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WAGE BARGAINING, LABOR TURNOVER, AND THE BUSINESS CYCLE: A MODEL WITH ASYMMETRIC INFORMATION

Motty Perry

Gary Solon

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ABSTRACT

This paper presents a wage bargaining model in which the employer and employee are each uncertain about the other's reservation wage. Under specified circumstances, the model's equilibrium is shown to involve unilateral wage setting and inefficient labor turnover. In addition, aggregate demand shocks affect the equilibrium in a way that produces procyclical quits and countercyclical layoffs. These results are obtained without resorting to assumptions of nominal wage rigidity, long-term contracting, or aggregate price misperceptions.

Motty Perry
Department of Economics
University of Chicago
1126 E. 59th Street
Chicago, IL 60637
(312) 962-8261

Gary Solon
Department of Economics
The University of Michigan
Ann Arbor, MI 48109
(313) 763-1306

WAGE BARGAINING, LABOR TURNOVER, AND THE BUSINESS CYCLE: A MODEL WITH ASYMMETRIC INFORMATION

1. Introduction

The paramount challenge in macroeconomics is to bridge the gap between microeconomic theory and macroeconomic phenomena. On one hand, standard microeconomic models of optimizing behavior imply efficient employment and output arrangements; on the other hand, the magnitude of aggregate employment and output fluctuations and their apparent sensitivity to nominal shocks suggest that these fluctuations are not efficient. The two main efforts to resolve this paradox have been the Keynesian and equilibrium models of the business cycle. In the Keynesian models, nominal wage rigidity combines with unilateral employment determination by the employer to produce inefficient unemployment. But, as Barro (1979) and others have argued, a fully satisfying theoretical explanation of nominal wage rigidity is lacking; furthermore, regardless of the wage-setting mechanism, it is unclear why, in long-term employment relationships, employers and employees would not cooperate to achieve efficient employment arrangements.

In contrast, the equilibrium models impose no wage rigidities, but assume that workers are imperfectly informed of aggregate price movements. The labor supply and/or job search response to the resulting discrepancies between actual and perceived real wages produces fluctuations in employment and output. But Okun (1980) and others have questioned the plausibility of population-wide misperceptions of aggregate prices. Moreover, the equilibrium models provide no explanation of observed countercyclical layoff patterns, and they predict countercyclical quits rather than the procyclical quits actually observed.[1]

More recently, implicit-contract theorists have explained inefficient employment arrangements as a consequence of information asymmetries between employers and employees. In some models, such as Grossman and Hart (1981), employers and employees are bound together in long-term relationships in which asymmetric information and risk aversion lead to temporary layoff unemployment. In other models, such as Hall and Lazear (1984), bilaterally asymmetric information produces permanent quits or layoffs that are inefficient relative to the full-information outcome. Few of these models, however, attempt to explain how employment outcomes and their efficiency vary over the business cycle in response to aggregate price shocks. In addition, as Hart (1983) has noted, the implicit-contract models raise difficult enforceability issues.

The present paper further explores the implications of asymmetric information without assuming long-term contracting. Instead, we present a wage bargaining model in which the employer and employee are each uncertain about the other's reservation wage. The employer and employee make offers and counteroffers until either they reach agreement or one side terminates the relationship through a quit or layoff. Even after agreement is reached, either side may reopen wage negotiations at any time, particularly when economic conditions change.

We show, under specified circumstances, that unilateral wage setting is the only equilibrium outcome of this model. The party that does not set the wage sometimes terminates the employment relationship through a quit or layoff. Furthermore, which party sets the wage and the resulting type of labor turnover are sensitive to the direction of shocks to the aggregate economy. Positive aggregate demand shocks shift the power to set wages to employers, who then shade their wage offers below the value of the employees' work. Some employees then quit their existing jobs even though, in some cases, they are less productive in their alternative jobs. Similarly, negative demand shocks shift wage-setting power to employees, who shade their offers above their best alternative wages. This results in layoffs, some of which occur even though the workers would be most productive if they stayed in their existing jobs. Thus, the model's equilibrium, which is inefficient relative to the full-information outcome, responds to aggregate demand shocks in a way that produces procyclical quits and countercyclical layoffs. The model therefore explains important features of aggregate labor market fluctuations without relying on controversial assumptions of nominal wage rigidity, enforceability of implicit long-term contracts, or aggregate price misperceptions.

