The Limited Influence of Unemployment on the Wage Bargain*

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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 be irrelevant. The job-seeker's threat point in the bargain is to delay bargaining, not to terminate bargaining and resume search at other employers. Similarly, the employer's threat point is to delay bargaining, not to terminate it. Consequently, the outcome of the bargain depends on the relative costs of delay to the parties, not on the results of irrational threats to disclaim any bargain. In a model of the labor market that otherwise adopts all of the features of the standard Mortensen-Pissarides model, unemployment is much more sensitive to changes in productivity and other aspects of the environment than in the standard model, because feedback through the wage is absent. We also present a model where the wage bargain is in partial contact with conditions in the labor market. In that model, the parties know that there is a probability that bargaining will be interrupted by the disappearance of the production opportunity. This model restores part of the link of the wage to unemployment. We explore other implications of the limited role of unemployment for wage determination, in partial and general equilibrium.

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1 Introduction

One of the most durable propositions in macroeconomics is that wages respond to unemployment. Although the persistence of depressions and recessions suggests that the response is not immediate and complete, the notion that wages respond to unemployment over time—the essence of the Phillips curve—remains persuasive.

Modern thinking about the issue is much under the influence of the Mortensen and Pissarides (1994) model of the labor market. In that model, the unemployed meet occasionally with suitable employers. At the time a job-seeker and an employer meet, the two parties enjoy a potential surplus from forming a match—the surplus is the excess of what the match would produce over what they would get if the job-seeker returned to search and the job remained unfilled. The job-seeker and employer form the match and agree on a wage that splits the surplus. This is sometimes called a Nash wage bargain, based on the assumption that the Nash threat points in the bargain are for the job-seeker to return to the market and for the employer to wait for another applicant. This paper challenges that assumption.

The Mortensen-Pissarides model links the bargained wage tightly to the job-seeker's value of unemployment. That 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, the job-seeker's reservation wage falls by almost the same amount and so the bargaining outcome—a weighted average of the two reservation wages—falls by the same amount. Wages are flexible and unemployment fluctuations correspondingly small. This is the point of an influential paper, Shimer (2005).

Our primary point in this paper is that the flexible-wage conclusion hinges on unrealistic assumptions about the bargaining threat points. 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 the most basic version of our model, a job-seeker loses 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, but not by the purely hypothetical possibility that she will return to job search.

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. Similarly, in times of low exogenous product demand, the interest rate is low and the wage rises relative to productivity, also discouraging employers from hiring. In both cases, because they have less to gain by hiring a worker, employers put fewer resources into recruiting, and the labor market is slacker. This mechanism operates just as Mortensen and Pissarides described.

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 wage-bargaining environment of the Mortensen-Pissarides class of models, a bargainer who gets a poor offer always continues to bargain, because that choice has a strictly higher payoff than taking the outside option. Consequently, changes in the value of the outside option never affect the bargaining outcome. The beauty of the BRW theory is that, just as in the older theory, there is a simple interpretation of the bargain in terms of giving each side an equal share of the surplus over some threat point. What it changes is the threat payoffs. In the Mortensen-Pissarides setup, they are the payoffs the parties receive separately if they forgo employment. In the BRW theory, they are the payoffs to the two sides of continuing to bargain forever.

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 any time and resources haggling over the wage.

In a second model, we introduce a probability that bargaining will end because the opportunity to form a productive match disappears while the parties bargain. If the bargaining ends that way, each party gets its outside option. As the probability rises, the bargaining outcome looks more and more like the Nash bargain in the standard model. The modified model delivers a closer connection of the wage to conditions in the labor market and thus lowers the sensitivity of unemployment to changes in driving forces.

We embed the new theory of the wage bargain in a simple and standard general-equilibrium model. Here we confirm that isolation of the wage from unemployment amplifies the effects of productivity shocks in the labor market. We also show that shocks in product demand—a driving force in traditional macro models that has had a less prominent role in recent macro theory—have large effects in the labor market. In fact, the bulk of the volatility of unemployment arises from these spending shocks rather than from productivity shocks.

2 Model

2.1 The standard model

We begin with a model directly in the tradition of Mortensen and Pissarides (1994). Initially, we consider the stationary state of the model of the labor market. Later we embed the model in a full dynamic stochastic general-equilibrium model.

A job-seeker achieves a value U. Upon finding a job, she receives a wage contract with a present value of W and also enjoys a value V 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 λ per period. She has a probability f, the job-finding rate, of finding and starting a new job. The discount rate is r. The stationary condition for U is

$$U = \lambda + e^{-r}\left[f(W+V) + (1-f)U\right]. \tag{1}$$

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). The stationary condition for V is

$$V = e^{-r}\left[sU + (1-s)V\right]. \tag{2}$$

The value of the outside option of the job-seeker when bargaining over the wage with a prospective employer is U.

Workers produce output with a present value Z over the course of the job. We will be concerned with the response of unemployment and other endogenous variables to changes in Z, the driving force of fluctuations.

The next step is to describe 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 θ, which in terms of the metaphor is the ratio of vacancies to unemployment. The job-finding rate depends on θ according to

$$f = \phi(\theta) \tag{3}$$

and the recruiting rate is

$$\rho(\theta) = \frac{\phi(\theta)}{\theta}, \tag{4}$$

which is assumed to be decreasing.

The standard view has free entry on the employer side, so that employer pre-match cost equals the employer's expected share of the match surplus in equilibrium. Employers control the resources that govern the rate of job finding. The incentive to deploy the resources is the employer's net value from a match, $Z - W$. Recruiting to fill a vacancy costs c per period. The zero-profit condition is:

$$\rho(\theta)(Z - W) = c. \tag{5}$$

Employers create vacancies, drive up the vacancy/unemployment ratio θ, and drive down the recruiting rate $\rho(\theta)$ 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.

