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INVOLUNTARY UNEMPLOYMENT AS A PERFECT EQUILIBRIUM IN A BARGAINING MODEL

BY AVNER SHAKED AND JOHN SUTTON[1]

This paper presents an analysis of a 2-person noncooperative bargaining game in which one party is free, subject to certain frictions, to switch between rival partners. This permits us to capture the notion of an asymmetry between "insiders" and "outsiders" in the context of a firm bargaining with its workers, in the presence of unemployment.

1. INTRODUCTION

NO CONCEPT IN ECONOMICS is at the same time of such central importance, and so elusive of a satisfactory theoretical formulation, as the notion of an "unemployment equilibrium." The central idea which must be captured here is that certain "unemployed" workers would *strictly* prefer to be employed, at the prevailing wage rate. In other words, the equilibrium wage lies above the Walrasian level, and jobs are rationed ("unequal treatment").

In order to motivate such a non-Walrasian equilibrium, we need to introduce some "imperfection" or "friction" into the competitive model.[2]

The competitive model may be represented in terms of an auction, in which all workers are treated in a symmetric matter. The firm can *simultaneously* announce offers to various workers, "paying off one against the other" to establish the Walrasian wage.

In the present paper, we depart from this "competitive" story by introducing a minimal friction which characterizes actual labor markets: the firm in practice operates with a certain workforce at any point in time. It cannot line these up against a "reserve workforce" of the unemployed, and play off one against the other in the manner of a Walrasian auction. It can, of course, replace its current workers—but such changes are in practice not instantaneous (or costless).

The key feature which must be captured is as follows: the firm's current workforce enjoy a bargaining advantage insofar as it takes some time to replace them; *but if the firm does replace them, then it will find itself at the same disadvantage in due course vis-a-vis the new workforce.*

Once this point is appreciated, it is not clear at first glance that the outsiders afford the firm any credible threat. We shall see below, however, that the firm can indeed gain by using this threat.

[1] Our thanks are due to the International Centre for Economics and Related Disciplines at LSE for financial support.

[2] Most of the recent literature in this field has tended either (i) to invoke imperfect information, in one form or another, as an explanation (implicit contract theories, adverse selection mechanisms, search models), (ii) to treat aggregate unemployment as a "disequilibrium" phenomenon, associated with some slowness of adjustment of "lengthy" wage contracts, or (iii) to replace the usual non-cooperative equilibrium concepts by a cooperative one—an appeal to "unionization."

The implicit contract literature is reviewed by Azariadis [**1**] and Hart [**5**]. For the "adverse selection" mechanism see Weiss [**11**]; the early search literature treating unemployment as a disequilibrium phenomenon is discussed in Phelps [7]. The "unionization" approach is based on positing some objective function for workers which includes the level of unemployment as an argument (for an elementary introduction, see Carrter [4, Chapter 8]). A further approach involves an appeal to "fairness" (Hicks [**6**], Akerlof [**2**]).

Now in trying to capture the problem involved here, we will find it convenient to work throughout in a simple *bargaining* framework. No production takes place; we merely investigate a firm engaged in negotiating a wage with some potential worker (and we assume it needs exactly one worker). We capture the "friction" alluded to above, by supposing simply that the firm can bargain only with one individual at a time: we label that individual the "insider." As bargaining proceeds, however, it is free, after some specified time, to switch over to some other worker, who thereby becomes the new "insider." If the frequency with which it can make a switch is very low, then we approach a bilateral monopoly between the firm and its "insider." Here, the unemployed constitute "no threat" to the firm's employees, and so their presence plays no part in wage determination. If, on the other hand, the firm can switch instantaneously, then the threat to do so will suffice to establish a Walrasian outcome. Our central aim in the present paper is to present a suitable equilibrium concept, which can span the range of possibilities lying between the Walrasian pole, on the one hand, and bilateral monopoly on the other.

In proceeding along these lines, we are relying on an *analogy* between the delay (and consequent loss of production) involved in practice, in changing the firm's workforce, and the delay which we introduce in our bargaining process, in respect of the firm's ability to switch to a new partner.