In the next section, we develop a game-theoretic model of wage bargaining and labor turnover, and we present our basic result on the model's equilibrium. Section 3 explores the model's implications for the business cycle, and Section 4 summarizes our findings.

2. The Model

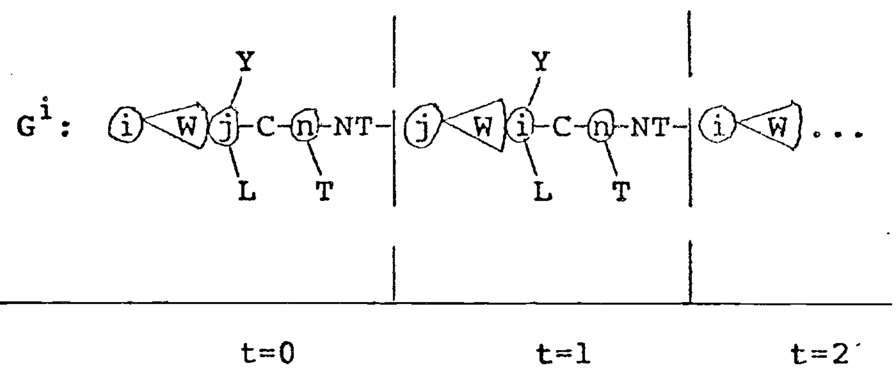
Our basic model describes wage bargaining between an employer and an employee with one indivisible unit of work to sell. At time $t=0$, they have a predetermined wage w_0 which is paid every period as long as they stay together without agreeing on a new wage.[2] The employer is identified by $m \in [\underline{m}, \bar{m}]$, which is his valuation of the employee's work. The employee is identified by $r \in [\underline{r}, \bar{r}]$, which is his best wage opportunity in the outside market. Throughout the paper, m and r will be referred to as "reservation wages" although they turn out not to be the wages the parties actually offer when bargaining. Because of the accumulation of specific human capital[3] in the existing employment relationship, m usually exceeds r, and we assume $\underline{r} < \underline{m}$ and $\bar{r} < \bar{m}$. The special nature of the existing relationship produces a bilateral monopoly situation in which the employer and employee must bargain over how to split rent. In contrast, the employee's best alternative wage r is assumed to equal his best alternative marginal product, so that no bargaining situations arise in the alternative market. The implicit assumption is that the number of type r alternative employers is large enough to bid the alternative wage up to the alternative marginal product.

Information in this model is bilaterally asymmetric. Each party knows his own reservation wage but is uncertain about the other's. The employee's information about m is summarized by the subjective probability distribution F(m); the employer's information about r is summarized by G(r). These distributions are common knowledge.

The bargaining game proceeds as follows. At time t=0, each party decides whether to move first. If only party $i \in \{r,m\}$ chooses to start, he immediately makes an initial wage offer. Then the other party j either accepts the offer, rejects it and leaves the game (thus terminating the relationship), or chooses to wait until period t=1 to make a counteroffer. In the latter case, the game continues similarly in period t=1 and so on, except that before each period there is a probability q that the game is terminated by "nature." This chance of exogenous termination reflects the possibility that a new shock to the economy will change the information structure of the game and thus initiate a new game between the same parties.[4]

The game G^i, in which party i moves first, is shown schematically in Figure 1. If both parties want to move first, the initiating party is chosen by a random device, and the game then proceeds as shown in Figure 1. If neither party wants to move first, each chooses whether to leave or to wait until t=1. If both choose to wait, then the process is reiterated in t=1. In any case, the game has three possible outcomes: (1) agreement on wage w at time t; (2) termination of the game (by nature or by a party's decision to leave) at time t; or (3) perpetual disagreement.