In this set-up, the worker and employer have a prospective surplus of $Z + V - U$, the difference between the value created by this job and the worker's subsequent career, $Z + V$, and the worker's non-match value, U. 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. The worker's value, $W + V$, is this threat value plus half the surplus:

$$W + V = U + \frac{1}{2}(Z + V - U), \tag{6}$$

so the worker's wage is:

$$W = \frac{1}{2}(Z + U - V). \tag{7}$$

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

The model has five endogenous variables, the worker's value of being unemployed, U, her value of employment after the prospective job, V, the job-finding rate, f, the vacancy/unemployment ratio, θ, and the present value of wage payments, W. It has five equations, (1), (2), (3), (5), and (7).

From the unique solution, we can calculate other variables, including the stationary unemployment rate, u. At equilibrium, the flow rate of workers into unemployment is $s(1 - u)$ and the flow rate out of unemployment is fu; equilibrium requires that these rates must be equal. So, the unemployment rate is:

$$u = \frac{s}{s + f}. \tag{8}$$

2.2 The wage bargain

In the standard model, the wage is the average of productivity Z and the worker's opportunity cost, $U - V$. The wage is highly responsive to changes in productivity because Z

and $U - V$ move together—the worker's opportunity cost $U - V$ depends sensitively on the wages of other jobs. Indeed, in our calibration, the derivative of W with respect to Z is 0.97. Further, if unemployment rises, the wage will fall because the worker's opportunity cost falls. For both of these reasons, a reduction in Z results in correspondingly large changes in W 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 for the worker. If the responding party makes a counter-proposal, both parties receive the disagreement payoff for that period and the game continues. During disagreement, the employer pays a flow cost of γ—no production is occurring but the firm has to pay for the executive time involved in the continuing negotiation and the worker receives a flow benefit denoted by ω. Notice that our sign convention is the opposite for workers and employers—workers have a benefit ω from waiting and firms incur a cost γ.

We are aware of only one earlier application of the BRW theory to individual wage determination, Rosen (1997). The focus of that paper is rather different from ours, however.

The bargaining game has three equilibria, depending on which of three alternatives maximizes the joint payoff:

1. When the joint payoff $\frac{\omega-\gamma}{r}$ is the highest among the choices, the parties bargain forever.

2. When the joint payoff U is the highest, the parties do not bargain at all; they immediately claim the outside options.

3. When the joint payoff from matching, $V + Z$, is the highest, the parties agree on a

wage.

Our exposition concentrates on the third possibility, because it is the only case that can justify positive search effort by employers and positive employment at equilibrium.

The time period separating one offer from the next is τ, which we take to be much smaller than one, because offers can be made and rejected relatively quickly. Many rounds of bargaining can occur within each period of search and employment. We ultimately consider the limiting case where the time between offers is infinitesimal. The flow payoffs to the parties from one offer to the next are are $\omega\tau$ and $\gamma\tau$.

The full BRW analysis of the bargaining game is too lengthy to incorporate here. Nevertheless, a clear intuition about the bargaining equilibrium can be developed, provided we accept without proof that the subgame perfect equilibria of the two bargaining games beginning with a proposal by either the employer or the worker are unique, so that the value of rejecting an offer and continuing to bargain is uniquely defined. With that assumption, 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. So, 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 assumptions imply that, in equilibrium, the bargainers never abandon the negotiations. Consequently, it is optimal for each side in the bargaining always to make a just acceptable offer to the other side. So, the employer always offers W and the worker always offers W'. Since the worker is just indifferent about accepting W, it must be that her payoff from accepting, which is $W+V$, is just equal to the larger of her unemployment payoff U or her payoff from rejecting the offer and countering with the acceptable offer of W' at the next round. Thus,

$$W + V = \max(U, \omega\tau + e^{-r\tau}(W' + V)). \tag{9}$$

A similar calculation for the employer establishes that

$$Z - W' = \max(0, -\gamma\tau + e^{-r\tau}(Z - W)). \tag{10}$$

There can be no equilibrium of the full model in which the employer's payoff is the same as its outside option payoff of zero, because then the employer would not exert any recruiting effort. With the calibrated parameters, the worker also gets more than her outside option of U. Solving the equations for that case leads to

$$W = \frac{\omega\tau + e^{-r\tau}\gamma\tau + e^{-r\tau}(1 - e^{-r\tau})Z - (1 - e^{-r\tau})V}{1 - e^{-2r\tau}}. \tag{11}$$

Letting τ approach zero yields the limiting solution that we will use in the rest of the paper:

$$W = W' = \frac{1}{2}\left(\Omega + \Gamma - V + Z\right). \tag{12}$$

Here $\Omega = \omega/r$ and $\Gamma = \gamma/r$; these can be loosely interpreted as the values of perpetual disagreement. The BRW solution with infinitesimal time between offers coincides with the Nash bargain where the threat points are Ω and $-\Gamma$—compare equation (12) to (7). In this limiting model, the wage does not depend on who makes the first offer. The surplus is the joint value $Z + V$ less the sum of the threat values $\Omega - \Gamma$.

Equations (7) and (12) are alternative structural equations of the model. In the next two paragraphs, we discuss the roles of the two versions of the structural wage-determination equation. This discussion should not be confused with our later discussions of comparative statics of the entire model, where we consider variations in an exogenous variable, productivity.

In the standard model, conditions in the labor market influence the wage through its positive dependence on the worker's opportunity cost or reservation wage, $U - V$. Superior conditions in the market give the worker a higher wage. By contrast, the only variable measuring conditions in the market in the new bargaining model is $-V$. V 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. The new model goes beyond isolating the wage from conditions in the (long-run) labor market—it reverses the influence.