In modelling this bargaining process, the crucial importance of the role of threats, and the question of whether they will be carried out, suggests that the appropriate equilibrium concept to explore is that of a Perfect Equilibrium (Selten [**9**]).

Thus, we do *not* take the approach of contract theory, where an agent undertakes "now" to carry out some action "later," which may not be in fact optimal. Here, we allow agents to freely revise their plans at each instant—and we investigate what sort of agreement they will reach in the light of this.

Now it is of course a commonplace that the "bilateral monopoly" problem in itself poses serious difficulties. Rubinstein [**8**] has recently presented a solution to this problem using the notion of a perfect equilibrium in a bargaining process. Our present analysis applies the same kind of approach within a more general context; so that the Rubinstein solution to the bilateral monopoly problem will emerge as a special case.[3]

For expository reasons, however, we begin by presenting a new and very simple method of solving Rubinstein's "bilateral monopoly" problem. The same method will then be used in analyzing the general model.

2. THE "BILATERAL MONOPOLY" CASE

A single firm requires the services of exactly one worker to produce a gross profit of one unit. In the present section, we assume that only one worker is available, with a reservation wage of zero.

[3] We are concerned with the "discount rate" case in Rubinstein's paper. He also considers a "fixed cost" scheme, in which equilibrium may not be unique. For an analysis of more complicated cases, see Binmore [**3**].

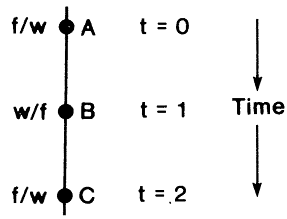

FIGURE 1—The "bilateral monopoly" game. The notation a/b reads: a makes a proposal to b.

The firm bargains with the worker in the following manner. At time zero, the firm makes an offer w to the worker. If he accepts, then the game ends, the payoffs received by the worker, and by the firm, being w and $1-w$ respectively.

If the worker rejects the offer, he may formulate a counter-offer; this takes a finite time interval, and we choose this interval as our unit of time in what follows. Thus the worker makes a counter-offer w' at time 1. If the firm accepts, the game ends. The payoffs to the worker, and the firm, are now equal to $\delta w'$ and $\delta(1-w')$, where $\delta < 1$ represents their common discount factor (the extension to the case of different discount factors is quite simple).

On the other hand, if the firm rejects the offer, it may in turn make an offer at time 2. Thereafter, firm and worker take turns to make proposals.

The notion that the time taken to formulate successive proposals is "negligibly small" may now be captured by considering the limit as $\delta \to 1$; we will be particularly interested in the properties of the model in this limit, in what follows. We remark that, in this limit, the outcome is independent of "who calls first."

Rubinstein has shown that there exists a *unique* perfect equilibrium partition in this game.[4] We now develop a (much simpler) analysis of the game, which re-establishes this result.

The strategies of firm and worker are said to constitute a *Perfect Equilibrium* if, in every subgame, the strategies relating to that subgame form a Nash Equilibrium. In a Perfect Equilibrium, a player will agree to a proposal if it offers at least as much as he will obtain in the future, given the strategies of all players. (See Rubinstein [**8**] for a precise definition.)

We express all payoffs in terms of their values discounted to period zero.

Consider point C in Figure 1. The discounted sum of the payoffs at that point is δ^2. Consider the game which begins at this point with a call by the firm. We define M as the supremum of the payoffs which the firm can obtain in any perfect equilibrium of this game. Discounted to $t=0$, this becomes $\delta^2 \cdot M$.

Now consider a call made by the worker in the preceding period (Point B in Figure 1). Any call by the worker which gives the firm more than $\delta^2 \cdot M$ will be accepted by the firm, so there is no perfect equilibrium in which the firm receives more than $\delta^2 \cdot M$; and since the discounted value of the total payoff at time $t=1$ is δ, it follows that the worker will get at least $\delta - \delta^2 \cdot M$ in any perfect equilibrium

[4] I.e., this is a unique division of the cake which can be supported as a perfect equilibrium.

of the subgame beginning from that point. In fact, $\delta - \delta^2 \cdot M$ is the infimum of the payoff received by the worker in this subgame.