Figure 1



i = party that moves first
j = party that does not move first
n = nature
W = wage offer
Y = accepts offer
L = leaves game
C = makes counteroffer
T = terminates game
NT = does not terminate game

The payoffs to parties m and r are described by the von Neumann-Morgenstern utility functions $U_m(\ )$ and $U_r(\ )$. If agreement is reached on wage w at time t, the employer's payoff is $U_m[s(m-w)+t(m-w_0)]$ where s is the agreement's duration, which depends stochastically on future events.[5] The employee's payoff is $U_r[s(w-r)+t(w_0-r)]$. If the game terminates with no agreement after t periods, then s is zero and the payoffs are $U_m[t(m-w_0)]$ and $U_r[t(w_0-r)]$. The functions $U_m(\ )$ and $U_r(\ )$ are assumed to be strictly increasing with $u'(\ )\geq\epsilon>0$ and are subject to the normalization $U(0)=0$, but no further assumptions regarding their properties are necessary. Payoffs on uncertain outcomes are obtained by standard expected utility calculations of $EU_m(\ )$ and $EU_r(\ )$.

What remains is to describe the equilibrium of the game. We will use the concept of "sequential equilibrium," which extends "perfect equilibrium" to games with incomplete information. This equilibrium concept requires that, at each stage of the game (including out-of-equilibrium points), each party's strategy for the remainder of the game must be Nash-optimal. For a detailed discussion, see Kreps and Wilson (1982).

Before we state the main theorem, we define

$$\bar{w}(m) = \underset{w}{\text{argmax}}\ G(w)\ EU_m[s(m-w)],$$

which is employer m's optimal wage offer given that any employee with $r\leq w$ accepts and any employee with $r>w$ quits. Similarly,

$$\bar{w}(r) = \underset{w}{\text{argmax}}\ [1-F(w)]\ EU_r[s(w-r)]$$

is employee r's optimal offer given that any employer with $m\geq w$ accepts and any employer with $m<w$ lays the employee off.

<u>Theorem</u>: If $r>w_0$ for all $r\epsilon[\underline{r},\bar{r}]$, then the only equilibrium play is:

(i) An employer of type m chooses to move first and make an offer of $\bar{w}(m)$.

(ii) An employee of type r chooses not to move first and then to accept any offer $w \geq r$ and to quit if $w<r$.

(When $m<w_0$ for all $m\epsilon[\underline{m},\bar{m}]$, the theorem is completely symmetrical with the employee offering $\bar{w}(r)$ and the employer either accepting or laying the employee off.)

The proof, which is similar to the one presented by Perry (1983) for a different game, is rather lengthy and is therefore relegated to an appendix. Here we provide an intuitive discussion of the result. Note first that, in the case where $r>w_0$ for all $r\epsilon[\underline{r},\bar{r}]$, both parties know they are negotiating a wage increase. The longer the negotiation takes, the longer the employer gets to pay the lower wage w_0. This gives the employer a sort of bargaining advantage that confers on him the opportunity to make the initial wage offer. Since the theorem indicates that no counteroffers are made, this power to make the initial offer is equivalent to unilateral wage-setting power.

The no-counteroffer result may seem surprising because the model allows indefinite bargaining and one might expect the parties to use counteroffers as bluffing devices. For example, after the employer made an initial offer, the employee could respond with a very high counteroffer in an effort to convince the employer that the employee's alternative r was unusually high. The employer, however, would realize that this stratagem was available to any employee, regardless of his true r, and therefore would refuse to change the original offer. Consequently, the employee understands that bargaining would be pointless and would only prolong his receiving the low preexisting wage w_0. Instead, he simply accepts the employer's initial offer if $w \geq r$ and quits in favor of his superior alternative if $w < r$. As detailed in the appendix, a similar analysis explains why the employee chooses not to make the initial wage offer.

