The Limited Influence of Unemployment on the Wage Bargain∗

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January 24, 2007

Abstract

When a job-seeker and an employer meet, find a prospective joint surplus, and bargain over the wage, conditions in the outside labor market, including especially unemployment, may have little influence. The job-seeker’s threat in the bargain is to hold out for a better deal, causing the employer to incur costs of formulating counter-offers, not to terminate bargaining and resume search at other employers. Similarly, the employer’s threat is to delay bargaining, not to terminate it. Consequently, the outcome of the bargain depends on the relative costs of additional rounds of bargaining to the parties, not on the results of irrational threats to disclaim any bargain. As a result of this wage rigidity, a stochastic model of the labor market that otherwise adopts all of the features of the standard Mortensen-Pissarides model yields much larger employment fluctuations than does the standard model.

∗We are grateful to Daron Acemoglu, John Kennan, Dan Quint, Randy Wright, four referees, and the editor for comments. Hall’s research is part of the program on Economic Fluctuations and Growth of the NBER. A file containing the calculations is available at Stanford.edu/~rehall
1 Introduction

We provide a new analysis of how small shocks to productivity or demand create substantial employment fluctuations. The critical difference between our analysis and previous ones lies in the way we model the wage-setting process. Labor market conditions in our model have a small effect on the terms of employment, so wages are also less sensitive to productivity fluctuations. Because the excess of productivity over wages is what motivates employer recruiting efforts, the consequence is that negative productivity shocks lead to greater declines in these efforts and a larger increase in unemployment than in the standard model.

The model of the wage-setting process at the heart of our analysis is a variant of the non-cooperative alternating offer model and improves on two common conceptions of wage bargaining. According to one conception, employers post wages and other terms and hire the most qualified applicant willing to work on those terms. The terms are offered to applicants on a strict take-it-or-leave-it basis. This model fails in an important way to describe the labor market—we present evidence that hardly any jobs come with posted terms.

A second common conception, which forms the basis of a large literature whose canon is Mortensen and Pissarides (1994), has wages and other terms of employment set by a so-called “Nash bargain.” Models using this formulation assume that the threat point for bargaining is the payoff pair that results when the job-seeker returns to the market and the employer waits for another applicant. We challenge that assumption.

A consequence of this second model is that the bargained wage is a weighted average of two values: the applicants productivity in the job and the value of unemployment. That latter value, in turn, depends on the wages offered in other jobs, how easy those jobs are to find, and the likely wages in future jobs. If an adverse shock reduces every employer’s reservation wage by a fixed amount, both terms in the average fall by almost the same amount and so wages also fall by that amount. Wages are flexible and unemployment fluctuations correspondingly small. This is the point of an influential paper, Shimer (2005).

Our primary point is that the flexible-wage conclusion hinges on unrealistic assumptions about bargaining threats. Once a qualified worker meets an employer, a threat to walk away, permanently terminating the bargain, is not credible. The bargainers have a joint surplus, arising from search friction, that glues them together. We make use of bargaining theory from Binmore, Rubinstein and Wolinsky (1986) to invoke more realistic threats during bargaining. The threats are to extend bargaining rather than to terminate it. The result is to overturn the tight connection with
outside conditions that delivers the flexible-wage, low-unemployment-response properties of the Mortensen-Pissarides model. In our model, a job-seeker loses most of the connection with outside conditions the moment she encounters a suitable employer, but before she makes her wage bargain. The bargain is controlled by the job’s productivity and by her patience as a bargainer relative to the employer’s. The possibility that she will return to job search remains in the picture because the job opportunity may disappear during bargaining, but this factor has a secondary influence.

The model delivers substantial volatility of unemployment through a mechanism similar to the one in Hall (2005a)—unemployment is high in periods when the wage bargain is unfavorable to employers. In times of low productivity, the wage falls only partly in response, the burden of the rest of the decline falls on employers. Because they have less to gain by hiring a worker, employers put fewer resources into recruiting, and the labor market is slack.

Wage negotiations between General Motors and the United Auto Workers illustrate the key change we make to the bargaining model (see Holden (1997) for an application of the BRW theory in the union setting). The wage agreement depends on the losses the bargainers suffer during a strike or lock-out. Each side is keenly aware of the costs of delay that fall on themselves and on the other side. The union accumulates strike funds and the company accumulates inventories to lower the costs of holding out for a better deal. The union never seriously considers permanent resignation of the workers as an option and GM does not consider discharging the workers permanently. Except in extreme circumstances, neither threat would be credible, because the workers would do better to accept a reduced wage than to quit, and GM would do better to pay a higher wage than to start over with new workers. This observation has important consequences for the comparative statics of the bargaining model. For example, if a new law were to make it costlier for GM to discharge its workforce during a work stoppage, that would be predicted to have no effect on the wage bargain.

Similarly, the non-cooperative bargaining model of Binmore et al. (1986) distinguishes between the outside-option payoff that the parties get by quitting the negotiation to seek other opportunities and the disagreement payoff that the parties get during the bargaining, during the disagreement period before the agreement is reached. Unless the outside option is especially favorable, it is the disagreement payoff—not the outside option—that determines the bargaining outcome.