Now consider the offer made by the firm in the preceding period (Point A in Figure 2). In the subgame beginning from this point, the worker will not accept anything less than the infimum of what he will receive in the game beginning next period—the present value of which is $\delta - \delta^2 \cdot M$. Hence the firm will obtain at most $1 - \delta + \delta^2 \cdot M$. In fact, as before, this is the supremum of what the firm will receive here.

But the game at point C is identical to the game at point A, apart from a shrinkage of all payoffs by a factor of δ^2. Hence it follows that the supremum of the firm's payoff here must equal M. Hence

$$M = 1 - \delta + \delta^2 \cdot M$$

whence

$$M = \frac{1}{1+\delta}.$$

But the above argument may be repeated exactly, if we instead begin by letting M represent the infimum of the payoff to f in any perfect equilibrium of G, and the interchange throughout the pairs of words: more/less, most/least, supremum/infimum and accept/reject.

Hence the above equation also defines M as the infimum of the payoff to f. Thus the payoffs in any perfect equilibrium partition are uniquely defined: the firm receives $1/(1+\delta)$ and the worker receives $w = 1 - 1/(1+\delta) = \delta(1+\delta)$.

It is easy to show that this solution is indeed supported by a pair of strategies, and so there exists a unique Perfect Equilibrium Partition. (These strategies are such that the offers made at any point correspond to the Perfect Equilibrium partition, and players agree to an offer of at least that amount.)

Note that as $\delta \to 1$, we have $w \to \frac{1}{2}$.

This completes our derivation of the Rubinstein result.

Three remarks are in order here, regarding this approach to resolving the "bilateral monopoly" problem.

REMARK 1: Consider a variant of the above game in which one of the players (say the "worker") is replaced by a succession of short-lived agents; each of these lives for exactly two periods. Thus the firm faces a succession of workers; it bargains with each for one "round" and then faces a new rival.

It is immediately clear from the preceding proof that the equilibrium payoffs are the same as before. Even though the "first" worker will not be involved in later rounds, his payoff is undiminished—he must offer to the firm only the amount which the firm can achieve in the appropriate lower subgame. The identity of the firm's subsequent rivals is immaterial. This is a point to which we return later.

REMARK 2: An interesting interpretation of the solution is as follows: at the start of each even numbered period $2n$, the firm makes an offer. If the worker fails to accept this, then the "cake shrinks" from size δ^{2n} to δ^{2n-1}, i.e., by $(1-\delta)\delta^{2n}$. The firm's payoff coincides with the sum of the shrinkages which occur during these time periods. To see this note that the firm's payoff can be expanded as follows:

$$\frac{1}{1+\delta}=(1-\delta)(1+\delta^2+\delta^4+\cdots).$$

This principle continues to hold good even when the discount rates are not equal, or where the time intervals between successive calls are irregular.

REMARK 3: The key idea involved here is to untangle two elements in the bargaining problem: (i) the technical framework within which bargaining occurs (the "rules of the game"); and (ii) the preferences of the bargaining agents.

The Rubinstein approach imposes *symmetry* in respect of the technical framework, or the "timetable" of offers, while allowing, in general, that the preferences of agents may differ. Now, once we move to a situation in which we have one firm, but many workers, it is natural to capture this difference in their respective positions by introducing an asymmetry into the technical framework of bargaining moves—the fact that the firm faces many workers enhancing the variety of moves open to it at any point in the game.

3. THE MODEL

Again we consider a firm which requires the services of one worker to produce a gross profit of one unit. Now, however, we assume there are $n>1$ workers available, each with a reservation wage of zero. Thus the Walrasian "market clearing" wage is zero.

The simplest story which leads to the Walrasian outcome here is that of the familiar "auction" market in which the firm announces offers to two (or more) workers *simultaneously*. In this case the only equilibrium is clearly the Walrasian.

The central idea of our present approach concerns our attempt to capture the fact, alluded to in the Introduction, that the typical firm in practice operates with a certain workforce at any point in time. It cannot line these up against a "reserve workforce" of the unemployed, and play one off against the other in the manner of the Walrasian auction.