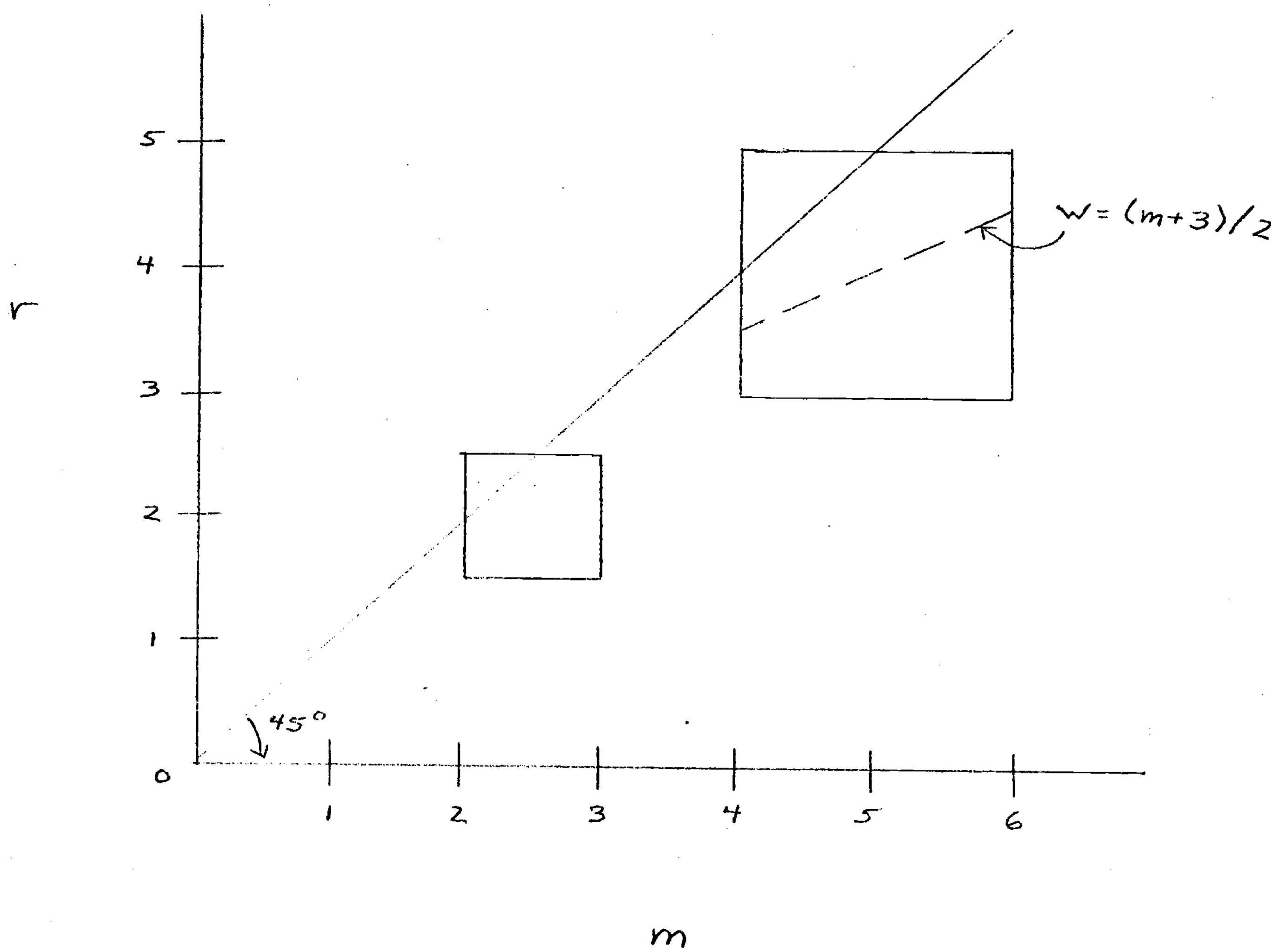
Finally, it is worth noting that, in this equilibrium, separations may occur that are inefficient relative to the full-information equilibrium. As will be illustrated in the next section, in the situation where $r > w_0$ for all $r \epsilon [\underline{r}, \bar{r}]$, the employer shades his wage offer w below m in an effort to capture monopoly rent. In cases where $w < r$, the employee then quits even though his alternative productivity r may be less than his productivity m on his current job. Similarly, in the symmetric situation where $m < w_0$ for all $m \epsilon [\underline{m}, \bar{m}]$, the employee shades his wage offer w above r. In cases where $m < w$, the employer than lays the employee off even though m may exceed r. In the next section, we discuss how these outcomes vary over the business cycle and present an illustrative example.

3. The Business Cycle

In this section, we characterize the case where $r>w_0$ for all $r\epsilon[\underline{r},\bar{r}]$ as being more prevalent after a positive aggregate demand shock than at other times. The idea is that a positive shock tends to shift some workers' alternative nominal wages above their preexisting nominal wages in their current jobs. These new conditions lead to wage renegotiations of the type analyzed in the previous section. Similarly, a negative aggregate demand shock tends to reduce some workers' nominal productivities below their preexisting wages in their current jobs, again initiating a new wage bargaining game. Positive and negative shocks, however, differ in their implications for which party assumes the power to set wages. As a result, aggregate price disturbances may have real effects on employment arrangements because they shift the balance of power in wage bargaining.