In the alternating offer wage-bargaining environment, a bargainer who gets a poor offer always continues to bargain, because that choice has a strictly higher payoff than taking the outside option. Threats to exercise the outside option simply are not credible. Since this is common knowledge,
changes in the value of the outside option cannot affect the bargaining outcome. In the BRW equilibrium, the parties do not actually spend any time bargaining. They think through the consequences of a sequence of offers and counter-offers and then move immediately to an agreement at the unique subgame perfect equilibrium of the bargaining game. They do not waste time and resources haggling over the wage.

2 Model

2.1 The standard model

We begin with a model directly in the tradition of Mortensen and Pissarides (1994). The driving force of the model is a discrete stationary state variable \( i \in [1, \ldots, N] \) with transition matrix \( \pi_{i,i'} \). Workers and employers are risk-neutral. Their discount rate is equal to the interest rate, \( r \).

We start by describing the mechanism by which employers and workers match. Matching results from non-contractible pre-match effort by employers—help-wanted advertising and other recruiting costs—reinforced by the search time of job-seekers. It is conventional to describe the mechanism in terms of vacancies, though this concept need be nothing more than a metaphor capturing recruiting effort of many kinds. The key variable is \( \theta_i \), the ratio of vacancies to unemployment. The job-finding rate depends on \( \theta_i \) according to the increasing function \( \phi(\theta_i) \) and the recruiting rate is the decreasing function \( \phi(\theta_i) / \theta_i \). The separation rate—the per-period probability that a job will end—is an exogenous constant \( s \) (see Hall (2005b) for evidence supporting this proposition).

During a period, an individual may be seeking a job or working and an employer may have a number of vacancies open and a number of employees. At the end of the period, the job seeker finds a potential position with probability \( \phi(\theta_i) \). The job-seeker and the employer bargain for a wage with present value \( W_i \) for the job to start at the beginning of the next period. Our model implies that bargaining always results in employment, so \( \phi(\theta_i) \) is also the job-finding rate. A worker’s job ends exogenously with probability \( s \). A vacancy is filled with a new hire with probability \( \phi(\theta_i) / \theta_i \). An employee departs the firm at the end of the period with probability \( s \). Finally, at the beginning of the next period, the firm decides how many vacancies to hold open during the period.

Three values characterize the job-seeker’s bargaining position. If unemployed, the job-seeker achieves a value \( U_i \). Upon finding a job, she receives a wage contract with a present value of \( W_i \) and also enjoys a value \( V_i \) for the rest of her career, starting with the period of job search that follows the job. While searching, a job-seeker receives a flow value \( z \) per period. She has a probability
\( \phi(\theta_i) \), the job-finding rate, of finding and starting a new job. Hence \( U_i \) must satisfy

\[
U_i = z + \frac{1}{1+r} \sum_{i'} \pi_{i,i'} [\phi(\theta_i)(W_{i'} + V_{i'}) + (1 - \phi(\theta_i))U_{i'}].
\]  

(1)

Similarly, \( V_i \) must satisfy

\[
V_i = \frac{1}{1+r} \sum_{i'} \pi_{i,i'} [sU_{i'} + (1 - s)V_{i'}].
\]  

(2)

The value of the outside option of the job-seeker when bargaining over the wage with a prospective employer is \( U_i \).

Workers produce output with a flow value of \( p_i \), the marginal product of labor. The present value, \( P_i \), of the output produced over the course of a job is:

\[
P_i = p_i + \frac{1}{1+r} \sum_{i'} \pi_{i,i'} (1 - s)P_{i'}. 
\]  

(3)

The standard MP model has free entry on the employer side, so that the expected profit from initiating the recruitment of a new worker by opening a vacancy is zero. In that case, employer pre-match cost equals the employer’s expected share of the match surplus. Employers control the resources that govern the job-finding rate. The incentive to deploy the resources is the employer’s net value from a match, \( P_i - W_i \). Recruiting to fill a vacancy costs \( c \) per period, payable at the end of the period. The zero-profit condition is:

\[
\frac{\phi(\theta_i)}{\theta_i} (P_i - W_i) = c. 
\]  

(4)

Employers create vacancies, drive up the vacancy/unemployment ratio \( \theta_i \), and drive down the recruiting rate to the point that satisfies the zero-profit condition. Because of free entry, the employer’s outside option while bargaining with a worker has value zero. Notice that we require that the zero-profit condition hold for each value of the driving force \( i \); this is what makes recruiting effort vary with \( i \).

In this set-up, the worker and employer have a prospective surplus of \( P_i + V_i - U_i \), the difference between the value created by this job and the worker’s subsequent career, \( P_i + V_i \), and the worker’s non-match value, \( U_i \). The standard model posits that the employer and worker receive given fractions of that surplus; we will take the fractions to be 1/2 for simplicity. The job-seeker’s threat point is the value achieved during the prospective employment period by disclaiming the current job opportunity and continuing to search, that is, the unemployment value, \( U_i \). The worker’s value, \( W_i + V_i \), is this threat value plus half the surplus:
\[ W_i + V_i = U_i + \frac{1}{2}(P_i + V_i - U_i), \quad (5) \]

so the worker’s wage is:
\[ W_i = \frac{1}{2}(P_i + U_i - V_i). \quad (6) \]

The developers of the standard model often rationalized this wage rule as a Nash bargain.