We capture this idea by constructing a bargaining framework, or timetable of moves, which has the key property that the firm can never make simultaneous offers to two different workers. At each point, one worker is identified as the current "insider." Bargaining between the firm and this worker proceeds as in the bilateral monopoly model just described. However, the firm can plan to "switch" to an outsider, thereby making him the new "insider" henceforward, subject to two restrictions.

The first is a minimal restriction designed to give the current "insider" an advantage vis-a-vis rival "outsiders," and to avoid the use of strategies by the firm which would be equivalent in effect to its making "simultaneous offers." We require that, following any offer by the firm, the "insider" can always reply with a counter-offer before the firm switches over to negotiate with an outsider. Within our present structure, then, we require the restriction:

CONDITION (i): If the firm makes an offer to the insider at any time, then it must wait for at least a time of 1 unit before switching.

It is easy to show that this is a *necessary* condition for obtaining a non-Walrasian outcome. For, if the firm can make successive offers to worker 1, and to worker 2 (without any counteroffer by 1 intervening), then we have a situation analogous to that in which the firm makes simultaneous offers.

(The precise role of restriction (i) in the analysis is explained in Section 5 below.)

The object of our second "restriction" is to introduce into the model some parameter which can capture the degree to which the "frictions" we embody here carry us away from the Walrasian solution. With this in mind we assume:

CONDITION (ii): If the firm begins bargaining with a given worker at some point in time, then it cannot switch until some minimum time, which we label T, has elapsed. Once this time has elapsed, it is free to switch at any time subject only to (i).

The parameter T measures the degree to which the outsiders represent a threat to the insiders. We will assume $T>1$; as $T\to 1$ it can be shown that we converge to the Walrasian solution. Here the firm can, having made an offer to worker 1, proceed to make an offer to 2 "almost" as quickly as worker 1 can make his counter-offer.

On the other hand, as $T\to\infty$, it will be shown that we obtain the case of bilateral monopoly.

We may now proceed to a description of the game.

At time 0, the firm makes an offer of w to some worker (say, worker "1"). The process of bargaining with "1" now proceeds until time T has elapsed, the firm, and worker 1, taking it in turns, period by period, to make proposals.

Once time T has elapsed, the firm faces a twofold choice: either continue bargaining in this way with 1, or else switch to some other worker (say "2"), and begin bargaining with 2, following the same pattern as before. Such a switch can be made at any time, subject to restriction (i). As of the moment the firm switches to worker 2, he becomes the new "insider;" and time T must elapse before it can switch back to 1, or move to a third worker.

The possibility arises that the firm makes an offer to the outsider simultaneously with receiving an offer from the insider; if so, the latter gets priority in the sense that it is considered first, and only if it is rejected, is the former proposal considered.

Thus the firm may be thought of as "lining up" an alternative worker, while continuing to bargain with the "insider."

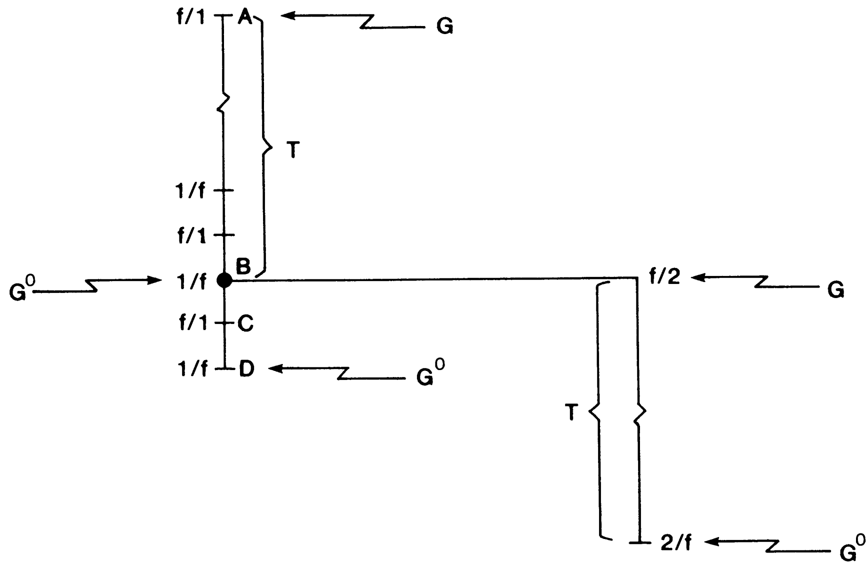

FIGURE 2—The notation a/b reads: a makes an offer to b.