Consider the following simple example. Suppose that, in the current state of the economy, r and m are drawn independently from uniform distributions, with r ranging from 3/2 to 5/2 and m from 2 to 3. The higher tendency of m is due to accumulation of specific human capital in the existing employment relationship. The set of all possible (and equally likely) pairs of r and m is demarcated by the smaller box in Figure 2. In all pairs below the 45 degree lines, m exceeds r and continuation of the employment relationship is socially efficient. Above the 45 degree

Figure 2



line, separation is efficient. Notice that, regardless of the type of wage bargaining that occurs in this state, no wage can be higher than 3 because this is the highest value of m.

Now suppose a demand shock doubles the aggregate price level so that r is now uniformly distributed between 3 and 5 and m between 4 and 6. The new joint distribution appears as the larger box in Figure 2. In the aggregate, this shock may be purely nominal in the sense that, aside from the nominal change in scale, the joint distribution is the same as before. For an individual employer or employee, however, the example's shock is also real in that the new r's and m's are drawn independently of their previous values. This is an extreme characterization of the fact that relative shocks occur continually in the economy at the same time that aggregate shocks arise.[6] In equilibrium models such as Lucas' (1981), it is individuals' inability to separate these two types of shocks that leads to business cycles. In the current model, however, employers and employees are perfectly informed about the magnitude of aggregate shocks and about their own reservation wages; they are uncertain only about the other party's reservation wage.

In the new state of the economy, $r>3$ for all workers so that $r>w_0$ for all $r \in [\underline{r},\bar{r}]$. Consequently, the theorem of the previous section applies to all existing employment relationships in the economy. Therefore, as a result of the upward price shock, employers set new wages, and employees either accept them or quit their jobs.

For example, if employers are risk-neutral, they set wages to maximize $G(w)[(m-w)/q]$ where $G(\ )$ is the cumulative uniform distribution function ranging from 3 to 5. A simple calculation of the first-order condition shows that an employer of type m offers a wage of $(m+3)/2$. This wage-offer function is shown as the broken line in Figure 2. The employee accepts the wage offer if it exceeds r; otherwise he quits in favor of his best alternative job. Quits therefore occur for all pairs of r and m above the broken line. Some of these pairs lie below the 45 degree line, so that inefficient separations arise.

If the aggregate price level were then to drop by half, so that the smaller box in Figure 2 applied again, the analysis would work in reverse. Now m would be less than the preexisting wage for all $m \epsilon [\underline{m},\bar{m}]$, and employees would make new wage offers which employers would accept or respond to with layoffs. The employees would shade their offers above their r's, and some of the resulting layoffs would occur even though the employees would be more productive in their old jobs than in their alternative jobs.

Several points are worth highlighting. First, in accordance with the stylized facts on labor turnover, this model of wage bargaining over the business cycle generates procyclical quits and countercyclical layoffs. Previous equilibrium models of the business cycle have failed to predict these turnover patterns, while Keynesian models have required assumptions of nominal wage rigidity. In the present model, wages are renegotiated when economic conditions change, but uncertainty of the employer and employee about each other's exact economic circumstances prevents wage adjustments from achieving efficient employment outcomes. Furthermore, the direction of an aggregate price shock determines the identity of the wage-setting party and hence imparts a cyclical pattern to the form of labor turnover.

Second, unemployment could be incorporated in the analysis if r were viewed as the employee's best alternative use of time, either on another job or at home. An employee for whom home time was the best alternative would then become unemployed if he quit or were laid off. Interestingly, this unemployment would be voluntary in one sense and involuntary in another. Consider the case of an employee who, after a negative demand shock, makes a wage offer w and is then laid off into unemployment by his employer, whose m is less than w. In principle, the employee could avoid unemployment by offering a wage no greater than m. Given his inability to observe m, though, his higher wage offer is an optimal choice. Furthermore, even after being told he would be laid off, lowering his wage offer would not be an equilibrium strategy. Otherwise, the employer would always threaten a layoff, regardless of the true m, to bargain down the wage rate. From his own viewpoint, then, the unemployed worker is constrained from working at what appears to him to be a "reasonable" wage.