The model has \(5N\) endogenous variables, the worker’s value of being unemployed, \(U_i\), her value of employment after the prospective job, \(V_i\), the vacancy/unemployment ratio, \(\theta_i\), the present value of productivity, \(P_i\), and the present value of wage payments, \(W_i\). It has \(5N\) equations, (1), (2), (3), (4), and (6).

From the solution, we can calculate other variables, including the unemployment rate, \(u\). In stochastic equilibrium while in state \(i\), the flow rate of workers into unemployment is \(s(1 - u)\) equals the flow rate out of unemployment, \(\phi(\theta_i)u\). Although in principle \(u\) is a separate state variable, it moves so much faster than \(i\) that we can use the stochastic equilibrium value as a close approximation to the actual value of unemployment:
\[ u_i = \frac{s}{s + \phi(\theta_i)}. \quad (7) \]

### 2.2 The wage bargain

In the standard model, the wage is the average of productivity \(P_i\) and the worker’s opportunity cost, \(U_i - V_i\). The wage is highly responsive to changes in productivity because \(P_i\) and \(U_i - V_i\) move together—the worker’s opportunity cost \(U_i - V_i\) depends sensitively on the wages of other jobs.

Indeed, in our calibration, \(W_i\) changes by 94 percent of the change in \(P_i\). Thus, a transition from one level of \(P_i\) to a lower one results in correspondingly large changes in \(W_i\) but only tiny changes in unemployment. This flexible-wage property of the standard model is the point of Shimer (2005).

Our bargaining model, adapted from Binmore et al. (1986), leads to quite a different conclusion. Bargaining takes place over time. The parties alternate in making proposals. After a proposer makes an offer, the responding party has three options: accept the current proposal, reject it and make a counter-proposal, or abandon the bargaining and take the outside option. If either party abandons the bargaining, that results in lump sum payoffs of zero for the employer and \(U_i\) for the worker. If the responding party makes a counter-proposal, both parties receive the disagreement payoff for that period and the game continues. The employer incurs a cost \(\gamma > 0\) each time it formulates a counter-offer to the worker. The worker receives the flow benefit \(z\) while bargaining.
Notice that our sign convention is the opposite for workers and employers—workers have a benefit \( z \) from waiting and firms incur a cost \( \gamma \).

In this bargaining game, when the joint payoff from matching, \( V_i + P_i \), exceeds both the unemployment payoff \( U_i \) and the capitalized flow \( \frac{1+r}{r}(z - \gamma) \), the parties agree on a wage \( W_i < P_i \). If \( V_i + P_i \) falls short of either of the other two values, no agreement is reached. If \( V_i + P_i = U_i \), the wage could be \( P_i \) but then employment will not occur because there is no incentive for recruiting effort by employers. The same is true if \( V_i + P_i = \frac{1+r}{r}(z - \gamma) \). Our exposition emphasizes the first possibility, because it is the only one that can justify positive search by employers and positive equilibrium employment in state \( i \).

We temporarily assume that the subgame perfect equilibrium of the bargaining models beginning with a proposal by the employer (or the worker) is unique; we return to prove this uniqueness the next subsection below. The consequence is that the value of rejecting an offer and continuing to bargain is uniquely defined, so the worker’s equilibrium strategy is to accept the employer’s offer if and only if it is better than both the continuation payoff and the payoff from exiting bargaining. Hence, there is some lowest wage offer \( W \) that the worker will accept. Symmetrically, there is a highest wage offer \( W' \) that the firm will accept.

Our calibration implies that, in equilibrium, the bargainers never abandon the negotiations. It is always strictly better for a worker or employer to make a counter-offer than to accept the outside options of \( U_i \) for the worker and zero for the employer. Consequently, it is optimal for each side in the bargaining always to make a just acceptable offer to the other side. The employer always offers \( W \) and the worker always offers \( W' \). Because the worker is just indifferent about accepting \( W \), it must be that her payoff from accepting, which is \( W + V \), is just equal to her payoff from rejecting the offer and countering with the acceptable offer of \( W' \) at the next round.

Our treatment of wage determination takes full account of Coles and Wright’s (1998) observation that alternating-offer bargaining in a dynamic setting requires that the bargainers be aware of the changes in the environment that will occur if they delay acceptance of an offer. To account for the dynamics, we subscript the relevant variables with the state variable \( i \).

We assume a probability \( \delta \) that the job opportunity will end in a given period during bargaining. In that event, the job-seeker gets the unemployment value \( U_i \) and the employer gets nothing. Thus, the indifference condition for the worker, when contemplating an offer \( W_i \) from the employer, is

\[
W_i + V_i = \delta U_i + (1 - \delta) \left[ z + \frac{1}{1 + r} \sum_{i'} \pi_{i,i'} (W_{i'} + V_{i'}) \right].
\]  

(8)
The similar condition for the employer contemplating a counter-offer from the worker, $W'_i$ is

$$P_i - W'_i = (1 - \delta) \left[ -\gamma + \frac{1}{1 + r} \sum_{i',i'} \pi_{i,i'} (P_{i'} - W_{i'}) \right]. \quad (9)$$

$W_i$ is the wage that the employer will propose and the worker accept, when it is the employer’s turn, and $W'_i$ is the worker’s counterpart. We assume that the employer makes the first offer, so $W_i$ is the wage in equilibrium. Although the employer makes the first offer and the worker always accepts it, the wage is higher than it would be if the employer had the power to make a take-it-or-leave-it offer that denied the worker any part of the surplus. The worker’s right to respond to a low wage offer by counter-offering a higher wage—though never used in equilibrium—gives the worker part of the surplus.