The source of the reversal is the bargainers' awareness that the worker achieves a value $W+V$ but the employer only pays W. In the thought experiment with U fixed, an increase in V would raise the surplus, entitling the worker to half of the increase, that is, $W+V$ must increase by only half the increase in V. The worker's total payoff, $W+V$ is positively related to market conditions, but the wage part of it is negatively related.

All the other equations of the model are the same as in the standard model. The derivative of the wage with respect to productivity is lower in this model than in the standard model. Fluctuations in the vacancy/unemployment rate and in the unemployment rate are correspondingly larger. The essential difference between the new bargaining model and standard model is the replacement of the unemployment value, U, by the perpetual delay value, $\Omega+\Gamma$. The wage in the standard model responds to the unemployment value, while the credible bargaining model lacks this response.

3 Calibration, Functional Forms, and Properties

3.1 The standard model

We measure time in months and calibrate to a separation rate of 3 percent per month and an unemployment rate of 5.5 percent. These imply a job-finding rate of 52 percent per month. We take the vacancy/unemployment ratio, θ to be 2. We normalize Z to 1 at the calibration point. We take the discount rate to be $r = 0.05/12$. We take the flow value of unemployment compensation and leisure to be $\lambda = 0.4(r+s)$, 40 percent of flow productivity. 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 $c = 0.036$, about a month of wages.

We take the job-finding function to be

$$\phi(\theta) = \phi_0 \theta^{0.5}, \tag{13}$$

so the recruiting rate function is

$$\rho(\theta) = \phi_0 \theta^{-0.5}. \tag{14}$$

We calibrate the efficiency parameter ϕ_0 to the job-finding rate and vacancy/unemployment ratio.

At the calibrated equilibrium, the wage is $W = 0.965$ and the job-seeker's value while unemployed is $U = 7.61$.

Figure 1 shows the determination of the equilibrium in the standard model in a diagram with the vacancy/unemployment ratio, θ, on the horizontal axis and the wage, W, on the vertical. The downward-sloping curve depicts values that satisfy equation (5), where firms earn zero profits from hiring. The upward-sloping curve describes the equilibrium of the rest of the model, including the Nash bargain for the wage. The equilibrium is stable in the following sense: When the vacancy/unemployment ratio is below the equilibrium, the wage determined in the model leaves hiring profits for employers. As they expand hiring, they raise the vacancy/unemployment ratio and move the labor market toward equilibrium.

3.2 The credible wage bargaining model

We calibrate the new model so that it replicates the equilibrium of the standard model. This calibration requires that $\Omega + \Gamma$ in the new model have the value that U had in the calibration of the standard model. In this case, equation (12) in the new model replicates equation (7) in the standard model. Because the two models share all of the other equations, their equilibria will be the same at the point of the calibration.

Recall that $\Omega + \Gamma$ is the net bias toward the worker in the bargaining process. The bias needs to be substantial for the model to describe a realistic equilibrium in the labor market. If the only source of the bias were the perpetuity value of the leisure and benefits from

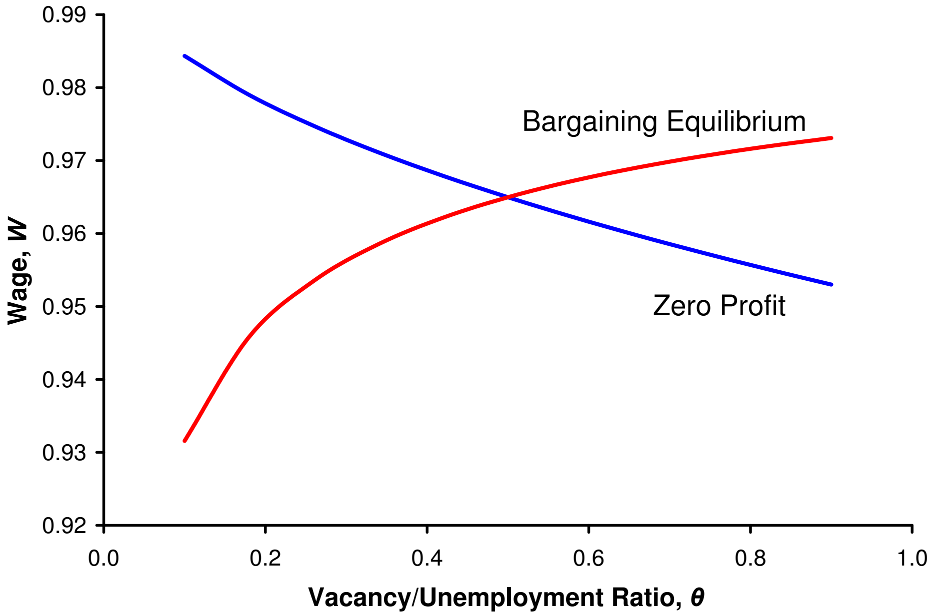

Figure 1. Determination of the Wage in the Standard Model

non-work, λ/r, the net bias would be quite a bit smaller, 43 percent of the calibrated value of $\Omega + \Gamma$. We assume implicitly that the job-seeker enjoys an extra benefit from bargaining rather than searching and that the employer incurs a cost during bargaining, with the two summing to the remaining 57 percent of $\Omega + \Gamma$. A specification described in a later section implies a much lower value of the net bias.

Figure 2 shows the equilibrium of the credible-bargaining model in the same framework as Figure 1. Notice that the zero-profit curve is the same as in the standard model. The bargaining-equilibrium curve is quite different—it slopes downward. This illustrates the point that—thanks to the influence of the outside labor market through the subsequent career value V—across stationary states, market conditions and the wage have a negative relation in the credible-bargaining model.