Third, the analysis has some obvious limitations. To begin with, the theorem's determinate equilibrium pertains only to aggregate shocks extreme enough to shift the whole distribution of r or m to one side of the preexisting wage w_0. Hall and Lazear's (1984) analysis suggests that less extreme shocks also would yield inefficient separations, but then it is no longer clear how wage and employment decisions would be made. Furthermore, although our model generates procyclical quits and countercyclical layoffs and can produce cyclical movements in other real variables as well, real output is not necessarily higher after positive demand shocks than after negative shocks. Finally, it is by no means clear what role, if any, the model implies for countercyclical government policy.

4. Summary

This paper has presented a model of wage bargaining with bilaterally asymmetric information. The equilibrium outcomes involve unilateral wage setting and inefficient labor turnover. The paper also has described how bargaining might be affected by aggregate demand shocks. The resulting procyclical quits, countercyclical layoffs, and quasi-involuntary unemployment conform to stylized facts of the aggregate labor market. These results do not depend on assumptions of nominal wage rigidity or implicit long-term contracts. On the contrary, the model allows renegotiation whenever conditions change. Nor does the model assume misperceptions of aggregate prices. All that is required is that each party is uncertain of the other's reservation wage and is aware of the direction of aggregate demand shocks. The model leaves many questions unanswered, but it illustrates the potential of information asymmetries for explaining the sensitivity of microeconomic allocation decisions to aggregate price shocks.

Appendix

The strategy for proving the theorem is first to show that plays involving either the employee's moving first or the employee's making counteroffers are not equilibria. Then we show that the play described in the theorem _is_ an equilibrium.

First, suppose there is a specific sequential equilibrium for the game G^r, in which the employee r makes the first offer and both parties eventually agree on the wage w. Let R be the set of employees who play this game, and let $\hat{r}=\sup\{R\}$. We can then establish two useful claims.

Claim 1: $w \le \hat{r}$.

Proof of claim 1: The proof is by contradiction. We will show that, if there exists an equilibrium wage $w>\hat{r}$ for some pair of players (r,m), then there must exist another pair (r',m') with equilibrium wage $w' \ge w+\delta$ where $\delta>0$. Since $w'>\hat{r}$, this argument can be repeated sufficiently many times to show that for some pair there is an equilibrium wage $w''>\bar{m}$, which is impossible because any employer would prefer leaving the game to accepting such a wage.

Assume that some pair (r,m) does agree on a wage $w>\hat{r}$. This agreement can be reached in two ways: (i) at some stage of the game, employee r offers w and employer m accepts, or (ii) employer m offers w and employee r accepts.

In case (i), why doesn't the employer reject the offer w and wait one period to make a counteroffer of the same w?

Since $w>\hat{r}$, no employee would quit in response to that counteroffer. (The fact that the game might be terminated by nature does not alter the employer's calculation.) Therefore, there must be some employee who would respond with a counteroffer. Because such an employee loses at least $w-w_0$ by turning down the employer's offer, there must be some employer m' with whom he can reach an agreement on wage $w'>w+\delta$, where $\delta>0$ is a fixed number great enough to compensate this loss.

In case (ii) where the employer offers w, why doesn't he offer $w-\epsilon$ instead? By the same reasoning as above, one can conclude that for some pair (r',m') there is an equilibrium wage $w'>w-\epsilon+\gamma$, where $\gamma>0$ is just great enough to compensate employee r' for foregoing the offered $w-\epsilon$. Clearly, for small enough ϵ, there exists $\delta>0$ such that $w-\epsilon+\gamma>w+\delta$.

Having established claim 1, we now proceed to the second claim.

<u>Claim 2</u>: Agreement on w can be reached in only one way -- the employer offers w and the employee accepts.