Equations (8) and (9) replace equation (6) and are alternative structural equations of the model. They differ only in the role of the threats. These are, for the worker, $U$ in the Nash model and the more complicated expression in equation (8) in the credible-bargaining model, and, for the employer, zero in the Nash model and the more complicated expression in equation (9) in the credible-bargaining model. Note that the threats are the same in the new model as in the standard model if $\delta = 1$.

The solution to equations (8) and (9) for the wage $W_i$ is somewhat complicated. The solution for the average $\frac{1}{2}(W_i + W'_i)$, which is hardly different from $W_i$ in our calibration, is helpful in explaining the substance of the credible bargain. In obvious matrix notation, the average is

$$\frac{1}{2} \left\{ P + \left( I - \frac{1 - \delta}{1 + r} \pi \right)^{-1} \left[ \delta U + (1 - \delta)(z + \gamma) \iota \right] - V \right\}, \quad (10)$$

where $\iota$ is a vector of ones. The effect of multiplication by

$$\left( I - \frac{1 - \delta}{1 + r} \pi \right)^{-1} \quad (11)$$

is to form a present value of a stream at interest rate $r$, subject to rate of decline $1 - \delta$, and obeying, in the case of the vector $U$, the transition matrix $\pi$.

Equation (10) for the credible bargain gives the same role to productivity $P$ and the worker’s subsequent career value, $V$ as does equation (6) for the Nash bargain. It differs from the Nash bargain only by giving less weight to $U$ and adding the present value of the bargaining bias, $z + \gamma$. Because $U_i$ reflects current conditions in the labor market while the $z + \gamma$ does not vary with the state, the wage is less sensitive to conditions as measured by unemployment under the credible bargain compared to the Nash bargain.
In the standard model with the Nash wage bargain, conditions in the labor market influence the wage through its positive dependence on the worker’s opportunity cost or reservation wage, $U - V$. Better conditions in the market give the worker a higher wage. In the credible bargaining model, $U$ enters with much less weight because the outside option is only relevant when the worker is forced to return to search because of the ending of the opportunity.

The subsequent career value $V$ has the same effect under credible and Nash bargaining. It reflects the post-employment opportunities enjoyed by a worker who takes a job today. Prolonging bargaining postpones the receipt of $V$, which is received at the time a job actually begins. Stronger long-run job opportunities $V$ lowers the wage by raising the cost to the worker of prolonging bargaining.

Another difference, of secondary importance, is that unemployment enters as the present value of the future values of $U$. In the new model, the persistence of the state variable $i$ has a role because it controls the relation between the current state of the labor market and the future states that enter the present value. Its persistence also influences $V$ under both Nash and credible bargaining.

All the other equations of the model are the same as in the standard model. The credible-bargaining model has $6N$ unknowns, because the hypothetical counter-offers $W'$ need to be calculated.

### 2.3 Uniqueness of the equilibrium

Equations (8) and (9) are linear in $W$ and $W'$. Because $\delta$ and $r$ are both positive, the linear system has full rank and the solution is unique. It remains to show that any equilibrium wages of the bargaining game must satisfy these two equations.

In an equilibrium, at any round, there is some lowest wage proposal by the firm at its first move above which the worker always accepts; we call that the *worker’s reservation wage*. Similarly, the *employer’s reservation wage* is the highest wage below which any worker proposal is accepted. Let $\underline{W}$ and $\underline{W}'$ denote the vector infimum across equilibria of the worker’s (respectively, the employer’s) reservation wages. These correspond to the best possible equilibrium bargaining outcomes for the employer in the full game and in the subgame beginning with an offer by the worker.

One can show by standard methods that the sets of reservation wages are closed, so there is an equilibrium of the game in which the employer initially offers $\underline{W}$ and the worker accepts. Hence, we may construct an equilibrium of the subgame beginning with the worker offer by specifying
that, if the worker offer is rejected, then the employer always proposes $W$ and the worker always accepts. Equation (8) can be solved for $W$ and written as $W = \Phi_1(W')$ and similarly equation (9) can be solved for $W'$ and written as $W' = \Phi_2(W)$. In the constructed equilibrium, at the worker’s first move, the employer’s reservation wage is $\Phi_2(W)$, so $W' \leq \Phi_2(W)$. In any equilibrium, the employer can never gain by rejecting a wage proposal less than $\Phi_2(W)$, so $W' \geq \Phi_2(W)$. Combining the inequalities, $W' = \Phi_2(W)$.