The figure shows two equilibria, one stable and the other unstable. The stable equilibrium is at the calibration point, with a job-finding rate of 52 percent per month. In the

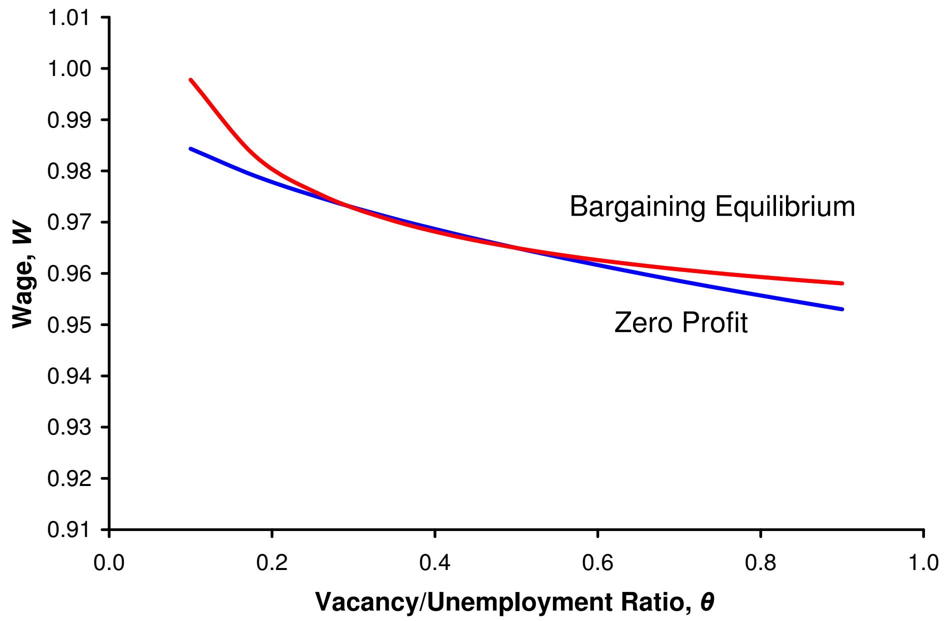

Figure 2. Determination of the Wage in the New Bargaining Model

calibration, the model is close to the point of non-existence of an equilibrium, where the two curves do not intersect. In a later section, we modify the model to reduce the negative slope of the search-equilibrium curve. That version of the model has a single equilibrium and is not close to the point of non-existence of equilibrium.

3.3 Responses to changes in productivity

To describe the model's response to changes in productivity, we need to consider how the bargaining bias, $\Omega + \Gamma$, responds to those changes. If the bias comes from the role of produced goods in delay costs and benefits, then, with all quantities measured in terms of goods, $\Omega + \Gamma$ will not change. On the other hand, if the delay costs and benefits are from the value of time of the players, then $\Omega + \Gamma$ will rise with productivity. We assume that both factors operate and take the elasticity of $\Omega + \Gamma$ with respect to Z to be 0.5.

Figure 3 shows the stationary unemployment rates as functions of a productivity shift.

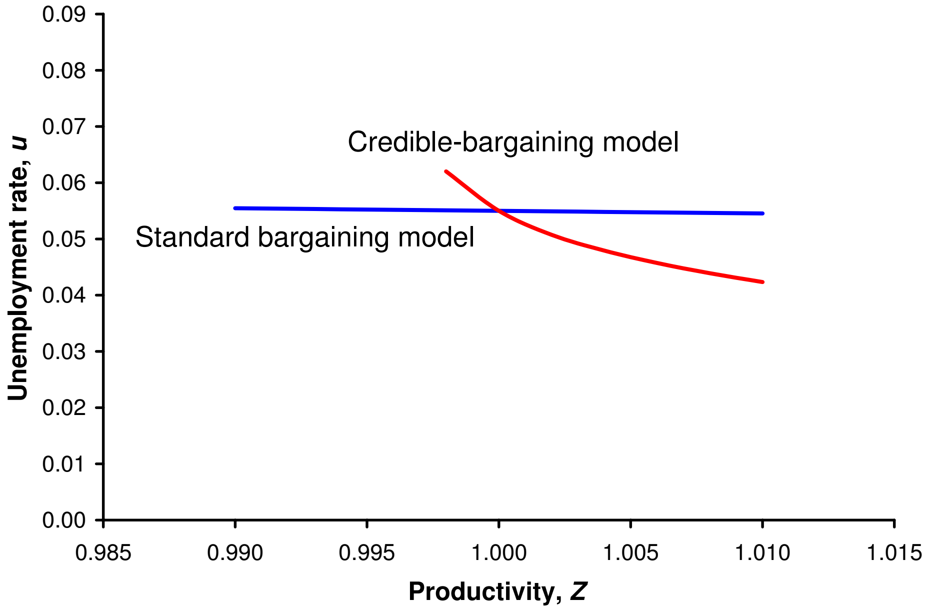

Figure 3. Effects of Productivity Shift in Standard and Credible Bargaining Models

Unemployment is vastly more sensitive to productivity in the credible-bargaining model. The model cannot generate an unemployment rate above 6.2 percent, however, because no equilibrium exists for values of Z below the critical level of 0.998. Again, this property of the model goes away in a version of the model with more wage flexibility.

4 Connecting the Wage to Unemployment in the Credible-Bargaining Framework

The extreme features of the model just developed arise from its assumption that bargaining takes place without reference to any possibility that the job-seeker might not work for the employer. Once a job-seeker and an employer encounter one another, the costs and benefits of delay in bargaining govern the wage, not the payoff to the job-seeker if no bargain occurs.

