha A\} \tag{11}$$

where

$$p = \beta(1-e^{-rT}),$$
$$\alpha = \frac{e^{-rT}}{1-\beta(1-e^{-rT})} \tag{12}$$

We note that (11) is also the solution to the problem:

$$V(R,S) = \text{arg} \max_W [(W-[(1-\alpha)S + \alpha A])^p (R-W)^{1-p}] \tag{13}$$

which indicates that the appropriate manner to take account of the outside option in our problem would be to weight it into the disagreement pay-off for the union.

6. Unemployment and Wage Formation

The link between alternative wages and the bargaining outcome in any one firm is utilized in theoretical models of equilibrium unemployment (See Pissarides (1985) and Fehr (1989). In this section we explore the consequences of the above bargaining model in an equilibrium framework of this type. Let the outside option take the value:

$$A = (1-u)W_a + uB \tag{14}$$

where we approximate the probability of getting a job to one minus the unemployment rate u. W_a is the expected average wage elsewhere in the economy and B are unemployment benefits.

Assume now that firms sets employment (L) ex post. For simplicity we assume constant elasticity of revenue with respect to employment (eg Cobb-Douglas production function and constant elasticity of demand). Let $\Phi = RL$ be the total revenue of the firm. A profit maximizing firm sets $\Phi'_L = W$ after the bargain is struck. We thus have $\Phi/L = R = W/\epsilon$, where $\epsilon = (\Phi'_L L)/\Phi$ is the elasticity of revenue with regards to employment. This is assumed to be known to the negotiating parties, and from (7), we get the agreed wage:

$$W = \frac{(1-e^{-rT})\beta W}{\epsilon} + (1-e^{-rT})(1-\beta)S + e^{-rT}A \tag{15}$$

Let $\gamma = (1-e^{-rT})$ be a measure of how long the union is able to last. The agreed wage is then:

$$W = \frac{\gamma(1-\beta)S + (1-\gamma)A}{1-\gamma\beta/\epsilon} \tag{16}$$

If $\gamma = 0$ the union may strike forever (T = ∞). In that case, the agreed wage is:

$$W = \frac{(1-\beta)S}{1-\beta/\epsilon} \tag{17}$$

which is completely determined by the "insider" factors S, β and ϵ.

If the union cannot credibly strike at all (eg have no funds such that T = 0) $\gamma = 1$.

18

In such a case the agreed wage is given by:

$$W = (1-u)W_a + uB \tag{18}$$

or the outside option A. No insider factors affects the wage.

Let $\gamma \in (0,1)$ and consider a long run equilibrium (LRE) of an economy with many identical firms. Let $\hat{s} = S/W$ be a common ratio of strike support to wages, and $b = B/W$ be the constant replacement ratio. Let W be the common wage level of all firms and W_A be their shared expected average. In LRE we must have $W = W_A$ and from (14) and (15) we may determine the LRE-unemployment rate:

$$u^* = \frac{(1-\beta)\hat{s} - (1-\beta/\epsilon)}{(1-b)} \frac{\gamma}{1-\gamma} \tag{19}$$

which is clearly increasing in γ. The longer the union is able to strike the higher is γ and consequently the higher is unemployment.

As in the shirking model of Shapiro and Stiglitz (1984), unemployment "disciplines" workers in this model. The effect is, however, not on work effort but rather on wage demands: - higher unemployment gives lower wage demands because the prospect of a lengthy strike is worse for the workers. Strike support may protect the "inside" workers from the labor market forces by making them able to keep on striking longer. This gives higher wages and higher equilibrium unemployment the longer workers are able to last.

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