The preceding conclusion implies that there is an equilibrium of the subgame beginning with the worker’s offer in which the worker offers $W'$ and the employer accepts. So, we may construct an equilibrium of the full game in which this continuation equilibrium is played whenever the employer offer is rejected. In the constructed equilibrium, the worker’s reservation wage is $\Phi_1(W')$, so $W \leq \Phi_1(W')$. In any equilibrium, the worker never accepts a wage less than $\Phi_1(W')$, because she can always do better by rejecting it and proposing $W' = \Phi_2(W)$, which is always accepted. Hence, $W \geq \Phi_1(W')$. Combining the inequalities, $W = \Phi_1(W')$.

Thus, the lowest equilibrium wages satisfy $(W, W') = \Phi(W, W')$ and hence $(W, W') = (W, W')$. A symmetric argument shows that the highest equilibrium wages satisfy $(W, W') = (W, W') = (W, W')$, so these are the unique equilibrium wage vectors.

3 Calibration and Functional Forms

3.1 Preferences and the flow value, $z$

Hall (2006) uses evidence on preferences about consumption and work to derive the implied value of $z$ from the three basic properties of the Frisch consumption demand and labor supply functions of an individual: the own elasticity of consumption demand (intertemporal substitution and risk aversion), the own elasticity of labor supply, and the cross elasticity (complementarity of work and consumption). His discussion suggests that $z = 0.6$, the value that we use. Although this figure is higher than the one in Shimer (2005), it is not high enough to explain the observed volatility of unemployment in an MP model with a Nash wage bargain, as we will show shortly.

3.2 Turnover and values in the standard model

We measure time in days and calibrate to a separation rate of 0.1 percent per day or 3 percent per month and an unemployment rate of 5.5 percent. These imply a job-finding rate of 1.7 percent per day. We take the vacancy/unemployment ratio, $\theta$ to be 0.5. The calibration is in the stationary
equilibrium of a version of the model with only one state \((N = 1)\) with marginal product of labor, \(p\), equal to one. We take the discount rate to be \(r = 0.05/365\). We then solve the model for the cost of the employer’s pre-match recruiting, \(c\), to fit the job-finding rate. The value is \(c = 0.71\).

We take the job-finding function to be

\[
\phi(\theta) = \phi_0 \theta^{0.5},
\]

so the recruiting rate function is

\[
\phi_0 \theta^{-0.5}.
\]

We calibrate the efficiency parameter \(\phi_0 = 0.024\) to the job-finding rate and vacancy/unemployment ratio.

At the calibrated stationary equilibrium, the wage is \(W = 859\), the job-seeker’s value while unemployed is \(U = 6960\), and the subsequent career value is \(V = 6121\). The lower limit of the bargaining set for \(W\) is \(U - V = 839\) and the upper limit is \(P = 879\).

### 3.3 The driving force

The driving force of cyclical fluctuations in our model is the marginal product of labor. Hall (2006) measures the marginal product by evaluating the marginal rate of substitution between hours of work and goods consumption based on observed hours and consumption, using the preferences mentioned above. The logic is that an efficient determination of hours of work will equate the marginal rate of substitution to the marginal product. We create a discrete version of his measure, with \(N = 5\) values, as shown in Table 1. The stationary probabilities of the five categories are equal at 0.2. Notice that the volatility of this driving force is considerably greater than productivity, a point discussed in Hall’s paper.

<table>
<thead>
<tr>
<th>Category</th>
<th>Marginal product of labor</th>
<th>Daily transition probability to new category</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.912</td>
<td>0.9980 0.0012 0.0009 0.0000 0.0000</td>
</tr>
<tr>
<td>2</td>
<td>0.962</td>
<td>0.0028 0.9939 0.0018 0.0016 0.0000</td>
</tr>
<tr>
<td>3</td>
<td>1.001</td>
<td>0.0000 0.0027 0.9950 0.0023 0.0000</td>
</tr>
<tr>
<td>4</td>
<td>1.039</td>
<td>0.0000 0.0010 0.0021 0.9955 0.0015</td>
</tr>
<tr>
<td>5</td>
<td>1.086</td>
<td>0.0000 0.0000 0.0001 0.0010 0.9988</td>
</tr>
</tbody>
</table>

Table 1. Time-series Process for the Marginal Product of Labor
Figure 1 shows the dynamic response of the marginal product of labor to a one-time disturbance. The figure shows the marginal product starting at category 2 with a value of 0.962 and plots the mean value of the marginal product each day thereafter as it follows the path determined by the transition matrix, $\pi$, in Table 1.

Figure 1. Impulse Response Function for the Marginal Product of Labor

3.4 The credible wage bargaining model

We calibrate $\gamma$ in the stationary version of the credible-bargaining model so that it replicates the stationary equilibrium of the standard model. The resulting value of $\gamma$ is 0.35 days of worker productivity. We interpret $\gamma$ as the cost that the employer incurs in formulating a counter-offer. The employer avoids this cost by accepting the worker’s offer. If the worker produces $20 per hour or $160 per day, then $\gamma = 0.35$ implies a cost of $56 to produce the counter-offer. Notice that the value of $\gamma$ only comes into play two steps off the equilibrium path. First, the worker makes a counter-offer to the employer’s starting offer, which never happens on the equilibrium path. Second, the firm counters the counter offer, which also never happens on the equilibrium path. Nonetheless, the value of $\gamma$ has an important role in determining the equilibrium bargain.