A variety of assumptions about matching and wage determination can overturn this stark property. In an earlier version of this paper, we considered the implications of a matching process where two or more job-seekers might encounter the same job opening in the same period. In the resulting three-way bargain, we assumed that the employer could induce Bertrand competition among the applicants, so that the employer captured all of the surplus. One of the applicants gets the job and the others return to search. Because the frequency of multiple applicants is higher in a slack labor market, the low Bertrand wage occurs more frequently. In that way, the average wage is linked to unemployment in this model, in contrast to the basic credible-bargaining model. The response of unemployment to changes in productivity is correspondingly smaller, because the wage has a larger equilibrating role than in the strict credible-bargaining model.

Another link from labor-market conditions to the wage arises when one job-seeker may meet more than one employer in the same period. In that case, an employer might suffer from Bertrand competition with another employer and the job-seeker would capture the entire surplus. This situation would occur more frequently in tight markets, so the resulting model would have more wage flexibility than our original bargaining model with isolation of the wage from labor-market conditions.

Yet another model could combine both features and thereby enjoy an increased resemblance to the labor market of the real world, where job-seekers compete with fellow job-seekers for the same opening and employers compete with other employers for the same prospective worker. With the addition of heterogeneity of job-seekers and jobs, the model would begin to approach realism.

Because the main purpose of this paper is to point out the importance of a view of wage bargaining based on credible threats, we do not pursue the more complex and realistic setup. In this section, we consider just one additional element. An important feature of the earlier models is that the parties believe that the only event that will end bargaining is agreement. In our second model, we follow BRW in positing a hazard δ that the production opportunity underlying the potential match will disappear. In that case, the job-seeker returns to search with payoff U and the employer has a payoff of zero.

In this setup, the equations governing the equilibrium are

$$W + V = \omega\tau + e^{-r\tau}\left[\left(1 - e^{-\delta\tau}\right)U + e^{-\delta\tau}\left(W' + V\right)\right] \tag{15}$$

and

$$Z - W' = -\gamma\tau + e^{-(r+\delta)\tau}\left(Z - W\right). \tag{16}$$

Solving and taking the limit as before, we find

$$W = \frac{1}{2}\left(\frac{\omega + \gamma}{r + \delta} + Z + \frac{\delta}{r + \delta}U - V\right). \tag{17}$$

Now the unemployment value U appears in the formula for the wage bargain, indexed by the hazard δ. Notice that this specification nests the standard Nash-bargain model, which occurs when $\delta \to \infty$. In the BRW framework, the Nash outcome occurs, with bargaining controlled by outside options, when the parties have only an instant to make their bargain.

A more elaborate and realistic model could incorporate the possibility that the match disappears either because the employer locates another worker for this job (leading to payoffs of $Z - W$ and U), or because the worker locates another job (leading to payoffs of 0 and $W + V$) and that the associated hazard rates may depend on other aspects of the environment, including conditions θ in the labor market. These variations also connect the wage to U and θ, but, for simplicity, we adopt the model described above for our calibration exercise.

Figure 4 shows the equilibrium in the modified model in the same format as Figures 1 and 2, with the hazard δ taken to be one percent per month. The bargaining-equilibrium curve remains downward-sloping, but now the model has equilibria for a larger region of values of Z below one. Lower values of Z shift the zero-profit curve down relative to the bargaining-equilibrium curve.

Figure 5 shows the response of unemployment to productivity in this and the standard and full-isolation models. The response is weaker than in the model with full isolation, but substantially stronger than in the standard model.