The essence of the firm's strategy involves the threat of making such a switch, and thereby increasing its bargaining power vis-a-vis the current "insider."

While it will turn out below that agreement will be instantaneous, so that such "switches of workforce" will not be observed, nonetheless the threat involved would indeed be carried out, were the "insider" to make certain proposals, and replies. This idea is central to the *Perfect Equilibrium* concept.

In working through the proofs which follow, the reader may find it helpful to imagine that each worker has complete information on all moves made in preceding negotiation, including those in which he did not take part. The essence of the method developed above, however, is that it establishes upper and lower bounds to equilibrium payoffs which are independent of the past history of the game. Thus the equilibrium we calculate below is the unique equilibrium of the game, irrespective of workers' information concerning past negotiations.

4. EXISTENCE AND UNIQUENESS OF EQUILIBRIUM

We will simplify the exposition by confining ourselves to the case where T is an integer.[5] The results for the general case are stated in Section 5 below.

The game is illustrated in Figure 2. The firm negotiates with some worker, labelled 1, for time T; it is then free to switch subject only to condition (i), i.e. the worker is allowed to first make a counter-offer in response to the firm's last offer.

[5] We are here following the advice of a referee. The general case is solved in a similar manner.

Now suppose T is odd. Then the firm is first free to switch immediately after receiving a counteroffer from the insider. It is this case which we will focus on in the present section. If T is even, the firm has a choice, once T has just elapsed, between making an immediate offer to the insider *or* to the outsider (but not to both!). A simple argument shows that, in this case, it will remain with the insider for one more period—so that this case is equivalent to that in which the delay is equal to $T+1$. (See Section 5 below.)

In Figure 2, then, the firm is free to switch to worker 2 at point B, or after (subject to restriction (i)). We will in fact show that it will choose to switch immediately, at point B. (See Proposition below.) At point B, the firm receives a counteroffer from 1. If at that point, it chooses to switch, it makes an immediate offer to 2.

We define G^0 as the game which begins immediately following a call by the "insider," and where the firm is free at this time to switch to an outsider. Clearly the homogeneity of the game permits us to define G^0 independently of the time elapsed since the beginning of the game. Let M^0 denote the supremum of the payoff to the firm taken over all equilibrium partitions of this game.

We note that the game immediately following a switch by the firm is the same as our initial game; we label this game G. Again we label the supremum of the payoff to the firm, taken over all equilibrium partitions of this game, as M.

We begin by establishing the following:

LEMMA: *Let M, M^0 be the suprema (infima) of the payoffs to the firm in any perfect equilibrium of G, G^0, respectively. Then*:

(i) $$M^0 = \max\,[\delta(1-\delta+\delta M^0);\, M],$$

(ii) $$M = \frac{1-\delta^{T+1}}{1-\delta} + \delta^T \cdot M^0.$$

PROOF: (i) In Figure 2, consider the game beginning from point B, at which the firm is free to switch from 1 to 2. Represent all payoffs in terms of their values discounted to this point.

At B, the firm chooses either to switch, or to remain with 1, according to which yields the higher payoff. We now note the amount which f can at most receive along each branch.

By switching to 2 it receives at most M. Suppose it remains with 1. Then (repeating the argument of Section 2) at point D the firm receives at most $\delta^2 M^0$. Hence 1 receives at least $\delta^2 - \delta^2 M^0$. Hence at point C, the firm receives at most $\delta - \delta^2 + \delta^2 M^0$. Hence, by not switching, the firm can receive at most $\delta(1+\delta+\delta M^0)$.

(ii) In Figure 2, express all payoffs in values discounted to point A. Beginning from point B, note that the firm can at most obtain $\delta^T \cdot M^0$ here. Proceeding to work backwards (repeating our above argument T times) to point A, we see that the firm receives at most

$$1-\delta+\delta^2-\delta^3-\cdots-\delta^T+\delta^T M^0=\frac{1-\delta^{T+1}}{1-\delta}+\delta^T M^0$$

which equals M. *Q.E.D.*

We now characterize the solution to the game G.