We have been unable to locate any data on the costs that firms would incur while bargaining with newly engaged workers. To the extent that our model is descriptive of the process, employers
never actually incur the costs, because they formulate an initial offer that saves them the cost. We believe that a daily schedule for responding to offers is reasonable and that $56 is a reasonable figure for the cost of formulating a counter-offer to an employer, but cannot go beyond this fairly limited statement.

For workers, we impute the same benefit of not working while bargaining that they enjoy while searching. The net benefit is the benefit of leisure less the costs of searching. Our assumption is that the costs that a worker would incur from dealing with an employer for an extra day and formulating a counter-offer are comparable to the costs of searching rather than enjoying leisure at home.

Finally, we take the probability of disappearance of an employment opportunity during bargaining, $\delta$, to be the same as the probability $s$ that the opportunity will end during employment.

The value of the job-seeker’s hypothetical counter-offer is $W' = 859.46$, while the employer’s original offer, and the governing wage, is $W = 859.08$. The job-seeker is indifferent between accepting $W$ and counter-offering $W'$ with a one-period delay in the onset of employment. The elements of the indifference condition in equation (8) are:

1. Lose $W$ and gain $\frac{1-\delta}{1+r} W'$ for a net loss of 0.60
2. Lose $V$ and gain $\frac{1-\delta}{1+r} V$ for a net loss of 6.96
3. Gain $\delta U = 6.96$
4. Gain $(1 - \delta)z = 0.60$

4 Responses to Changes in the Marginal Product of Labor

The key property of the model that illustrates the difference between Nash and credible bargaining is the response to a change in the marginal product of labor, which may arise from a change in productivity or in other factor prices. With Nash bargaining, the wage responds directly to $P$ from the weight of 0.5 in equation (6). It responds indirectly through the presence of the opportunity cost $U - V$ in the same equation. $U$ falls by more than $V$, so the opportunity cost falls and the wage falls on that account as well. The first line of Table 2 shows the slopes of the responses of the relevant variables, measured by comparing the values in state 2 with those in state 4. The unemployment value $U$ rises by 1.55 times as much as $P$ rises—this reflects the direct effect of a higher $P$ on the wage and thus on $U$ plus the added benefit from the tightening of the labor market,
which raises $U$ by shortening the time until the next job begins to pay. The value of the worker’s subsequent career, $V$, rises by less than $P$, because the increase in $P$ is transitory, as shown in Figure 1. Thus $U - V$ rises by nearly as much as $P$ and adds almost another 0.5 to the wage. The response of the wage is 0.94 times the increase in $P$. Because the wage responds almost point for point, the profit contribution of a new worker, $P - W$, hardly increases. Finally, according to equation (4), the vacancy/unemployment ratio $\theta$ rises only a little, so unemployment falls only slightly. The elasticity of unemployment with respect to $P$ is -2.5, which is not nearly large enough to account for the volatility of unemployment—see Shimer (2005).

<table>
<thead>
<tr>
<th>Slope with respect to $P$</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U$</td>
<td>$V$</td>
</tr>
<tr>
<td>Nash bargaining</td>
<td>1.55</td>
</tr>
<tr>
<td>Credible bargaining</td>
<td>1.85</td>
</tr>
</tbody>
</table>

Table 2. Responses to Changes in the Marginal Product of Labor

The responses with credible bargaining are quite different. Equation (10) is a close approximation that helps explain the responses. Again, the wage responds directly to a productivity change with a coefficient of 0.5. $V$ responds by more than it does in the Nash case, but that is offset by the partial response to the increase in $U$. The latter increase is larger than in the Nash case, because the labor market tightens much more with credible bargaining. Because of the limited response to $U - V$, the wage response is only 0.50, in contrast to 0.94 in the Nash case. The profit contribution, $P - W$, rises substantially, stimulating recruiting effort and lowering unemployment. The elasticity of unemployment with respect to $P$ is -20.8, easily in the area where the observed volatility of the marginal product of labor can explain the volatility of unemployment.

Table 3 presents the same information in a different format. The far right column shows the same wage responses as in Table 2. The three columns to the left decompose the responses into the three channels corresponding to $P$, $U$, and $V$. The direct effects from $P$ in the left column are 0.5 for both Nash and credible bargaining. The positive effects operating through unemployment value $U$ are much larger in the Nash case than in the credible-bargaining case—this is the point of our analysis. The effects operating through the subsequent career value $V$ are somewhat more negative in the credible-bargaining case because the decrease in unemployment caused by an increase in the marginal product is so much stronger in that case.
5 Applicability

A good deal of thinking about the labor market assumes, explicitly or implicitly, that an employer sets a wage first and then fills a job with a worker willing to work at the posted wage. We have been unable to find any academic empirical literature on the process by which employers and job-seekers arrive at the terms of employment. If wage posting is the rule in the market, then the model in this paper is irrelevant, because we consider a process where wage determination is the last step in forming a match.

Wegerbauer (2000), a book offering advice to job-seekers about negotiating with a prospective employer, begins as follows: “Congratulations! You made it through the interview process. Both you and the hiring manager agree that you are the right person for the job. Now, however, you must negotiate the terms of the job offer.” Our model applies to the environment presumed in the book.