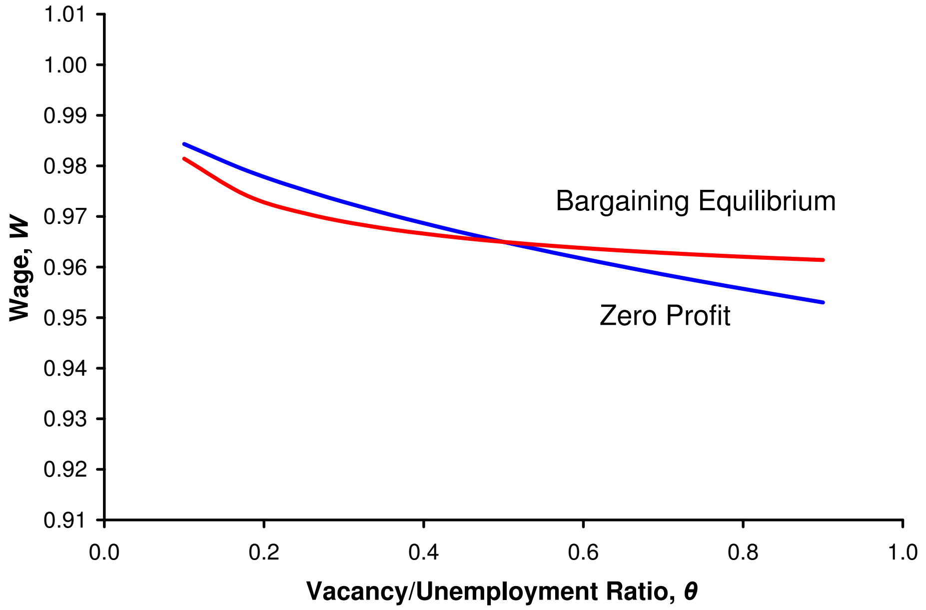

Figure 4. Determination of the wage with partial isolation

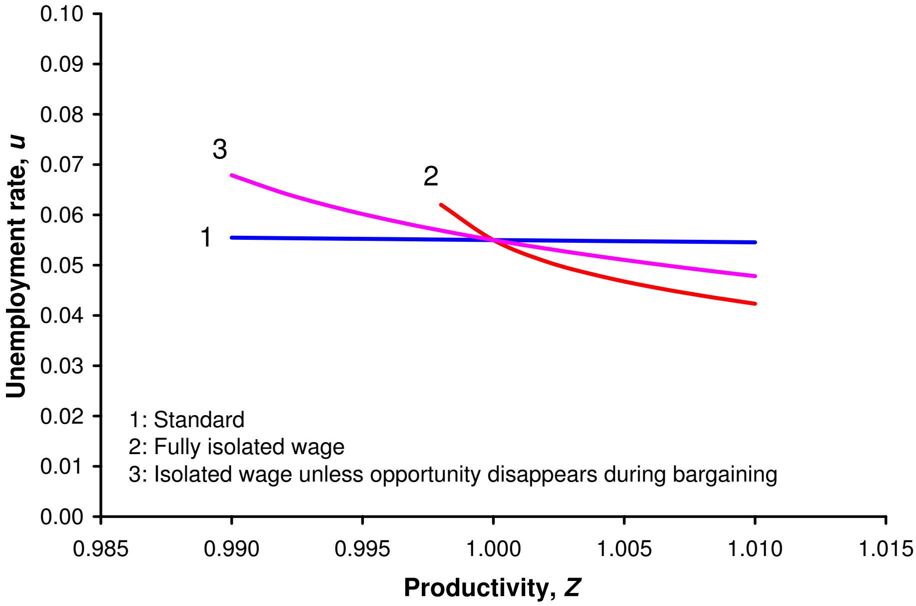

Figure 5. Responses of unemployment to productivity in the three models

Model	*du/dZ*	*dW/dZ*
Standard	-0.05	0.97
Fully isolated wage	-3.51	-1.26
Isolated wage unless opportunity disappears during bargaining	-0.89	0.39

Table 1. Responses of unemployment and the wage to productivity in the three models

Table 1 gives the responses of unemployment and the wage to changes in productivity for each of the three models. In the standard model, the wage moves almost point-for-point with productivity. Productivity enters the wage directly with coefficient 1/2 and indirectly through the unemployment value, U, with a further effect of 0.47. Unemployment hardly responds at all. In the model with the fully isolated wage, the wage falls by 1.26 for a unit increase in productivity, as the negative effect of the increase in the subsequent career value V swamps the direct positive effect of productivity. The unemployment response is correspondingly strong—3.5 percentage points of decreased unemployment per percent change in productivity. The model with partially isolated wage puts the response of the wage to productivity, dW/dZ, at 0.39. The response of unemployment is negative, at 0.89 percentage point of reduced unemployment per percentage point of productivity.

5 Further Implications of the Isolation of Wage Bargaining from Unemployment

So far we have focused on the response of unemployment to changes in productivity, following the literature launched by Shimer (2005). But the credible-bargaining model has important implications for changes in other aspects of the environment. The most important is the response in the labor market to changes in the discount rate.

5.1 Responses to changes in the discount rate

Here we take changes in r to be exogenous, but in a later section, we will treat the discount rate as an endogenous variable that responds to exogenous changes in product demand. In this analysis, it is important to recall that $\Omega = \omega/r$ and $\Gamma = \gamma/r$. In addition, we make the role of r in the present value of productivity, Z, explicit:

$$Z = \frac{z}{e^r - 1 + s}; \tag{18}$$

recall that s is the separation hazard. Here z is the exogenous flow productivity.

To explain the effects of changes in the discount rate, we rewrite equation (17) in terms of the employer's part of the surplus,

$$Z - W = \frac{1}{2}\left(Z - \frac{\omega + \gamma}{r + \delta} - \frac{\delta}{r + \delta}U + V\right) \tag{19}$$

We may interpret this equation as applying to a non-stationary world to describe the result of the bargaining that takes place today. With that interpretation, r designates the current short-term interest rate and the component $\frac{\omega+\gamma}{r+\delta}$ depends only on that rate, but Z depends on interest rates about three years forward and V depends on rates forward over the job-seeker's entire career. And $\frac{\delta}{r+\delta}U$ depends on the current rate and on long forward rates, acting in opposite directions.

Our general-equilibrium model, to be presented shortly, includes a complete analysis of the effects of an exogenous shock—such as an increase in government purchases—on the term structure. The effects are concentrated at the short end. The positive effects operating through $-\frac{\omega+\gamma+\delta U}{r+\delta}$ outweigh the negative effects operating through $Z + V$ for intermediate values of the hazard, δ. For both $\delta = 0$ (the fully isolated credible bargaining model) and $\delta = \infty$ (the standard Nash-bargain model), the effects of spending shocks are weak or in the other direction.

	Determinant	*Standard model*	*Credible-bargaining model, δ=.01*
φ_0	Efficiency of matching	-1.00	-3.14
s	Separation rate	0.26	-24.56
λ	Flow value during search	0.34	-0.47
c	Flow cost of vacancy	0.50	1.57

Table 2. Elasticities of the Responses of the Standard and Partial-Isolation Models to Changes in Parameters

5.2 Responses to other determinants

Table 2 shows responses in the forms of elasticities of unemployment for a number of other determinants. The first line shows the elasticities of unemployment with respect to ϕ_0, the efficiency of the matching function. Higher matching efficiency lowers unemployment in both models, but the effect is more than three times stronger in the credible-bargaining model. The second line shows the effects of changes in the separation rate. A higher rate raises unemployment in the standard model, but lowers unemployment dramatically in the credible-bargaining model. The reason is that a higher separation rate raises the future career value V, which lowers the wage and tightens the labor market. This effect overwhelms the direct effect of higher separations on unemployment.