PROPOSITION: *The game G has a unique perfect equilibrium partition in which the firm receives payoff*

$$M=\frac{1-\delta^{T+1}}{(1+\delta)(1-\delta^T)}.$$

PROOF: We proceed by showing that the two equations stated in the preceding Lemma have a unique solution.

Two cases arise, corresponding to the possibilities that (a) the firm does not switch, and (b) the firm switches, i.e., either:

(a) $\quad M^0=\delta(1-\delta+\delta M^0)$

or:

(b) $\quad M^0=M.$

We show that (a) is impossible, i.e., the firm will carry out its threat to switch. To see this, assume it does not switch, i.e.,

$$M^0=\delta(1-\delta+\delta M^0).$$

Solving, we obtain

$$M^0=\frac{\delta}{1+\delta},\quad \text{whence}\quad M=\frac{1}{1+\delta}$$

(where the last step follows from part (ii) of the Lemma). But equation (i) of the Lemma implies that $M^0\geqslant M$, which implies a contradiction.

It therefore follows that (b) holds, i.e., the firm does switch. Hence $M^0=M$, and substituting this into equation (ii) of the Lemma, we obtain the result, that equations (i) and (ii) have a unique solution. Thus the infimum, and the supremum, of the firm's payoff in any Perfect Equilibrium partition, coincide.

It is straightforward to show that this solution is indeed supported by a pair of strategies, as noted in Section 2 above, so that there exists a unique Perfect Equilibrium Partition. *Q.E.D.*

We now turn to the interpretation of this result. The firm's payoff equals

$$M=\frac{1-\delta^{T+1}}{(1+\delta)(1-\delta^T)}.$$

Now if $T=1$, we have the Walrasian solution, $M=1$. Notice that this is not a case of "simultaneous" calls by the firm, but rather an equivalent "limiting" case: the firm must call workers one at a time, but as soon as each replies with a counter-offer, the firm can instantaneously switch to another worker, and this is enough to ensure a Walrasian outcome.

We now turn to the other pole, where $T \to \infty$. Here we have

$$M = \frac{1}{1+\delta}.$$

This corresponds to Rubinstein's solution to the bilateral monopoly problem. In this case, then, the threat of the outsiders has vanished, and the asymmetry between the relatively advantaged "insiders" and the competing outsiders has become so large, that the outsiders do not impinge on the outcome at all.

We now wish to show that the qualitative features of these results are preserved in the limit where the delays incurred in bargaining become negligibly small. We allow δ to converge to unity. This can be interpreted in two ways, (a) the agents are "far sighted," so that the losses incurred by delaying agreement for one bargaining round are negligible, or (b) the length of a bargaining round becomes negligibly small (reinterpreting δ in the obvious manner).

Now in the limit $\delta \to 1$, it is readily shown that

$$N = \frac{1}{2} \cdot \frac{T+1}{T}.$$

At $T=1$, we obtain the Walrasian solution as before, while as $T \to \infty$, we have $M = \frac{1}{2}$, corresponding to bilateral monopoly.

5. SOME FURTHER COMMENTS

We here state the general results for the case where T takes any (integer or noninteger) value. For proofs, the reader is referred to Shaked and Sutton [**13**].

First suppose T is an even integer. Then, at the moment when T has just elapsed, the firm can choose whether to make an immediate offer to 1, *or* to make an immediate offer to 2. In the latter case it faces a constraint, in that it must stay with 2 for time T thereafter. In the former case, it does not (it can switch after one period). Thus, clearly, the firm will stay with the insider for one more round before switching. Thus the case where T is an even integer is equivalent to the case where the delay equals $T+1$.

Now suppose that $T = k + \varepsilon$ where k is an odd integer and $0 \leq \varepsilon < 1$. Then two cases arise, according as ε lies below, or above, some critical value $\varepsilon^*(k)$. For $\varepsilon < \varepsilon^*(k)$, the firm chooses to switch immediately time $T = k + \varepsilon$ has elapsed. On the other hand, if $\varepsilon > \varepsilon^*(k)$, then the firm does not switch at once; rather, it waits to make one more offer to the insider, and on receiving the insider's counter-offer, immediately switches to an outsider. Hence its payoff will not depend on ε in the range $\varepsilon^*(k) \leq \varepsilon < 1$.