We can offer one piece of evidence that employers do not make the wage terms of an opening publicly available. Of the 762 new jobs in the help-wanted ads in the Chicago Tribune (www.careerbuilder.com) on December 18, 2006, 602, or 79 percent, had no information at all about pay. Another 147, or 19 percent, quoted pay in a range, often quite wide—many of the ranges started at zero. Only 13, or 2 percent, quoted an hourly wage in a range of a dollar or less or annual pay in a range of $2,000 or tighter. For the mix of jobs listed in help-wanted ads, posted wages are essentially non-existent. Posted wages may be more common in unionized jobs where wages are held above market levels and thus jobs are not listed in help-wanted ads.

Our impression of the process of wage determination—not founded on any extensive body of systematic empirical evidence—is that job-seekers gather information from friends, help-wanted ads, and they post resumes on websites to find jobs for which they are well matched. Employers review information about applicants and they search databases for good matches. They call in the more promising prospects for interviews. Having found what appears to be a good match,
the employer make a comprehensive job offer, including pay, benefits, and duties. We believe that employers almost always make the initial offer. Many job-seekers accept the initial offer, but others make counter-offers. The probability that the job-seeker and employer will make an acceptable deal is high, once the employer has decided to make the initial offer.

Our model is a stylized representation of this process. We do not try to model the directed nature of the search—in our model, job-seekers know nothing about a job. And there is nothing to know because all jobs are alike. We concentrate on one realistic aspect—one party starts the process by making an offer and the other can then accept or respond with a counter-offer. The unique equilibrium in our model is for acceptance of the initial offer. Thus the model is successful in explaining why few job-seekers make counteroffers (if that is true) but not successful in explaining why some job-seekers do make counter-offers. Models with information asymmetries might be able to explain the latter.

6 Other Research Relevant to the Wage Bargain

6.1 The Alternating Offer Bargaining Model

Infinite horizon, alternating offer bargaining models were introduced into economics by Rubinstein (1982) and have spurred a very large literature. Rubinstein and Wolinsky (1985) incorporate search and bargaining in a non-stochastic model and find that market outcomes may be far from the competitive equilibrium even when search costs and search times are vanishingly small. Gale (1986) introduces the possibility that the arrival of other parties may interrupt bargaining and create an auction; he shows that this structure reverses the Rubinstein-Wolinsky conclusion. Osborne and Rubinstein (1990) give an integrated review of the early literature.

Binmore et al. (1986) first developed the distinction between a threat point and an outside option in their alternating offer bargaining model. Binmore, Shaked and Sutton (1989) report laboratory experiments that affirm the importance of this distinction. Malcomson (1999) argues for its importance in analyzing labor contracts, while a number of others have applied the BRW theory to individual wage determination. These include Rosen (1997), Shimer (2005), and Menzio (2005). None of these papers deals with our topic, the way that alternating-offer bargaining delivers substantial employment fluctuations.
6.2 Hagedorn and Manovskii’s defense of the Nash bargain

Hagedorn and Manovskii (2006) construct a model in the Mortensen-Pissarides tradition where bargaining with unemployment as the threat point delivers a sufficiently unresponsive wage to rationalize the observed volatility of unemployment with realistic volatility of the driving force. The behavior of the key variables in their equilibrium is quite similar to the behavior in ours: The elasticity of the wage with respect to productivity is about 0.5, so that movements in productivity result in large changes in the payoff to the employer from new hires and correspondingly large changes in recruiting effort and thus in the vacancy/unemployment ratio and in unemployment itself.

Two controversial assumptions underlie Hagedorn and Manovskii’s calibration. First, they assume that nearly all bargaining power lies with the employer, which ensures that wages depend on the value of unemployment, but not on current productivity. This delivers wage rigidity, but only at the cost that workers are nearly indifferent about whether they get a job. Second, they assume that the flow value of unemployment is $z = 0.955$. This calibration is needed to rationalize the observed level of wages despite the low bargaining power of the worker, but this assumption, too, is problematic.

Generally, levels of $z$ higher than 0.9 imply wage elasticities of labor supply that far exceed any found in the literature. When the flow value of non-work, $z$, is close to the wage, workers are nearly indifferent to work, so small change in the wage result in large changes in labor supply, contrary to the findings of studies of labor supply. For a full discussion, see Hall (2006).

A superficial similarity between our model and calibration and that of Hagedorn and Manovskii is that while they calibrate $z = 0.955$, we set the bargaining bias to be $z + \gamma = 0.95$. Both bargaining models need threat costs close to productivity to rationalize a wage close to productivity. The logic supporting such threats is powerful—if the wage is much below productivity, a large volume of resources is being consumed in recruiting, which seems implausible. Whereas Hagedorn and Manovskii pair the unexamined assumptions that workers have much lower bargaining power than employers and that workers lose little by remaining unemployed, our model posits approximately equal bargaining power for firms and workers and calibrates the bargain by plausible differences in the costs of bargaining.
7 Competing Opportunities During Bargaining

So far, we have assumed that as the worker and employer negotiate, they are never interrupted by another competitor—a worker or employer. How might allowing new arrivals during negotiations alter our analysis?