The third line of the table shows the effect of a higher flow value of non-work, λ. In the standard model, the result is higher unemployment, because the higher λ raises U and thus raises the value of the job-seeker's threat point in the Nash bargain. In the credible-bargaining model, by contrast, the result is lower unemployment, because higher λ raises V and makes waiting during bargaining more costly to the job-seeker.

The fourth line of the table shows the effect of a higher flow cost of maintaining a vacancy, c. In both cases, unemployment rises, because more costly vacancies require a higher recruiting rate to satisfy the zero-profit condition, and this implies a slacker market. The effect is substantially stronger when the wage is partially isolated, because feedback through unemployment to a lower wage in the standard model limits the required increase in the recruiting rate. This feedback is absent in the credible-bargaining model.

6 Credible Bargaining in General Equilibrium

Hall (2005c) develops a general-equilibrium stochastic growth model suitable for studying the implications of alternative models of wage setting. The framework is particularly helpful for understanding the implications of the new credible-bargaining model, because it supplies values for the subsequent career value, V, that are consistent with realistic assumptions about the economy's response to shocks.

In the GE model, the economy fluctuates because of two shocks, one to productivity and the other to exogenous product demand—government purchases plus net exports. The magnitude and time-series properties for the shocks mimic U.S. data for the past 50 years. The model has a single production sector with a Cobb-Douglas technology. Long-lived households make consumption decisions with a standard Euler equation. Investment is subject to moderate adjustment costs. Labor-force participation is inelastic. Hours of work for employed workers do not vary. Variations in employment come entirely from variations in unemployment.

We consider two versions of the model. In the first, the labor market operates according to the standard principles of the Mortensen-Pissarides tradition—worker and employer make a Nash wage bargain with their outside options as threat points. In the second, the wage bargain follows the principles of this paper, with credible threat points.

In the GE setting, we need to revisit the question of the costs and benefits of delay, to link them to variables in the stochastic growth model. The stochastic-growth GE framework does not permit these costs and benefits to be constant in terms of output, because the upward trend in productivity makes any such cost or benefit disappear in relative terms as time goes by. The stochastic growth model is stationary in variables that are stated as ratios to the capital stock. Capital grows along with productivity. Thus our delay costs and benefits need to grow along with the capital stock. We do have a choice between making them constant in relation to capital or linking them to the marginal product of labor, which itself grows in proportion to the capital stock in the longer run. In the short run, the marginal product of labor responds immediately to a surprise in productivity, while the capital stock adjusts over time to the surprise. As before, we split the difference by having the net bias in bargaining respond to the capital stock with an elasticity of one half and to the marginal product of labor with an elasticity of one half.

The economy offers households two vehicles for saving. One is installed capital. The other is a one-quarter debt instrument, with zero net supply. The instrument pays off in units of output in proportion to the net bias in bargaining. We include this debt instrument so that we can calculate the short-term interest rate r, taking proper account of risk.

We need to calibrate the hazard δ that bargaining will be terminated by the worker finding another job. We do so by finding the value of δ that approximately matches the observed volatility of unemployment. Higher values of δ connect the wage more powerfully to productivity and thus result in diminished volatility of unemployment. The calibrated value is $\delta = 1.3$, which implies a likelihood of one-half that bargaining will be terminated within 2.3 weeks.

At the calibrated value of δ, the value of the flow bargaining bias, $\omega + \gamma$, calculated as earlier to match the wage from the standard model at the non-stochastic stationary point, is 0.27. By comparison, the model assumes that the flow value of unemployment is 0.3 and flow productivity is 1.0. Whereas the credible-bargaining model with full isolation relies on an unreasonably high value of the bias, the partial-isolation model with $\delta = 1.3$ corresponds to a fully reasonable value of the bias, in which, for example, bargaining has no cost to the employer and pays off to the job-seeker at a flow somewhat below the flow

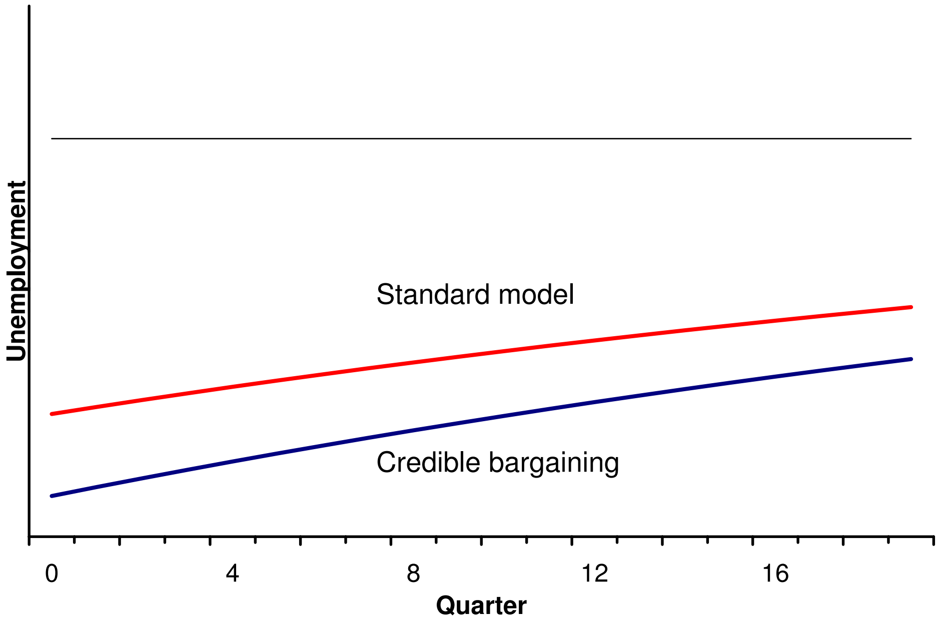

Figure 6. Responses of Two Models to a Productivity Impulse

benefit of unemployment.