Finally, suppose $T = K + \varepsilon$ where k is even, and $0 < \varepsilon < 1$. Then restriction (i) requires the firm to wait until at least $T+1$, and the payoff to the firm equals that which obtains when T equals $k+1$.

The solution is:

$$Q = \begin{cases} \dfrac{1-\delta^{k+1}}{1-\delta^{k+\varepsilon}} \cdot \dfrac{1}{1+\delta}, & \varepsilon \leqslant \varepsilon^*(k), \\ \dfrac{1-\delta^{k+3}}{1-\delta^{k+2}} \cdot \dfrac{1}{1+\delta}, & \varepsilon \geqslant \varepsilon^*(k), \end{cases}$$

where $\varepsilon^*(k)$ is defined as the value where these two expressions coincide. In the limit $\delta \to 1$, this becomes

$$Q = \begin{cases} \dfrac{1}{2} \cdot \dfrac{k+1}{k+\varepsilon}, & \varepsilon \leqslant \varepsilon^*(k) = \dfrac{2}{k+3}, \\ \dfrac{1}{2} \cdot \dfrac{k+3}{k+2}, & \varepsilon \geqslant \varepsilon^*(k) = \dfrac{2}{k+3}. \end{cases}$$

This solution is illustrated in Figure 3.

A central feature of our result, which we wish to emphasize, concerns the behavior of the model in the limit $\delta \to 1$. The point we wish to make is best seen by re-examining the role of restriction (i) in the analysis.

Restriction (i) forbids the firm to switch to an outsider immediately following an unsuccessful offer to the current insider; i.e. it gives the insider a "right to reply." Suppose we dropped this restriction, while continuing to require the firm to remain with the insider for at least time T before making a switch. The firm could then simply wait for time T to elapse, and in due course make a proposal to 1, and then imediately make a proposal to 2. Thus it could in effect make simultaneous proposals to 1 and 2, and so establish a Walrasian solution after a certain delay.

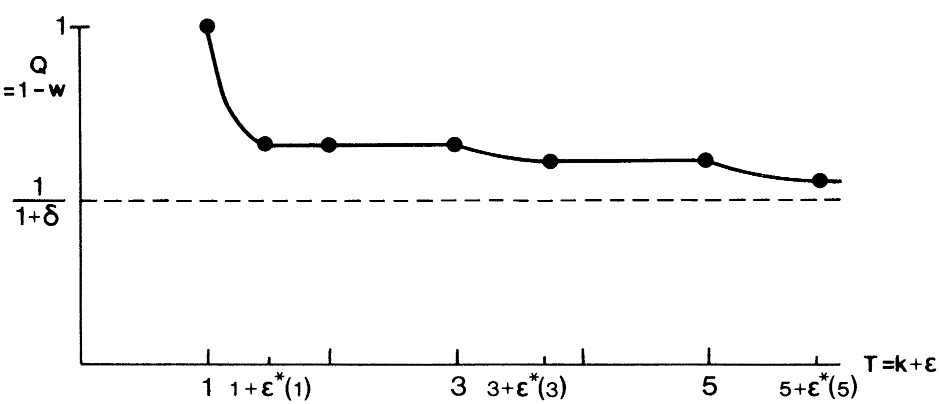

FIGURE 3—The payoff to the firm as a function of T. Note that the wage w equals $(1-Q)$.

The outcome would, however, still be non-Walrasian. The insider could extract a positive wage at time 0 which reflected the fact that the delay involved in waiting for a Walrasian outcome imposes a loss on the firm.

However, in the limit $\delta \to 1$, the solution would now converge to the Walrasian; here, the departure from the Walrasian solution just reflects the agents' valuation of a transient delay involved in achieving a Walrasian outcome.