Rubinstein and Wolinsky (1985) found negotiated prices far from competitive equilibrium even when search frictions are small in an alternating offer bargaining model. Gale (1986) modified their model to allow arrivals of additional players during bargaining and assumed that new arrivals trigger an auction. In the labor market context, if the newly arriving bargainer were a worker and the two workers bid in an auction for the single job, then the losing bidder would return to unemployment, which pays $U$. Then, Bertrand competition would also limit the winning bidder to a payoff of $U$, tying the equilibrium wage tied tightly to the unemployment payoff. If the new arrival were another employer, Bertrand competition between the two employers would give the worker the entire surplus.

We study the two cases separately. In the case of two workers bidding for the same job, the basic structure of the Mortensen-Pissarides model permits a simple argument that the auction will have the same equilibrium wage as bilateral bargaining. Employers create jobs costlessly, apart from a recruiting cost. An employer cannot commit not to bargain with the loser of the auction, because the bargain will yield a positive value to the employer, as in our earlier analysis. The bids in the auction will reflect the knowledge that the loser gets the bargained wage. Hence the equilibrium of the auction is the bargained wage, and the auction possibility has no effect on our earlier conclusions.

The case of two employers bidding for the same worker is quite different. The losing employer returns to recruiting—there is no alternate worker standing in the wings, comparable to the alternate job in the previous case. The lucky worker receives a wage equal to productivity and the winning employer receives no part of the surplus. The result is to connect the wage to productivity, not to make the unemployment value $U$ a direct determinant of the wage. However, labor-market conditions have a larger role in wage determination because they control the probability that a second employer will appear during bargaining.

It should not be taken for granted that a job-seeker can run an auction where two employers make competing bids. We have found no empirical literature studying how bargaining takes place in labor markets, but casual empiricism suggests that for many types of jobs, auctions among employers for a worker are not common.
One practical reason that auctions for a worker do not occur is that an employer cannot verify
the bid of another employer. The worker’s representation about a competing opportunity is cheap
talk. The best the worker can do is to pick the employer where the bilateral bargain is most
favorable and make that bargain.

Even when wage offers are common knowledge among the parties, the equilibrium depends on
the bargaining protocol. Consider the following bargaining game, which we believe may govern
important parts of the labor market. When it is the worker’s turn to make an offer, she can abandon
bargaining with the first-to-arrive employer and instead make an offer to the second employer,
leaving the first employer to return to recruiting.

In this game, when the worker abandons bargaining with the first employer, she enters a sub-
game that is identical to the bargaining game we have analyzed above, leading to a worker’s payoff
of \( W + V \). So, we can analyze the subgame perfect equilibria of the new game by replacing the
subgame with a terminal node at which the worker is assigned a payoff of \( W + V \). That payoff
functions as an outside option for the worker—an amount that she can claim if she stops bargaining
with the first employer. By the BRW logic, this outside option does not affect the agreement with
the first employer: the worker cannot credibly threaten to refuse a deal today paying \( W + V \) and
terminate negotiations today in favor of a deal paying the same amount tomorrow. Hence, in this
model, the wage bargain is unaffected by the arrival of a new job applicant.

The same conclusion applies for any model in which the worker can switch back and forth a
maximum of \( N \) times, where \( N \) is any positive integer. This follows by induction: Suppose that
the worker’s unique equilibrium payoff is \( W + V \) in any game where it can switch \( N - 1 \) times.
Then, just as above, \( W + V \) is the employer’s outside option in the initial negotiation with the
first-to-arrive worker and the conclusion follows.

Binmore (1985) analyzed a similar “telephone bargaining” model, but with no limit \( N \) on the
number of times the bargainer can switch back and forth between the employers. He found that
the same offer policies emerge at one equilibrium. The uniqueness argument made above was
written to apply to this game as well; it proves that the equilibrium wage offer \( W \) is unique. The
equilibrium itself is not unique. Indeed, there are infinitely many subgame perfect equilibria, but
they vary only in the way the worker chooses a bargaining partner whenever she faces that choice.

Of course, we do not believe that competition from other applicants for a job or other jobs
available to a worker is actually as limited as the characterization in our model. Not every employer
has a second job ready when two qualified applicants appear at the same time for one job. In some
cases, competing offers to the same applicant can be verified, so a worker can run an auction. Perhaps in some cases workers can put competing employers in the same room and make them bid directly against each other. Our point is that there are good reasons to think that these situations are not the rule and that the rule is bilateral alternating-offer bargaining.

8 Concluding Remarks

The process by which workers and employers reach agreement on the terms of employment is key determinant of real-wage rigidity and has first-order implications for the volatility of unemployment. If the parties believe that rejecting an offer results in an immediate return to unemployment, then the wage is naturally sensitive to conditions in the labor market. But the belief that the only alternative to accepting an offer is to return to unemployment is wrong; the parties can instead simply continue to bargain. When two well-matched parties recognize that one side cannot credibly refuse to consider a counter-offer, conditions in the outside labor market have much less influence on the wage bargain.

In the standard Mortensen-Pissarides model, if unemployment were to become high, the resulting fall in wages would stimulate labor demand and excess unemployment would vanish. With credible wage bargaining, however, the limited influence of unemployment on the wage results in large fluctuations in unemployment under plausible movements in the driving force.
References