Further details about the construction and solution of the model appear in Hall (2005c). Figures 6 and 7 display the differences between the standard model and the credible-bargaining model. Figure 6 shows the responses of unemployment in the two models to a productivity impulse. The response is greater in the credible-bargaining model, but both responses are actually quite small, in line with Shimer (2005)'s finding.

Figure 7 shows the responses of unemployment in the two models to an impulse in exogenous product demand. In the standard model, the response is always small, but grows slowly over time. The increase in product demand is highly persistent, though it ultimately shrinks to zero. Consumption smoothing results in a depletion of the capital stock that continues over the period shown in the figure. The marginal product of labor rises as a ratio to the capital stock, which stimulates recruiting effort slightly and lowers unemployment slightly.

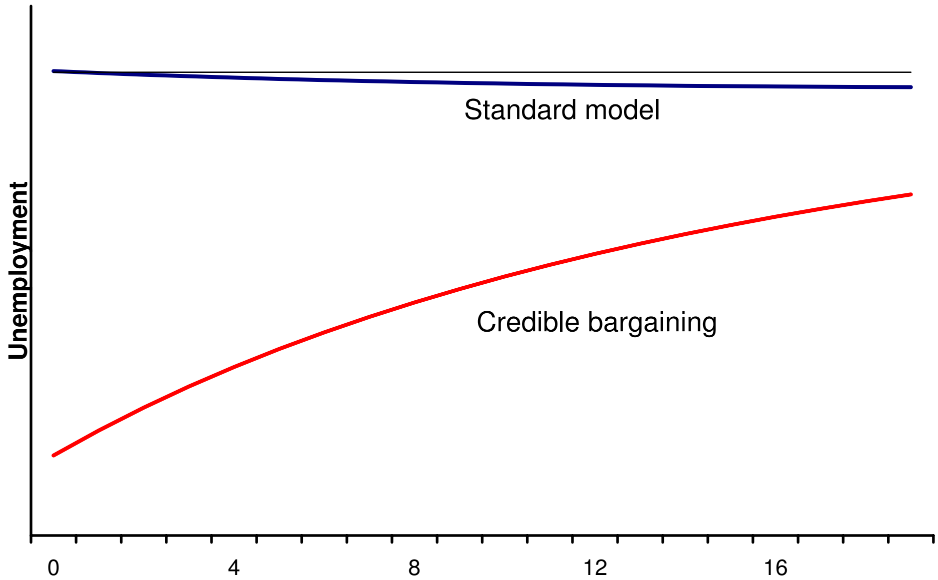

Figure 7. Responses of Two Models to an Impulse in Exogenous Product Demand

On the other hand, Figure 7 shows that the response of unemployment in the model with credible wage bargaining is vastly stronger but more transitory. We explained this response earlier. The demand expansion drives up the discount rate r in the short run but not in the long run, so the upward effect on r overpowers the downward effect on the forward discounted components. Hence the demand expansion leaves more of the surplus for employers, who then put more resources into recruiting. The labor market tightens. This effect lasts only as long as the short-term interest rate is elevated, which is much briefer than the period of depleted capital that derives unemployment dynamics in the standard model.

The comparison of Figures 6 and 7 shows that most of the volatility of unemployment in the GE model with credible bargaining arises from the product-demand shock rather than from the productivity shock. If the model lacked the demand shock, unemployment volatility, from Figure 6, would be only about 20 percent higher than in the standard model, where it is very low.

Standard deviations	*Actual*	*Standard model*	*Credible threats in wage bargaining, δ = 1.3*
Consumption growth	0.85	0.98	1.00
Investment/capital ratio	0.22	0.23	0.22
Log of capacity/capital ratio	4.43	4.84	4.83
Unemployment	1.53	0.22	1.54

Table 3. Volatilities of Key Macro Variables Implied by Two Models
Consumption and investment measured at quarterly rates

Table 3 shows the standard deviations of the key macro variables implied by the standard and credible-bargaining models. Both models predict similar standard deviations for consumption, the investment/capital ratio, and the log of the capacity/capital ratio (capacity is defined as the level of output if unemployment were zero). Both models somewhat overstate the volatilities of consumption growth and capacity/capital and match the volatility of the investment/capital ratio. The standard model grossly understates the volatility of unemployment, whereas the model with credible bargaining, thanks to the calibration of δ, matches it almost exactly.

7 Concluding Remarks

We have pointed out a paradox in the theory of the labor market—in the bargaining problem of a job-seeker and and employer, if both parties are limited to credible threats, conditions in the outside market are irrelevant to the wage bargain. In particular, the unemployment rate does not influence the wage. As in many other macro models, the stickiness of the wage implies high sensitivity of unemployment to driving forces, such as productivity.

We do not believe that wages are completely isolated from unemployment and other aspects of the outside labor market. Our second model demonstrates a plausible link that restores some connection between wages and unemployment, but still implies higher sensitivity of unemployment to driving forces, because the wage response is limited.

Our model has striking implications for macro fluctuations. In a realistic calibration, most of the movement of unemployment comes from changes in government purchases and other exogenous shifts in product demand rather than from shocks to productivity. Although our model of wage rigidity is rather distant from Keynesian nominal wage rigidity, the important role given to shifts in product demand is similar.

Future models of the wage-bargaining process, in our view, should respect the principle that the threats in bargaining need to be credible. Progress will be made by creating realistic models of the interplay among job-seekers and employers. In actual labor markets, job-seekers think simultaneously about a variety of possible jobs and employers consider multiple applicants for a given job. The final bargain is often bilateral, where the employer bargains with the best-matched applicant. A model richer than any in this paper will be needed to understand the operation of the market more fully.

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