The effect of our use of restriction (i) in the analysis is to ensure that the firm can never make simultaneous offers to two workers; and it is this which leads to our much more dramatic departure from the Walrasian model.[6]

6. SUMMARY AND CONCLUSIONS

We have been concerned throughout with an attempt to formalize the notion that the firm in practice has an "existing workforce" at any point in time. It cannot instantly and costlessly switch them for a rival workforce drawn from the unemployed; and this drives a wedge between the labor market we describe, and that of the Walrasian auction in which the firm can play one worker off against another by making simultaneous offers to each.

To capture this idea, we have followed Rubinstein's model of bilateral monopoly in describing a firm and a worker, who take turns to announce offer and counter-offer according to some timetable. It is natural to take this timetable, or structure of bargaining moves, to be symmetric, for the case of a bilateral monopoly.

Now once we move to the case where the firm faces a number of potential employees, an asymmetry exists between the bargaining position of the firm, and that of the worker. It is this asymmetry which we are trying to capture here. We have done so by describing the firm, at any point in time, as being involved in a negotiation of the "bilateral monopoly" type vis-a-vis some "insider"—the "existing workforce." Subject to the insider's "right of reply," it is free however to switch after time T to an "outsider" who thereafter becomes the new "insider."

The effect of this is to allow the firm to make certain choices as the game proceeds, as to whether it will switch or not. Since in each case it chooses the path advantageous to itself, this enhances its equilibrium payoff.

Now since the firm, at each time, has some particular worker as its "insider," the resulting game can in fact be seen as equivalent to one in which the firm negotiates with a single worker—but at certain times it has a choice as to setting (or re-setting) the timetable of offers and counter-offers. As we noted in Remark 1 on the Rubinstein model, the identity of the firm's rival at each point does not matter in itself here.

[6] The following question might be asked: since the worker can extract a surplus w, might it be attractive to change the "rules of the game" to allow the firm to charge an "entry fee" to the worker for beginning negotiation with him, thus extracting the surplus? It is intrinsic to the "Perfect Equilibrium" idea, that the firm could, having received the fee, keep switching to successive outsiders, extracting a similar fee from each—thus making the payment of such a fee unacceptable to the worker.

To illustrate this point, consider the limiting "Walrasian" case where $T = 1$. Here, as soon as the insider makes his first counter-offer the firm can immediately switch to a new worker. Reinterpret the game as one between a firm and a single worker: the firm calls at $t = 0$; at $t = 1$ the worker replies and then the firm calls again; at $t = 2$ the worker replies and then the firm calls again—and so on. Applying the argument developed in Remark 2 on the Rubinstein model, the firm clearly receives the entire "cake" here—in fact the arrangement is analogous to that in which the firm announces a take-it-or-leave-it offer in a one-shot game.

What matters, then, is not the *identity* of the worker with whom the firm negotiates. The role played by the availability of a substitute workforce is that it allows the firm to "change the timetable," choosing from between alternative sequences the one most advantageous to itself. More generally, *the advantage for the firm of being in this asymmetric position vis-a-vis workers is simply that it widens the range of options open to the firm in bargaining.*

This asymmetry in their respective positions is captured in the present framework, which allows the firm to "dominate" in the bargaining process—increasing the fraction of the bargaining period in which the firm "has an offer on the table."

We finally remark that our model can be extended to the case where the parties have different discount factors (for the "bilateral monopoly" case, see Rubinstein [**8**]). Now the discount rate here represents the loss in utility incurred as a result of delays in reaching agreement. It is through this channel for example, that the factors traditionally identified as the "costs of a strike" to workers will appear.

The limitations of the present exercise, on the other hand, are self-evident. We have confined ourselves to the relatively tractable case in which the firm has a single worker. Progress in extending the analysis to the n-worker case requires some advance in the (notoriously difficult) n-person bargaining problem. Thus, in the present paper, many issues which arise as to the interplay between insiders themselves (individual bargaining versus union bargaining, say) are avoided. The extension of the model, to a theory of unemployment, requires, moreover, a full specification of the demand side (and so of the determinants of the level of employment).

The main contribution of the present paper is that it allows us to characterize equilibrium in a situation where an "asymmetry" exists between "insiders" and "outsiders," which may be more or less pronounced. Our central theme is that, once such an asymmetry is present, a non-Walrasian outcome is the general rule, and a Walrasian equilibrium is merely an extreme, limiting, case.

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