Proof of claim 2: Assume the opposite, that in some cases the employee offers w and the employer accepts. Now let R be this set of employees and $\hat{r}=\sup\{R\}$. Clearly, $w\geq\hat{r}$ because no employee would offer a wage below his reservation wage. But why does the employer accept instead of waiting one period to offer w? Since the employee would not quit in response to this offer, there must be some employee who would respond with a counteroffer. But, because such an employee loses at least $w-w_0$ by turning down w, there must be some employer with whom he can reach an agreement on wage $w'>w+\delta$ where δ is sufficient to compensate the loss. But then the same reasoning used in claim 1 suggests that there must be still another employer with whom the employee could agree on wage $w''>w'+\delta$. The argument can be reiterated until one obtains a wage agreement $w'''>\bar{m}$, which is impossible.

With the help of claims 1 and 2, we can now prove the theorem. First consider an equilibrium play in which some employees choose to move first. Let R be the set of such employees and $\hat{r}=\sup\{R\}$. By claim 1, the employee cannot hope for a wage higher than $\hat{r}$. By claim 2, he has to wait at least one period before agreement is reached. Hence his payoff cannot be more than $EU_r[s(\hat{r}-r)-(r-w_0)]$, which is less than $U_r(0)=0$ for any $r'\epsilon R$ close enough to $\hat{r}$. But then r' would have preferred quitting the game without making any offer. Therefore, a play in which some employees move first cannot be an equilibrium.

Next consider an equilibrium in which some employees choose to make a counteroffer. If we let R be the set of such employees and $\hat{r}=\sup\{R\}$, the analysis in claims 1 and 2 applies to this situation as well. These claims result in the same type of contradiction for this play as for the one in the paragraph above.

Finally, we must show that the play described in the theorem can be an equilibrium. To define a complete strategy for an employer or employee, we need to specify his behavior in all contingencies, including out-of-equilibrium ones. Actually, there are many equilibrium pairs of strategies that produce the outcome described in the theorem. We will describe only one.

The strategy for employee r is as follows. Regardless of his type, he chooses not to move first. At any subsequent information set of the employee, he leaves the game if the employer either chooses not to make an offer or makes an offer less than r; otherwise, the employee accepts. Employer m's strategy is to move first and then to offer $\bar{w}(m)$ under any information set, unless he has just been offered $w<\bar{w}(m)$, in which case he subsequently offers w. At each stage, the employee's beliefs about the employer are summarized by the distribution F( ). The employer's prior beliefs about the employee are summarized by the distribution G( ). The employer's beliefs are then updated in light of wage offers from the employee, given the employer's awareness that r must be less than these offers.

It is simple to check that, at each stage of the game, each player's strategy constitutes an optimal response to that player's beliefs and the remainder of the other player's strategy.

Footnotes

[1]The empirical evidence on cyclical turnover patterns is surveyed in Parsons (1977).

[2]We assume that the employer-employee relationship can be perpetuated only by wage payments for ongoing work. Consequently, strikes and lockouts are precluded.

[3]See Becker (1962) and Oi (1962) for detailed analyses of specific human capital. Specific human capital may be interpreted to include not only specific job skills, but also any other hiring or mobility costs.

[4]The possibility of future games between the same employer and employee does not affect the equilibrium strategies in individual games. The reason is that a threat which would not be credible in a single game (e.g., "pay me an exorbitant wage or I'll quit") could be "backed up" in a multiple-game setting only by following through on the threat to terminate the relationship. But, once the relationship is terminated, having established the credibility of the threat is worthless because there are no reputation effects on third parties in our model.

[5]This formulation of the utility function assumes that w will not affect the outcomes of future games, which is correct under the specific conditions of our theorem. More generally, we could write the expected payoff to the employer as $V_m[w,t(m-w_0)]$ where $\partial V_m/\partial w \le \epsilon < 0$ and $\partial V_m/\partial[t(m-w_0)] \ge \epsilon > 0$. The results would be unaffected.

'In a world with only nominal aggregate shocks, wage agreements might incorporate complete indexation, in which case our results on cyclical patterns would not apply. In the absence of explicit long-term contracts, however, it is unclear how such agreements would be enforced. More generally, in a world with relative shocks also, it is unclear whether employers and employees would agree to complete indexation even if it could be enforced. (Even explicit collective bargaining agreements often lack indexation provisions, especially if the agreements cover periods of less than three years. See Ehrenberg, Danziger, and San (1983), particularly footnote 21.) This topic undoubtedly warrants further research.

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